Western Copper Corporation

2009 ANNUAL QUARTZ MINING LICENCE REPORT

Submitted to Yukon Government, Energy Mines and Resources

Yukon Quartz Mining Licence QML-0007

March 2010

Prepared for Carmacks Copper Ltd.

Prepared by:

ACCESS CONSULTING GROUP

www.accessconsulting.ca

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Carmacks Copper Project, Yukon Territory

Submitted by:

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EXECUTIVE SUMMARY

Activities at the mine site during the period 1 January 2009 to 31 December 2009 have been limited as Carmacks Copper Ltd's efforts focused on procuring licenses. The most notable site activities were four water quality sampling visits, the Annual Engineer's Inspection and the maintenance work that was undertaken in response to that inspection. Copies of the associated reports have been attached to this report. No exploration activities were undertaken in 2009 and no development activities.

Two plans were approved by the Chief of Mining Land Use during the year; the Preliminary Reclamation and Closure Plan (May 2009) and the Stage 1 Construction Site Plan (October 2008). A Contingency Plan as required by the QML was prepared in 2009 and submitted in January 2010.

Three laboratory tests were in progress in 2009, a large column rinsing test, a kinetic test on leached ore and a test on liner material samples. The kinetic testing was concluded in early 2010 and report included herewith.

Security in the amount of $80,300 has been posted with Yukon against the liability incurred to date as a result of exploration activities.

This report has been formatted to respond to the specific requirements in the QML even though there has been no activity in some of those areas. It is expected that this report will also serve as the annual report to the Yukon Water Board in future years and additions to the scope of the report will be required.

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1.0 INTRODUCTION

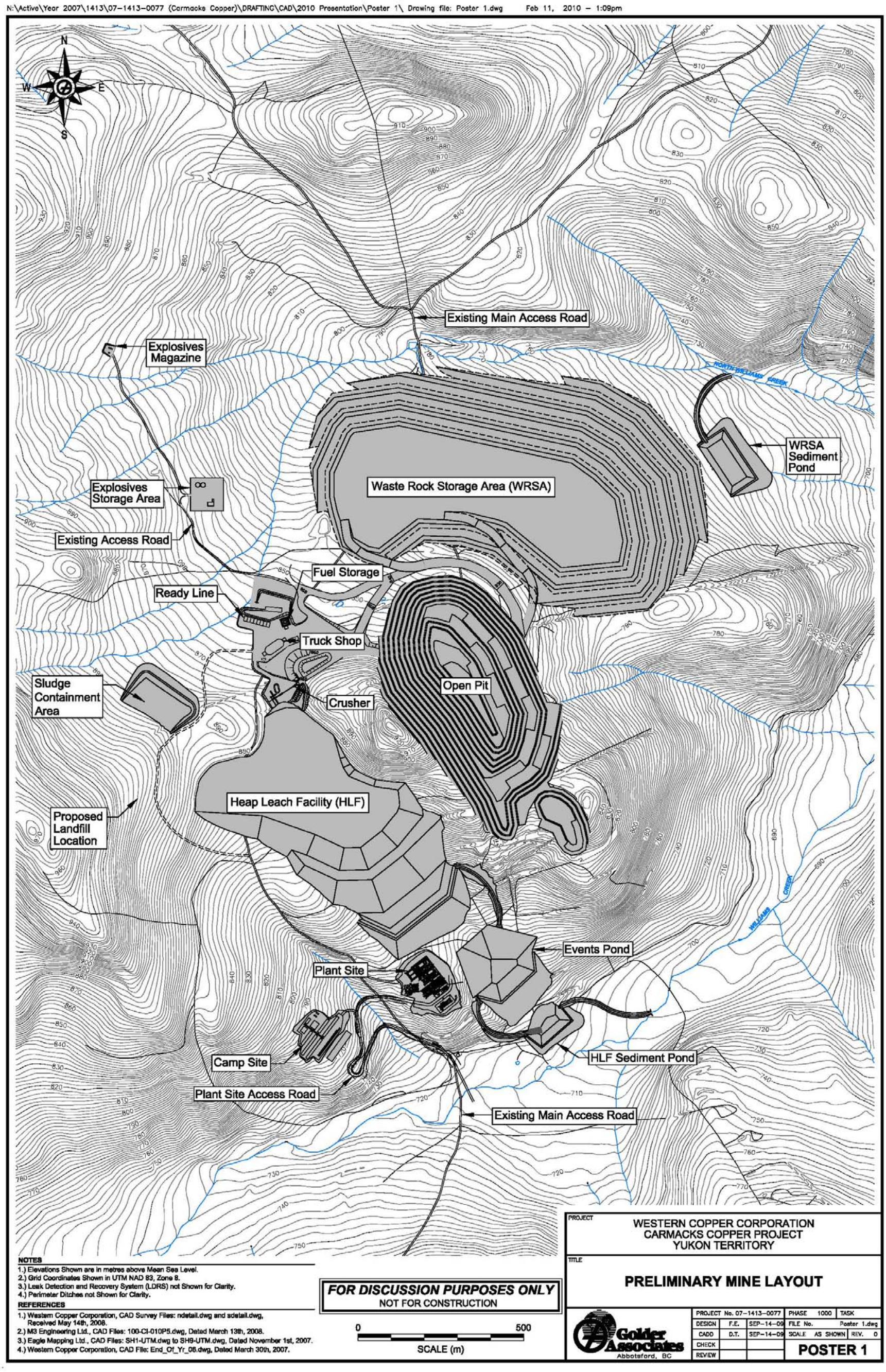
This Annual Report has been prepared for Carmacks Copper Ltd. (CCL) and covers the period from 1 January, 2009 to 31 December, 2009 as required by Clauses 16.5 and 16.6 of Quartz Mining Licence (QML) QML-0007. This report provides a summary of activities at the Carmacks Property for the reporting year, including but not limited to: physical stability inspection and minor maintenance activities, and surface and groundwater water quality monitoring.

As indicated in the Executive Summary, the project was largely in the permitting/licensing phase in 2009, with activities centered around the QML and Water Use Licence (WUL) applications. As such, few activities occurred that will normally form a part of this report in future years once a WUL has been issued. The report has been structured to accommodate reporting on these other aspects of work where such requirements are known. Additional sections and information will be added as necessary to accommodate expanded reporting requirements that may develop from future mine development and related plans.

It is intended that this annual report will ultimately also be issued to the Yukon Water Board to satisfy reporting requirements of a Type A WUL. This will likely require that further sections be incorporated when the specific terms of the WUL are made known.

The preliminary mine layout is illustrated in Figure 1.

Figure 1. Preliminary Mine Layout



2.0 SITE ACTIVITIES

2.1 EXPLORATION

No exploration activities occurred during the 2009 reporting period. BC Gold Corp. used the Carmacks Copper exploration camp and facilities from June to September as a base for exploration work on their adjacent property.

2.2 CONSTRUCTION AND DEVELOPMENT

2.2.1 Overview of Activities by Quarter

No construction or development activities occurred on the property in 2009.

2.2.2 As built drawings

No “as-built” drawings were produced in 2009.

2.3 MINING ACTIVITIES

2.3.1 Overview of Activities by Quarter

No mining activities took place in 2009.

2.3.2 Production Schedule – Ore and Waste Removal

Not applicable for this reporting period; no mining activities took place in 2009.

2.3.3 Average Head Grades

Not applicable for this reporting period; no mining activities took place in 2009.

2.3.4 Open Pit Stability

Not applicable for this reporting period; no mining activities took place in 2009.

2.3.5 Heap Leach Cells – Status of Leaching (including layout drawing)

Not applicable for this reporting period; no mining activities took place in 2009.

2.3.6 Copper Production

Not applicable for this reporting period; no mining activities took place in 2009.

2.3.7 Spills

No spills occurred during the reporting period.

2.3.8 On-going Reclamation

No reclamation activities occurred during the reporting period.

2.3.9 Actions Undertaken in Response to Annual Engineer's Inspection

On 8th and 9th September, in response to the August 13th annual Engineer's Inspection (see Section 3.11), a small crew was mobilized to site to implement an erosion and sediment control program to minimize the potential for sediment release from the project site during the following year's spring freshet and summer rains. The work consisted largely of silt fence installation, sediment basin excavation and repair, regrading of roads and ditches to redirect run-off and the placement of sand bags to control erosion. Some seeding was done in selected areas with a view to establishing vegetation for improved run-off control.

These measures were not intended as a long term solution to erosion control and will require inspection and possibly maintenance after the 2010 freshet.

A full report prepared by the engineer in attendance is included in Appendix A. This report has been previously submitted to the Chief of Mining Land Use.

2.3.10 Access Road

The access road to the site has not been constructed; however, some maintenance work was undertaken on the existing access route and site roads.

2.4 RESOURCES AND RESERVES

The resource and reserve estimates (Tables 1 and 2 respectively) for the property both remain as stated in the "Feasibility Study" prepared in 2007:

Table 1. Water Mineral Resources at 0.25% Total Copper Cut-Off

Rock Group	Grade Group	Density (t/m^3)	Tonnage t (000)	Cu (%)	CuX (%)	CuS (%)	Au (g/t)	Ag (g/t)	Class
Oxide	Meas	2.680	3,288	1.23	1.03	0.20	0.652	6.135	1
	Ind	2.680	7,084	1.09	0.93	0.16	0.458	4.382	2
	Meas+Ind	2.680	10,372	1.13	0.96	0.17	0.519	4.938	
	Inf	2.684	82	0.82	0.62	0.21	0.207	1.502	3
Sulphide	Meas	2.710	1,256	0.72	0.04	0.67	0.227	2.398	1
	Ind	2.710	4,399	0.78	0.06	0.72	0.227	2.200	2
	Meas+Ind	2.710	5,655	0.77	0.05	0.71	0.227	2.244	
	Inf	2.710	3,161	0.69	0.07	0.62	0.180	1.644	3

Table 2. Mineral Reserve

Reserve Class	Ore t (000)	Total Cu (%)	Cu Oxide (%)	Cu Non-Oxide (%)	Au (g/t)	Ag (g/t)
Proven Mineral Reserve	3,190	1.227	1.028	0.199	0.659	6.20
Probable Mineral Reserve						
Open Pit Ore	6,462	1.099	0.938	0.162	0.466	4.49
Estimated Dilution	960	0.065	0.043	0.021	0.018	0.20
Total Probable Mineral Reserve	7,422	0.965	0.822	0.144	0.408	3.93
Proven and Probable Mineral Reserve	10,611	1.044	0.884	0.160	0.483	4.62

2.5 CARE AND MAINTENANCE

No activities to report.

2.6 PROPOSED DEVELOPMENT AND PRODUCTION FOR UPCOMING YEAR

There are presently no development or production plans for the 2010 year.

3.0 MONITORING PROGRAMS AND STUDIES

The QML contains a number of requirements for studies and monitoring programs. The following sections outline the work done in respect of these studies and programs. Copies of the actual reports relating to these are appended.

3.1 ON-GOING METALLURGICAL STUDIES

3.1.1 Field Tests

No metallurgical field tests were in progress as of 2009.

3.1.2 Laboratory Tests

During 2009, one full height column test was in progress at PRA Laboratories in Richmond, B.C. At year end the test was in the final phase, representing the rinsing and neutralization of the leached ore. The test will conclude in early 2010 and a report will be issued following that. The final metallurgical report will be appended to the 2010 Annual Report.

An extended test on exposure of liner specimens to conditions similar to those in the heap is in its final year and will be concluded in May 2010. Results will be included in the 2010 Annual Report.

3.2 HEAP LEACH PAD LINER PERFORMANCE MONITORING

No liner has been placed and no performance monitoring is in progress.

3.3 WATER QUALITY SURVEILLANCE PROGRAM

During 2009, four separate site visits were made for the purpose of collecting water quality data. These visits took place on the following dates:

May 20th – 21st

July 10th – 12th

September 8th – 10th

October 15th – 16th

The following table lists the locations (shown on Figure 2) that have been established for the routine monitoring of water quality to date. Further locations will be added as the mine is brought into production.

Table 3. Water Quality Surveillance Program Site Descriptions and Locations

Station	Description	Northing	Easting
W2	Williams Creek Upstream of North Williams Creek Confluence	6914145	413499
W3	Lower North Williams Creek Upstream of Confluence with Williams Creek	6914379	413640
W4	Williams Creek Downstream of Confluence with North Williams Creek	6914653	413888
W5	South East Tributary to Williams Creek	6912947	412978
W6	Williams Creek Downstream of South East Tributary	6913373	413042
W7	Upper North Williams Creek Tributary Upstream of Road Crossing	6914810	411778
W9	Williams Creek Upstream of Access Road Crossing	6912511	411907
W10	Williams Creek Upstream of Yukon River	6919033	416606
W11	Nancy Lee Creek (Tributary of Williams Creek)	6918096	415803
W12	Williams Creek Downstream of Confluence with Nancy Lee Creek	6918000	416102
W13	Williams Creek Upstream of Confluence with Nancy Lee Creek	6917984	415912
Y1*	Yukon River Upstream of Williams Creek	6918974	416752
Y2*	Yukon River Downstream of Williams Creek	6919308	416249

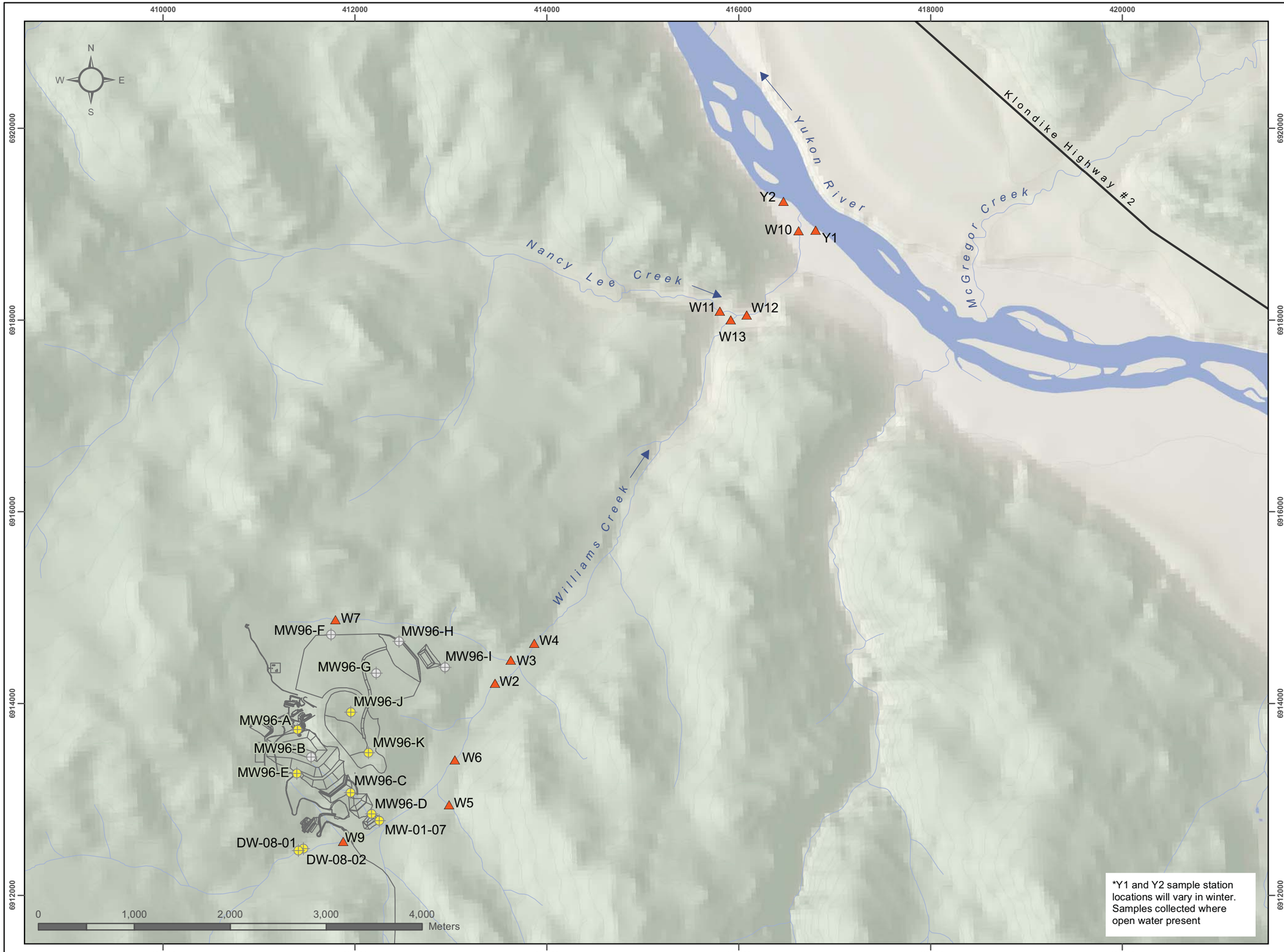
Notes: Coordinates are UTM Zone 8 NAD83

* Yukon River open water sample station locations; during freezing conditions samples collected where open water available.

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*Y1 and Y2 sample station locations will vary in winter. Samples collected where open water present

- Actively Monitored Well
- Inactive Well
- Surface Water Monitoring Station
- Contour
- Watercourse
- Waterbody

Datum: NAD83; Projection: UTM Zone 8N

National Topographic Data Base (NTDB) compiled by Natural Resources Canada at a scale of 1:50,000. Cadastral data compiled by Natural Resources Canada. Reproduced under license from © Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

FIGURE 2

MONITORING STATION LOCATIONS

ACCESS CONSULTING GROUP

Drawn by MD | MARCH 2010 | Checked by NS

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3.3.1 Surface Water Quality

Surface water quality sampling was conducted during the four site visits in 2009. The reader is referred to the Environmental Monitoring Update and Data Summary – Revision 5, included in Appendix B for details of the 2009 sampling and results.

3.3.2 Groundwater Quality

As for the surface water quality sampling, groundwater monitoring was also conducted during each of the year's site visits. The reader is referred to Appendix B for details of the sampling and the results.

3.4 HYDROGEOLOGY STUDIES

A revised hydrogeologic assessment was carried out as a result of new information and to provide additional input to the engineering designs for the project. Modelling takes the open pit into consideration both during operations and at closure, as well as the operation of two water supply wells, and the design of the Heap Leach Facility. Conclusions from the assessment of hydrogeological conditions during operation and closure are found in the report provided in Appendix C.

3.5 WATER TREATMENT AND MANAGEMENT

No water treatment studies or water management studies were required or conducted in 2009.

3.6 CLIMATE DATA AND SNOW SURVEY MONITORING PROGRAM

Climate data from the meteorological station maintained by Yukon Government close to the property was not available for the year 2009 due to an equipment malfunction. Carmacks Copper plans to install and maintain its own climate monitoring station at the site once a decision to proceed with construction has been made. Refer to Appendix B for the latest Yukon Government survey results at the Williams Creek snow course station.

An updated analysis of precipitation to account for recent available climate data was conducted in October 2009 and reported in the Site Water Balance Update, located in Appendix D. Meteorological data used to complete the Site Water Balance Update is presented in the Williams Creek Site Hydrology Update prepared in November 2009 (Appendix E).

3.7 GEOCHEMICAL STUDIES AND ACID-BASE ACCOUNTING

Kinetic testing (humidity cells) of three leached ore samples was also in progress during 2009. The tests which were being conducted by Golder Associates of Burnaby, B.C. concluded in early 2010 and the report is attached as Appendix F to this Annual Report.

3.8 PHYSICAL MONITORING PROGRAM

No physical monitoring of structures and facilities at the site took place in 2009 besides that described below in Section 3.11. However, a thermal analysis for the waste rock storage area was conducted in September 2009 in support of the preliminary design and to assist in an evaluation of the stability of the waste rock storage area. Thermal models and results are provided in Appendix G.

3.9 ENGINEER'S ANNUAL PHYSICAL INSPECTION REPORTS

As required under Section 16.1 and 16.2 of the QML, Carmacks Copper Ltd. engaged Golder Associates Ltd. to perform an Annual Physical Inspection of the site. Due to scheduling conflicts within Golder, the inspection could not be carried out by 1st August (Section 16.1). Carmacks Copper Ltd. sought and obtained permission from the Chief of Mining Land Use to delay the inspection to 13th August. The complete report is contained in Appendix H. This report has been previously submitted to the Chief of Mining Land Use.

Since no development has taken place on site, the report focused largely on the exploration camp area and drainage and soil stability issues that had been disturbed during exploration activities in previous years.

The report contained a number of recommendations, all of which were acted upon as described in Section 2.3.9.

3.10 RECLAMATION AND REVEGETATION STUDIES

In 2007 a test patch of seeding was completed on an approximately 500 m x 12 m area adjacent (west) to the access road south of the Williams Creek crossing and the helicopter pad area. The seeding and resulting vegetation was intended to help stabilize sediments in this area and has been observed in the past two years to be performing well. The seed mixture (Table 4) was spread at density of approximately 40 kg/ha and contained the following seed varieties:

Table 4. Seed Mixture

Seed Type	Percentage
Violet Wheatgrass	38%
Sheep Fescue	25%
Fowl Bluegrass	20%
Tufted Hairgrass	18%

3.11 SUBMISSION AND APPROVAL OF PLANS

During 2008 two plans were submitted to the Chief of Mining Land Use for approval: the Stage 1 Construction Site Plan (October 2008) and Preliminary Detailed Closure and Reclamation Plan (December 2008). The Preliminary Detailed Closure and Reclamation Plan was updated and resubmitted in May 2009 in response to comments received.

Approval of the Stage 1 Construction Site Plan was issued by the Chief of Mining Land Use on 4th May, 2009 and approval of the revised Preliminary Detailed Closure and Reclamation Plan was issued on 14th May, 2009. These approved plans are now an integral part of the QML.

A Contingency Plan was prepared during the latter part of 2009 as required by Section 11.0 of the QML. This is discussed further in Section 4.4.

3.12 OTHER COMMUNICATIONS AND COMMITTEES

On January 13, 2009, prior to the issuance of the QML, the company participated in a Technical Workshop organized by YG-EMR and held in Whitehorse. The workshop was facilitated by J. Gadsby. A copy of the letter "Suggestions for Consideration on the Project" issued by the Facilitator is attached to this report as Appendix J. In the letter, two suggestions made by the facilitator were addressed to Western Copper:

- Creation of a working group with representatives of LSCFN and SFN to plan for meetings and activities to help advise WCC in addressing technical issues as they arise; and
- Establishing and maintaining a library in Whitehorse at WCC's office where paper and digital copies of all reports available on the Carmacks Copper project are made available for consultation.

Working Group:

At this time, the working group as not been formally set-up but the company is hopeful that such a group can be organized in the future. In the interim, separate briefings were held with SFN and with LSCFN to discuss the results of the 2008 Environmental Monitoring Update and Data Summary prior to 2009 environmental field monitoring activities starting. Both SFN and LSCFN were invited to participate in the various field activities. LSCFN was able to provide staff participation on two occasions. In addition, invitations were extended to LSCFN and SFN to participate in the Contingency Planning workshop held in October 2009.

Project Library:

Western Copper is maintaining a project library at its Whitehorse office where paper and electronic copies of reports are available for consultation.

4.0 OUTSTANDING FINANCIAL LIABILITY

4.1 HEAP LEACH

At present there has been no update to the assessment of the liability associated with the Heap Leach Facility which was presented in the May 2009 revision of the Preliminary Detailed Closure and Reclamation Plan.

4.2 WASTE ROCK STORAGE

There has also been no update to the assessment of the liability associated with the Waste Rock Storage Facility which was presented in the May 2009 revision of the Preliminary Detailed Closure and Reclamation Plan.

4.3 OVERALL LIABILITY

The estimated maximum overall liability associated with the development and operation of the mine remains as set out in the May 2009 revision of the Preliminary Detailed Closure and Reclamation Plan

Facility or Area Description	**Cost**	
OPEN PIT	$	23,000
HEAP LEACH FACILITY	$	17,295,000
HLF EVENTS AND SEDIMENT PONDS	$	296,000
WASTE ROCK STORAGE AREA	$	740,000
PLANT AND ANCILLARY FACILITIES	$	467,000
CAMP	$	103,000
TRUCK SHOP SERVICE COMPLEX	$	70,000
MISCELLANEOUS FACILITIES	$	95,000
ACCESS AND HAUL ROADS	$	248,000
SITE MANAGEMENT	$	1,103,000
TOTAL	$	20,440,000

An additional $2.675 million is estimated to cover costs associated with rinsing and neutralization of the heap leach facility, should it extend to a 9 year period as opposed to the initially estimated 4.5 year period.

To date security in the amount of $80,300 has been posted with Yukon Government. This represents the liability incurred to date due to exploration activities on the site.

4.4 ENGINEERING CONTINGENCIES

In accordance with Section 11.0 of the QML, Carmacks Copper Ltd. prepared a Contingency Plan on the basis of a workshop held in October 2009. The plan was submitted to the Chief of Mining Land Use in January 2010. The main purpose of the Contingency Plan was to identify possible alternative approaches to decommissioning the Heap Leach Facility however other facilities were also examined. The plan identified a number of possible failure modes and contingency measures for each of the facilities and recommended further work that should be undertaken. The report was issued in draft format pending comments from government. No further work has been undertaken at this time to develop any of the contingency plans identified.

A copy of the Contingency Plan is attached to this report as Appendix I.

5.0 CLOSING STATEMENTS

Access Consulting Group of Whitehorse, Yukon, has prepared this Annual Report on behalf of Carmacks Copper Ltd. We trust this document fulfills your present requirements. If you have any questions or require further details, please contact the undersigned.

ACCESS CONSULTING GROUP

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Environmental Scientist

David Petkovich, B.Sc.
Senior Environmental Manager

WESTERN COPPER CORP
(On behalf of CARMACKS COPPER LTD.)

Jonathan Clegg, P.Eng.
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Western Copper Corporation

2009 ANNUAL QUARTZ MINING LICENCE REPORT

SUBMITTED TO YUKON GOVERNMENT, ENERGY MINES AND RESOURCES

YUKON QUARTZ MINING LICENCE QML-0007

Appendix A

Erosion and Sediment Control Measures, September 2009

TECHNICAL MEMORANDUM

DATE October 2, 2009

PROJECT No. 07-1413-0077/7400
Doc. No. 123

TO Mr. Jonathan Clegg
Western Copper Corporation

CC John Hull, Fiona Esford

FROM Javier Ubilla

EMAIL jubilla@golder.com

EROSION AND SEDIMENT CONTROL MEASURES, SEPTEMBER 2009, CARMACKS COPPER PROJECT, YUKON TERRITORY

1.0 INTRODUCTION

This technical memorandum summarizes the work completed between September 9 and 10, 2009, at the Carmacks Copper Project site. The effort consisted of an inspection and maintenance of the work completed during September 23 to 27, 2008 (Golder, 2008).

The objective of the 2008 and 2009 work is to implement a short term strategy for erosion and sediment control, designed to minimize the potential for sediment release from the Project site to Williams Creek during the spring and summer season.

Personnel and equipment available on site included Al Serafinchon (Kluane Drilling), operator of an excavator Caterpillar 225, and Javier Ubilla (Golder Associates), field supervisor.

2.0 INSPECTION AND MAINTENANCE OF 2008 WORK

After the initial inspection of the site it was noted that the work completed during September, 2008, consisting on the construction of berms, sediment basins, as well as road re-contouring and the installation of sand bags and silt fences (Golder, 2008), was able to minimize the erosion and sediment movement in the Heap Leach area.

The performance of the measures implemented during 2008 was considered satisfactory and therefore the 2009 work mainly consisted in the maintenance of the existing elements for sediment and erosion control. However, new observations led to the implementation of additional features as described in Section 3.

Table 1 presents a summary of the results of the inspection and a brief description of the work completed. Figure 1 presents the location of each one of the sites inspected.

Table 1: Inspection and Work Completed.

Site	Inspection	Work Completed
Road 1a	Sediment basin full of sediments.	Sediment basin re-excavated.
Road 1b	Sand bags damaged in culvert area.	20 new sand bags installed to replace damaged existing sandbags.
Site 2a	Silt fence damaged.	Silt fence repaired.
Site 2b	Sediment basin full of sediments.	Sediment basin re-excavated. Upstream area seeded for erosion protection (Table 3). Spillway built with clean sand and gravel and new sandbags installed at the crest of the spillway.
Site 2c	Silt fence damaged.	New silt fence installed upstream of old silt fence providing better coverage.
Road 3a	Road drainage directed to vegetated area.	No work required.
Road 3b	Road drainage directed to vegetated area.	No work required.
Road 3c	Road drainage directed to vegetated area.	No work required.
Road 4a	Flow directed to vegetated area.	Small sediment basin excavated before entering to vegetated area.
Road 4b	Sediment basin full of sediments.	Sediment basin re-excavated.
Road 4c	Road drainage directed to vegetated area.	No work required.
Road 4d	Sediment basin full of sediments. Overflow to sediment basin 2b.	Sediment basin re-excavated to restore storage capacity.
Road 5a	Berm across road.	No work required.
Road 5b	Road drainage directed to vegetated area.	No work required.
Road 5c	Sediment basin with remaining capacity.	No work required.
Road 5d	Sediment basin full of sediments. Overflow to vegetated area.	No work required.
Road 5e	Sediment basin full of sediments. Overflow to vegetated area.	No work required.
Road 5f	Road drainage directed to vegetated area.	No work required.
Road 5g	Berm directing sediments to vegetated area.	Sediment basin excavated upstream of the berm to provide storage capacity. When full over flow will be toward vegetated area.
Road 6a	Road drainage directed to vegetated area.	No work required.
Road 6b	Road drainage directed to vegetated area.	No work required.
Road 6c	Berm, reducing speed of water flow.	No work required.
Road 6d	Berm directing sediments to vegetated area.	No work required.
Road 6e	Road drainage directed to vegetated area.	No work required.
Road 7a	Road drainage directed to vegetated area.	No work required.
Road 7b	Road drainage directed to vegetated area.	No work required.
Site 8 Williams Creek North	Silt fences installed to protect watercourse severely damaged.	New silt fences installed on either side of the road.

Figure 2 shows photographs of the sediment basins at Sites 2b and 4d. The basins were re-excavated to restore the initial storage capacity. These two sites together with Site 5g (sediment basin and berm, Figure 3) are considered the final features in the sediment plan program to retain sediments from being transported from the heap area towards Williams Creek (Figure 1). Sediment basins 2b, 4d and 5g were re-excavated to restore the storage capacity they had after the 2008 work. Sediment control elements in roads 4, 5, 6 and 7 also help to reduce the amount of sediments being mobilized.

Figure 4 shows the silt fences that were replaced or repaired, particularly in Sites 2a, 2c and Site 8.

Figure 5 presents the upstream and downstream ends of the culvert area in Road 1. Due to the limited supply of sand bags, the sand bags were installed only to replace the most damaged sand bags. It was also observed that sand bags are not performing effectively in the long term. Due to environmental exposure most of the sand bags were ripped and, in general, the sand bags were not providing the desired level of protection of the soils at the culvert. It is recommended the if the development of the operation is delayed, a more effective longer term solution, for example the installation of light rip-rap, should be considered to replace the sand bags and minimize the sediment load entering Williams Creek in this area.

It was also noted that along the east or upslope side of Road 4, a natural ditch was created by the water flowing downstream. This ditch is more prominent on the north side of Road 4 and eventually could affect the access to the north area of the site through Road 4. No work was required or completed in this area as it is not required at this time. However, it is recommended that the implementation of engineered measures to stabilize this natural ditch be considered next year if the erosion continues.

3.0 ADDITIONAL WORK FOR EROSION AND SEDIMENT CONTROL

During the 2009 fieldwork a few new elements were included to the system for erosion and sediment control implemented during the 2008 fieldwork, as described in Table 2.

Table 2: New Elements for Erosion and Sediment Control

Site	Work Completed
Site 2c	Sediments deposit area (see Figure 1) between silt fence and road (next to Site 2f) seeds were sowed (Table 3).
Site 2d	Road regraded and berm breached to direct water and sediments toward vegetated area.
Site 2e	Road regraded and berm breached to direct water and sediments toward vegetated area.
Site 2f	Berm to stop high velocity water before crossing road.

As mentioned in Tables 1 and 2 some areas where seeded with a Custom Reclamation Mix provided by Alexco Resource Group (Whitehorse Office). Three 25 Kg bags of seeds where provided and about 1.8 bags were used on site, the rest where left in the site office to be used early in the 2010 spring season, if needed. Table 3 presents a detailed content of the seeds.

Table 3: Seed Mixture

Seed Type	Percentage
Violet Wheatgrass	36%
Fringed Bromegrass	15%
Sheeps Fescue	14%
Rocky Mountain Fescue	14%
Tundra Bluegrass	11%
Able Alfalfa	10%

Figure 6 presents photographs of the seeding activities, including ripping the surface in Site 2c before sowing the seeds. Seeds where spread from about 3 m behind the silt fence shown in the photographs all the way to the road next to site 2f (Figure 1). It is anticipated that the vegetation will help to stabilize the sediments in this area. The same type of seed mixture was spread on Site 2b on the sediments excavated from the sediment basin and upstream the sediment basin (See Figure 2).

Sites 2d and 2e are also new features developed this year to minimize ongoing erosion. At the time of site visit the Road 2 was in good condition however, according to Al Serafinchon, (a personal communication), this road had significant erosion which he repaired during June, 2009. The source of this erosion was water over flowing from sediment basin 2b and reaching Road 2, then moving eastward an eventually reaching the Site 2c (Figure 1). Based on this information, Road 2 was regraded at two points as shown in Figure 7. This provides an exit point and diverts the water and sediments running through Road 2 to vegetated areas before reaching Site 2c.

The area of Site 2f is shown in Figure 8. It is a zone located just upstream of Site 2c with significant gradient and shows evidence of erosion. Even though the material on the slope appeared stable and no further sediment movement was expected, it could be a source of water reaching Site 2c that may cause erosion. For this reason a berm was built with the intention of reducing the energy of water crossing Road 2 and reaching Site 2c.

Additional work also includes the excavation of a ditch along the east side of Road 1 to the south of Williams Creek, with the objective of directing water to vegetated areas away from the road. This work was being completed at the time of Golder representative arrived to site.

4.0 COMMENTS AND RECOMMENDATIONS

The interim erosion and sediment control measures described above are not intended to prevent erosion from occurring on site. Instead, they are prescribed and implemented to assist in both reducing the rates of erosion and localizing the extents of erosion and sediment deposition. They were implemented with available equipment and resourced prior to onset of winter conditions. These temporary measures are intended to be enhanced or repaired with more robust measures and management practices in early 2010 (after freshet).

We recommend that immediately after the snowmelt and spring runoff in 2010, the temporary measures should be inspected to assess current conditions and to determine how the features functioned in the freshet period. Several of these interim structures are designed to promote sediment deposition and storage, and consequently they may require periodic maintenance. In the event of delays in the start of large-scale construction at the site, and in the implementation of the construction-phase storm water management plan (Golder, 2007), a review of site conditions in June 2010 will identify what, if any, additional interim measures may be warranted in 2010 for erosion and sediment control at the site.

GOLDER ASSOCIATES LTD.

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Javier Ubilla, Ph.D.
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John Hull, P.Eng. (BC, NWT, NU, YK)
Principal

Attachments: Figures 1 to 8

JU/JAH/FCE/mrb

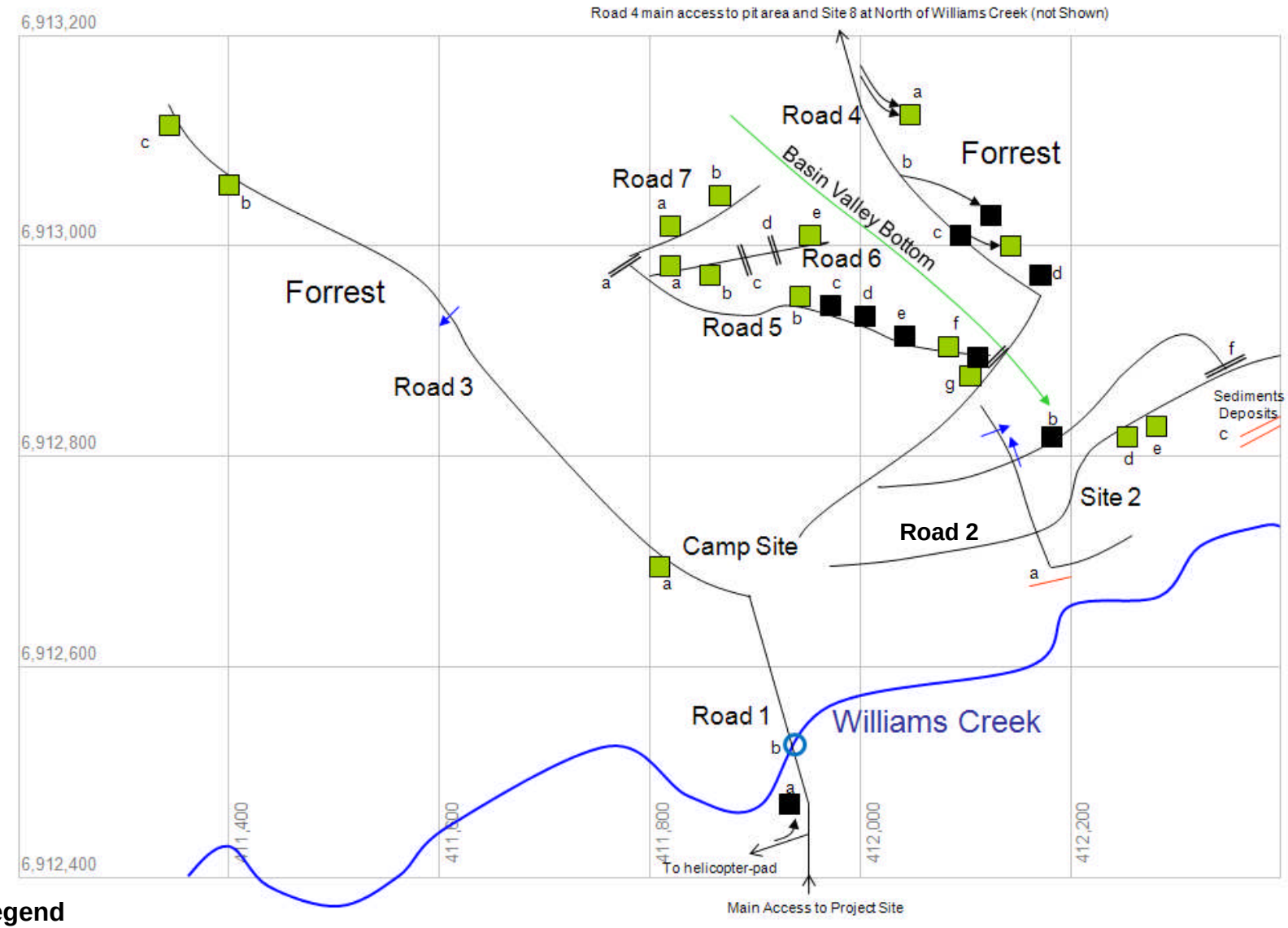
\\bur1-s-filesrv2\final\2007\1413\07-1413-0077\doc. 123 final tm 1002_09\doc. 123 tm 1002_09 erosion and sediment control measures_sept 2009.docx

REFERENCES

Golder Associates (Golder), 2007. Report on Preliminary Surface Water Management Plan, Carmacks Copper Project, Carmacks, Yukon. Doc. No. 046 dated November 29, 2007.

Golder Associates (Golder), 2008. Erosion and Sediment Control Measures, Fall 2008, Carmacks Copper Project, Yukon Territory. Doc. No. 088 dated October 21, 2008.

FILE LOCATION: FINAL\.....



Legend

- Road / Trail
- Silt fence
- Berm
- Sand bags culvert area
- Road drainage directed to vegetated area
- Road drainage directed to sediment basin
- Road re-sloping for drainage

Golder Associates

CARMACKS COPPER PROJECT

Site Sketch

Drawn: JU	App'd:	Date: September 25, 2009	Figure: 1

Project No.: 000-0000

Revision No.:

FILE LOCATION: FINAL\.....



Site 2b – Main sediment basin re-excavated



Site 4d – Caterpillar 225 working



Site 2b – New sand bags spillway area



Site 4d – Pond re-excavated

Golder Associates		CARMACKS COPPER PROJECT Sediment Basin Excavation	
Drawn: JU	App'd:	Date: September 25, 2009	Figure: 2
Project No.: 000-0000			Revision No.:

FILE LOCATION: FINAL\.....



Golder Associates		CARMACKS COPPER PROJECT Site 5g - Berm and Sediment Basin	
Drawn: JU	App'd:	Date: September 25, 2009	Figure: 3
Project No.: 000-0000			Revision No.:

FILE LOCATION: FINAL\.....



Site 8 – New silt fence



Site 2c – New silt fence



Site 8 – New silt fence



Site 2a – Silt fence repaired

Golder Associates

CARMACKS COPPER PROJECT

Silt Fence Installation

Drawn: JU	App'd:	Date: September 25, 2009	Figure: 4

Project No.: 000-0000

Revision No.:

FILE LOCATION: FINAL\.....



Sand bags in culvert area - upstream



Sand bags in culvert area - downstream

Golder Associates		CARMACKS COPPER PROJECT Sand Bags Culvert Area	
Drawn: JU	App'd:	Date: September 25, 2009	Figure: 5
Project No.: 000-0000			Revision No.:

FILE LOCATION: FINAL\.....



Site 2c - Ripping activities before seeding



Seeds – Custom Reclamation Mix



Site 2c – Seeds on the ground

Golder Associates		CARMACKS COPPER PROJECT Seeding	
Drawn: JU	App'd:	Date: September 25, 2009	Figure: 6
Project No.: 000-0000			Revision No.:

FILE LOCATION: FINAL\.....



Site 2d – Road 2 regraded and side berm breached



Site 2e – Road 2 regraded and side berm breached

Golder Associates		CARMACKS COPPER PROJECT Site 2 – Road Regraded	
Drawn: JU	App'd:	Date: September 25, 2009	Figure: 7
Project No.: 000-0000			Revision No.:

FILE LOCATION: FINAL\.....



Golder Associates		CARMACKS COPPER PROJECT Site 2f – New Berm	
Drawn: JU	App'd:	Date: September 25, 2009	Figure: 8
Project No.: 000-0000			Revision No.:

Western Copper Corporation

2009 ANNUAL QUARTZ MINING LICENCE REPORT

SUBMITTED TO YUKON GOVERNMENT, ENERGY MINES AND RESOURCES

YUKON QUARTZ MINING LICENCE QML-0007

Appendix B

2009 Environmental Monitoring Program Update and Data Summary – Revision No.5

Western Copper Corporation

2009 Environmental Monitoring Program Update and Data Summary – Revision No.5

Carmacks Copper Project
Yukon Territory

Prepared by:

ACCESS CONSULTING GROUP

March 2010

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Appendix A Water Quality Graphs for Williams Creek Watershed, 2005 to 2009

1.0 BACKGROUND & INTRODUCTION

The Carmacks Copper project is a proposed open pit copper mine and solvent extraction and electrowinning processing facility being developed by Carmacks Copper Ltd., a wholly owned subsidiary of Western Copper Corporation (Western Copper) of Vancouver, British Columbia. The ore body is located in Yukon (Figure 1), about 38 km northwest of the Village of Carmacks, or 192 km northwest of Whitehorse (Figure 2). The project site is located in the upper reaches of Williams Creek, approximately 9 km upstream of the confluence with the Yukon River. Williams Creek is a small erosional creek originating in the Dawson Range and draining northeast into the Yukon River downstream of Carmacks.

An initial assessment of baseline environmental conditions at the project site was undertaken between 1992 and 1994, with periodic data collection occurring in 1997 and 1999. In August 2005 the environmental monitoring program was re-activated to update baseline data for the project area and has continued on a regular basis during ice free months, roughly between April and October.

This report provides a summary of environmental monitoring program activities completed and data collected to incorporate results and analysis from the four site visits in 2009. Details on planned monitoring efforts upon commencement of project construction are found within the Stage 1 Construction Site Plan (Access Consulting Group, 2008), approved to be implemented as per the Quartz Mining Licence QML-0007. The Company is in the process of applying for a Water Use Licence, which would contain additional monitoring requirements that would be implemented once a licence is granted. Development activities at the Carmacks Copper site in 2009 were minimal with no construction or development planned until major project licensing is completed. With respect to environmental baseline data collection, four site visits took place in May, July, September and October in order to track baseline water quality and fisheries resources.

Table 1 summarizes some of the main environmental monitoring activities that have occurred at the Carmacks Copper site between 2005 and 2009.





Western Copper Corporation

ACCESS CONSULTING GROUP

2009 ENVIRONMENTAL MONITORING PROGRAM UPDATE AND DATA SUMMARY

REVISION NO. 5

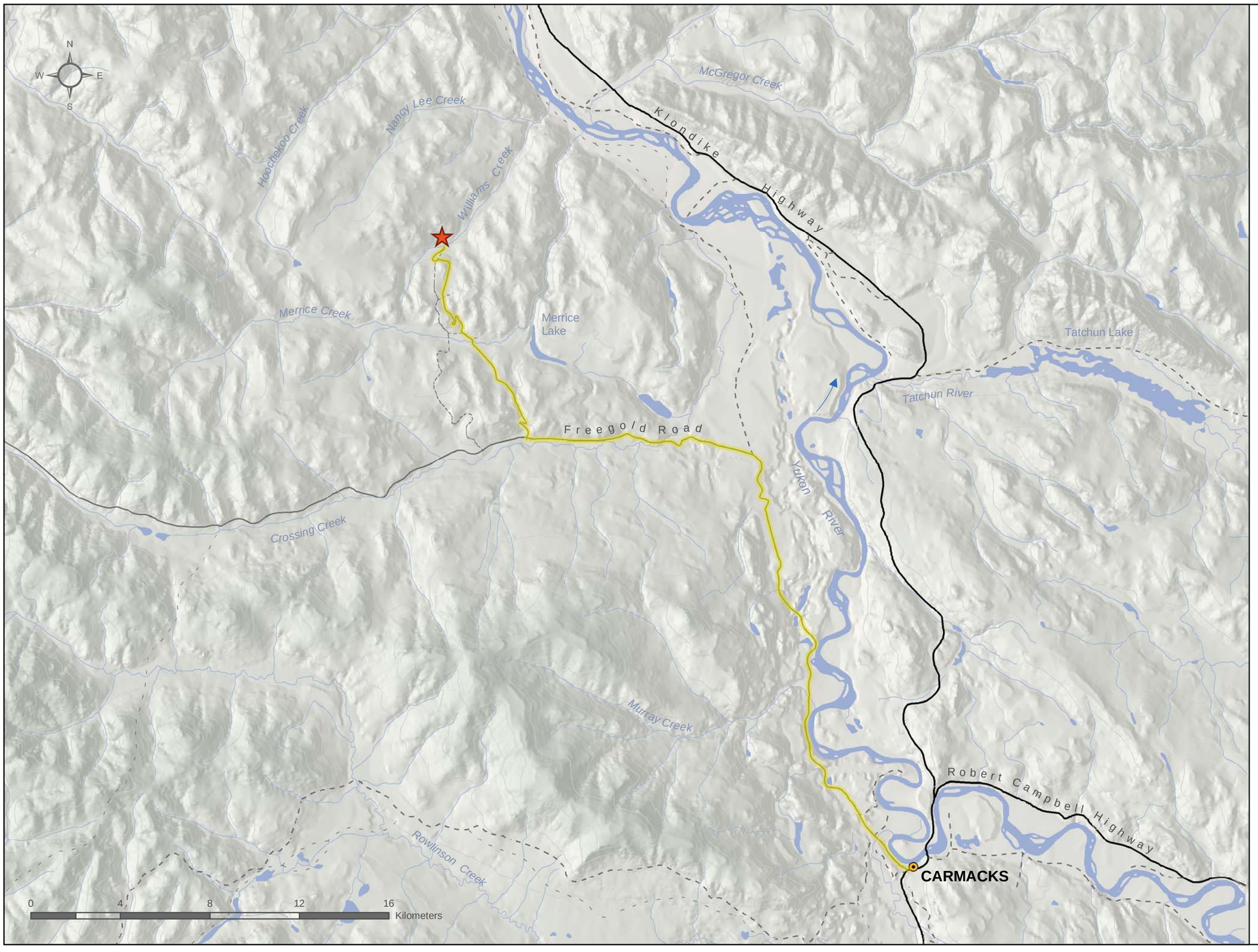
FIGURE 1
PROJECT LOCATION

CARMACKS COPPER PROJECT

2009 ENVIRONMENTAL MONITORING PROGRAM UPDATE AND DATA SUMMARY

REVISION NO.5

Western Copper Corporation



- Project Location
- Access Road
- Road
- Exploration Road
- Contour
- Watercourse
- Waterbody

Datum: NAD83; Projection: UTM Zone 8N

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FIGURE 2

PROJECT OVERVIEW

ACCESS CONSULTING GROUP

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Table 1 Summary of Environmental Monitoring Conducted Between 2005 and 2009

Date	Water	Groundwater	Sediment	Benthos	Fisheries	Wildlife	Vegetation
Aug-05	√		√				
Oct-05	√		√		√		
Dec-05						√	
Mar-06	√						
Jun-06	√	√	√		√		
Jul-06	√	√	√		√	√	√
Aug-06	√	√	√				
Sep-06	√	√	√	√	√		
Oct-06	√	√	√				
Apr-07	√	√					
May-07	√	√					
Jun-07	√	√					
Jul-07	√	√					
Aug-07	√	√					
Sep-07	√	√	√	√			
Oct-07	√	√					
Mar-08	√						
Apr-08	√						
May-08	√	√					
June-08	√	√					
July-08	√	√					
Aug-08	√	√					
Sept-08	√	√	√				√
Oct-08	√	√	√				
Nov-08	√						
May-09	√	√					
July-09	√	√			√		
Sept-09	√				√		
Oct-09	√	√					

2.0 SURFACE WATER QUALITY MONITORING

Water samples are routinely collected from Williams Creek, Nancy Lee Creek, and the Yukon River for analysis of physical parameters (pH, conductivity, total suspended solids, total dissolved solids, turbidity, hardness); inorganic nonmetallic parameters (ammonium, nitrogen, phosphorous, orthophosphate, dissolved organic carbon, total inorganic carbon, total organic carbon); and total and dissolved metals. In-situ measurements (temperature, pH, conductivity, total dissolved solids, and dissolved oxygen) are also collected during sample collection.

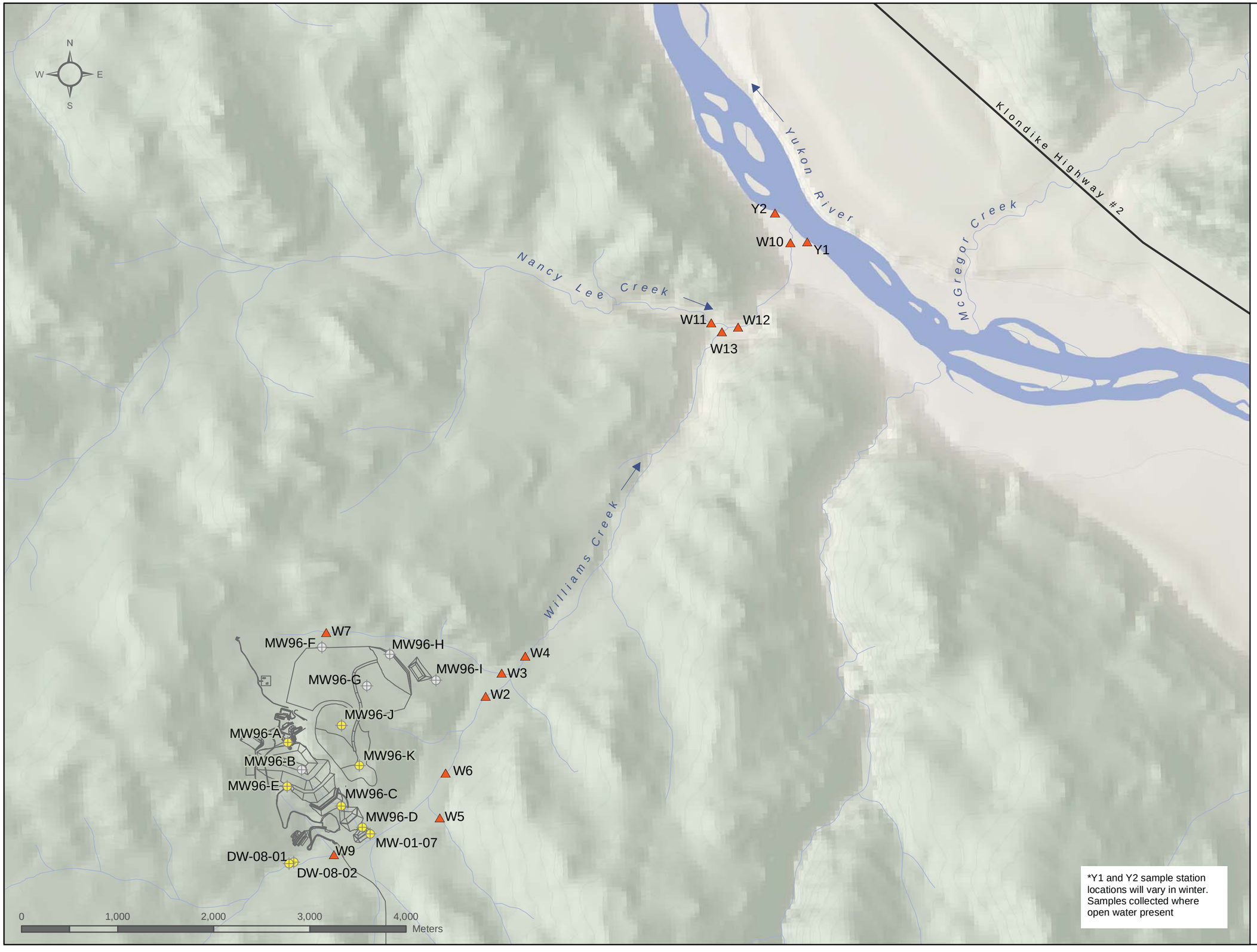
2.1 WATER QUALITY SAMPLE STATION LOCATIONS & FREQUENCY

The thirteen water quality monitoring stations located on mainstem Williams Creek (seven), tributaries to Williams Creek (four), and on the Yukon River (two) are described in Table 2 and illustrated on Figure 3.

Table 2 Water Quality Monitoring Station Locations in Williams Creek Watershed

Station	Description / Location
W2	Williams Creek Upstream of North Williams Creek Confluence
W3	Lower North Williams Creek Upstream of Confluence with Williams Creek
W4	Williams Creek Downstream of Confluence with North Williams Creek
W5	South East Tributary to Williams Creek
W6	Williams Creek Downstream of South East Tributary
W7	Upper North Williams Creek Tributary Upstream of Road Crossing
W9	Williams Creek Upstream of Access Road Crossing
W10	Williams Creek Upstream of Yukon River
W11	Nancy Lee Creek (Tributary of Williams Creek)
W12	Williams Creek Downstream of Confluence with Nancy Lee Creek
W13	Williams Creek Upstream of Confluence with Nancy Lee Creek
Y1	Yukon River Upstream of Williams Creek
Y2	Yukon River Downstream of Williams Creek

Surface water monitoring activities took place at all thirteen stations during May, July, September and October 2009 (see Table 3).



CARMACKS COPPER PROJECT

2009 ENVIRONMENTAL MONITORING PROGRAM UPDATE AND DATA SUMMARY

REVISION NO.5

Western Copper Corporation

- Actively Monitored Well
- Inactive Well
- Surface Water Monitoring Station
- Contour
- Watercourse
- Waterbody

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FIGURE 3

MONITORING STATION LOCATIONS

ACCESS CONSULTING GROUP

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Table 3 Water Quality Monitoring between 1989 and 2009

Sample Event	Sample Stations												
	W2	W3	W4	W5	W6	W7	W9	W10	W11	W12	W13	Y1*	Y2*
Oct-89	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	-	-
Aug-91	N	Y	Y	Y	N	Y	Y	Y	N	N	N	-	-
Dec-91	N	N	Y	Y	N	Y	Y	Y	Y	N	N	-	-
May-92	N	Y	Y	Y	N	Y	Y	Y	Y	N	N	-	-
Jul-92	N	Y	Y	Y	N	Y	Y	Y	N	N	N	-	-
Oct-92	N	Y	Y	Y	N	Y	Y	Y	Y	N	N	-	-
May-94	N	Y	Y	Y	N	Y	Y	N	N	N	N	-	-
Sep-97	N	Y	Y	N	N	N	Y	N	N	N	N	-	-
Oct-99	N	N	N	N	N	N	Y	Y	N	N	N	-	-
Aug-05	Y	Y	Y	N	N	Y	Y	N	N	N	N	-	-
Oct-05	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	-	-
Mar-06	N	Y	Y	N	N	N	Y	Y	N	Y	Y	Y	Y
Jun-06	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Jul-06	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Aug-06	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sep-06	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Oct-06	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y
Apr-07	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y
May-07	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
Jun-07	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N
Jul-07	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Aug-07	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sep-07	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Oct-07	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N
Mar-08	Y	N	Y	N	N	N	Y	N	Y	Y	Y	Y	Y
Apr-08	Y	Y	Y	N	Y	N	Y	N	Y	Y	Y	Y	Y
May-08	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Jun-08	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Jul-08	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Aug-08	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sep-08	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Oct-08	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Nov-08	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	Y
May-09	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
July-09	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sep-09	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Oct-09	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

* Yukon River sample stations established in 2006

2.2 PROTOCOL

Water quality sampling was undertaken using Standard Operating Procedures for the collection of surface water samples. Samples were field preserved or filtered and preserved, depending on their requirements, on the same day they were obtained. All samples were kept cool and shipped to Maxxam Analytics in Burnaby, BC for analysis.

2.3 RESULTS AND DISCUSSION

Water quality data collected since 2005 are stored in an EQWin database that is customized to manage environmental sampling data. Historic data has not been entered into the database due to formatting challenges as the data is not available in its original format. Further, evaluation of the older data revealed that the laboratory's method detection limit (MDL) for many parameters was greater than applicable Canadian Water Quality Guidelines (CWQG; CCME 1999).

A summary of water quality data for each station sampled between 2005 and 2009 is provided for a number of parameters of interest, most of which have an associated CWQG for freshwater aquatic life including: pH, total suspended solids, total aluminum, total arsenic, total cadmium, total copper, total chromium, total iron, total lead, total mercury, total molybdenum, total selenium, total nickel, total zinc, ammonia nitrogen, nitrate nitrogen and nitrite nitrogen. These parameters have been recently proposed to the Yukon Water Board (February 2010) as licensed receiving water quality standards in lower Williams Creek. Summary statistics are provided at each station for:

- sample size;
- min;
- max;
- mean;
- median; and
- 95^{th} percentile.

Where concentrations were below the laboratory MDL, one half the MDL value was used in the calculation. Water quality summary graphs for most parameters have been prepared and can be found in Appendix A.

For the most part pH falls within the CWQG range of 6.5 – 9.0. However, the occasional measurement of pH is below this range, with values as low as 4.64 (W5 on May 9, 2007) observed. The few occasions where pH was measured below 6.5 tend to occur during spring freshet when high water levels were flowing over moss and organics present along the creek banks. As water seeps through layers of decaying organic matter it can dissolve carbonic dioxide produced by decay which may in turn be the cause of lower pH levels. Measurements have also been observed to be near to pH 9.0, with one measurement of 9.97 at W2 on September 9, 2009. On average (as shown in Table 4) pH ranges between 7.32 and 7.97 for all sites.

Table 4 Field pH – Water Quality Summary Statistics for 2005 – 2009

STATION	COUNT	MIN	MAX	MEAN	MEDIAN	95th PERCENTILE
W2	25	7.01	9.97	7.91	7.90	8.76
W3	25	6.36	8.50	7.32	7.27	7.94
W4	25	6.98	9.03	7.73	7.70	8.40
W5	22	4.64	8.10	7.36	7.43	8.00
W6	23	7.03	8.31	7.72	7.76	8.31
W7	21	6.23	8.40	7.36	7.30	8.40
W9	24	6.53	8.84	7.58	7.60	8.14
W10	23	6.60	8.65	7.78	7.96	8.49
W11	22	5.13	8.80	7.79	7.91	8.39
W12	24	6.57	8.90	7.91	7.90	8.85
W13	24	5.63	8.71	7.88	8.00	8.59
Y1	20	6.92	8.70	7.96	8.05	8.53
Y2	19	6.93	8.63	7.97	8.10	8.58

Total suspended solids (TSS) values were generally low during sampling events, with average values ranging between 4.3 mg/L and 15.3 mg/L for all sites (Table 5). Elevations in TSS or spikes tend to occur during freshet as well as follow rain events.

Table 5 Total Suspended Solids – Water Quality Summary Statistics for 2005 – 2009

STATION	COUNT	MIN	MAX	MEAN	MEDIAN	95th PERCENTILE
W2	25	0.5	100	7.2	1	22.8
W3	25	0.5	26	5.8	2.5	19.8
W4	26	0.5	76	7.2	1	25.3
W5	22	0.5	35	6.8	1	28.9
W6	22	1	123	15.3	2.5	52.0
W7	20	0.5	29	4.3	1	24.3
W9	25	0.5	24	4.4	2	18.0
W10	22	0.5	42	6.3	1	39.9
W11	22	0.5	34	5.8	1.5	26.5
W12	24	0.5	40	5.1	1	18.3
W13	24	0.5	120	10.8	1	56.2
Y1	23	1	98	14.5	6	49.1
Y2	24	1	90	12.8	5	54.7

Aluminum concentrations regularly exceed the CWQG of 0.1 mg/L, which is why a CCME derived site specific water quality objective of 0.66 mg/L has been calculated by Minnow Environmental Inc. As is shown in Table 6, average concentrations for all sites range between a minimum of 0.0808 (W9) and 0.3937 mg/L (Y2).

Table 6 Total Aluminum – Water Quality Summary Statistics for 2005 – 2009

STATION	COUNT	MIN	MAX	MEAN	MEDIAN	95th PERCENTILE
W2	27	0.0100	1.440	0.1194	0.0630	0.2175
W3	27	0.0060	1.760	0.1732	0.0420	0.8356
W4	28	0.0100	1.480	0.1389	0.0510	0.4386
W5	22	0.0100	1.680	0.1687	0.0500	0.4691
W6	24	0.0100	2.090	0.2333	0.1095	0.7504
W7	22	0.0250	0.405	0.0853	0.0495	0.3539
W9	27	0.0055	0.623	0.0808	0.0360	0.2718
W10	23	0.0050	1.080	0.1778	0.0780	0.6829
W11	23	0.0088	0.746	0.1367	0.0400	0.5193
W12	25	0.0100	0.634	0.1135	0.0500	0.3544
W13	25	0.0025	1.120	0.1443	0.0360	0.5956
Y1	23	0.0190	2.100	0.3135	0.0894	1.1771
Y2	24	0.0100	2.040	0.3937	0.2290	1.6785

As shown in Table 7, arsenic concentrations are well below the CWQG of 0.005 mg/L and often below laboratory detection levels. Average arsenic values for the sites are estimated to range between 0.0004 and 0.0006 mg/L.

Table 7 Total Arsenic – Water Quality Summary Statistics for 2005 – 2009

STATION	COUNT	MIN	MAX	MEAN	MEDIAN	95th PERCENTILE
W2	27	0.0001	0.0016	0.0006	0.0005	0.0011
W3	27	0.0001	0.0022	0.0005	0.0004	0.0011
W4	28	0.0001	0.0014	0.0006	0.0005	0.0011
W5	22	0.0002	0.0023	0.0005	0.0005	0.0007
W6	24	0.0001	0.0013	0.0006	0.0005	0.0011
W7	22	0.0001	0.0026	0.0005	0.0004	0.0008
W9	27	0.0001	0.0013	0.0005	0.0005	0.0009
W10	23	0.0002	0.0018	0.0005	0.0004	0.0007
W11	23	0.0003	0.0016	0.0005	0.0005	0.0009
W12	25	0.0001	0.0008	0.0004	0.0004	0.0007
W13	25	0.0001	0.0008	0.0004	0.0004	0.0008
Y1	23	0.0001	0.0026	0.0006	0.0005	0.0013
Y2	24	0.0002	0.0016	0.0006	0.0005	0.0010

The CWQG for total cadmium is dependent on hardness, and Minnow Environmental Inc. calculated the guideline to range between 0.00003 and 0.00006 mg/L (depending on the station) in their *Evaluation of Water Quality and Development of Background-Based Site-Specific Water Quality Objectives for Williams Creek* (May 2008), which evaluated data collected between 2005 and 2007. Maximum total cadmium concentrations periodically exceed the calculated guideline of 0.00003 mg/L. Average concentrations (Table 8) are typically below the lower range of the guideline.

Table 8 Total Cadmium – Water Quality Summary Statistics for 2005 – 2009

STATION	COUNT	MIN	MAX	MEAN	MEDIAN	95th PERCENTILE
W2	27	0.0000025	0.000050	0.000017	0.000010	0.000040
W3	27	0.0000025	0.000040	0.000015	0.000010	0.000037
W4	28	0.0000025	0.000120	0.000021	0.000010	0.000070
W5	22	0.0000050	0.000041	0.000014	0.000008	0.000040
W6	24	0.0000025	0.000089	0.000017	0.000010	0.000040
W7	22	0.0000050	0.000240	0.000030	0.000010	0.000107
W9	27	0.0000050	0.000080	0.000018	0.000010	0.000040
W10	23	0.0000050	0.000060	0.000020	0.000013	0.000049
W11	23	0.0000025	0.000340	0.000035	0.000020	0.000094
W12	25	0.0000025	0.000241	0.000029	0.000010	0.000050
W13	25	0.0000025	0.000040	0.000017	0.000010	0.000040
Y1	23	0.0000050	0.000054	0.000018	0.000010	0.000049
Y2	24	0.0000050	0.000050	0.000019	0.000016	0.000040

The CWQG for total chromium (0.001 mg/L) has been exceeded at each station. In Minnow's evaluation of water quality (Minnow, 2008) the guideline for chromium was observed to be exceeded at 5 percent or less of the time. Average total chromium (Table 9) ranges between 0.00057 mg/L (W12) and 0.00113 mg/L (Y2).

Table 9 Total Chromium – Water Quality Summary Statistics for 2005 – 2009

STATION	COUNT	MIN	MAX	MEAN	MEDIAN	95th PERCENTILE
W2	27	0.00005	0.0027	0.00070	0.00050	0.00140
W3	27	0.00005	0.0039	0.00086	0.00050	0.00333
W4	28	0.00005	0.0027	0.00077	0.00050	0.00206
W5	22	0.00020	0.0034	0.00081	0.00055	0.00197
W6	24	0.00005	0.0038	0.00095	0.00075	0.00196
W7	22	0.00020	0.0026	0.00082	0.00060	0.00226
W9	27	0.00005	0.0017	0.00062	0.00050	0.00147
W10	23	0.00005	0.0020	0.00059	0.00050	0.00137
W11	23	0.00005	0.0020	0.00071	0.00060	0.00193
W12	25	0.00005	0.0014	0.00057	0.00050	0.00128
W13	25	0.00005	0.0025	0.00064	0.00050	0.00146
Y1	23	0.00005	0.0040	0.00104	0.00060	0.00310
Y2	24	0.00010	0.0037	0.00113	0.00100	0.00358

The CWQG for total copper is hardness dependent and regularly exceeded:

- 0.002 mg/L at hardness less than 120 mg/L;
- 0.003 mg/L at hardness from 120 – 180 mg/L; and
- 0.04 mg/L at hardness greater than 180 mg/L.

Minnow Environmental calculated the following hardness dependent, CCME derived site specific water quality objective for total copper:

- 0.021 mg/L at hardness less than 120 mg/L;
- 0.032 mg/L at hardness from 120 – 180 mg/L; and
- 0.042 mg/L at hardness greater than 180 mg/L.

As is shown in Table 10, average concentrations for all sites range between 0.00137 mg/L (Y1) and 0.00562 mg/L (W7). However, at W7 the maximum total copper concentration of 0.066 mg/L is thought to be erroneous. At W7 North Williams Creek is narrow and shallow and mobilization of sediment or soil may have incidentally contaminated the sample.

Table 10 Total Copper – Water Quality Summary Statistics for 2005 – 2009

STATION	COUNT	MIN	MAX	MEAN	MEDIAN	95th PERCENTILE
W2	27	0.0005	0.00800	0.00172	0.00100	0.00370
W3	27	0.0005	0.00500	0.00199	0.00200	0.00400
W4	28	0.0005	0.01400	0.00233	0.00200	0.00465
W5	22	0.0005	0.00700	0.00213	0.00200	0.00300
W6	24	0.0005	0.00500	0.00171	0.00154	0.00300
W7	22	0.0010	0.06600	0.00562	0.00273	0.00685
W9	27	0.0005	0.00400	0.00155	0.00100	0.00300
W10	23	0.0010	0.00400	0.00248	0.00200	0.00400
W11	23	0.0007	0.00500	0.00258	0.00247	0.00400
W12	25	0.0005	0.00401	0.00237	0.00200	0.00400
W13	25	0.0005	0.00700	0.00213	0.00200	0.00489
Y1	23	0.0005	0.00400	0.00137	0.00100	0.00380
Y2	24	0.0005	0.00800	0.00182	0.00100	0.00485

In addition to total aluminum and copper, total iron concentrations also regularly exceed the CWQG of 0.3 mg/L. Therefore, a CCME derived site specific water quality objective of 1.1 mg/L has been calculated by Minnow Environmental. As shown in Table 11,

average concentrations for all sites range between a minimum of 0.198 mg/L (W12) and 0.702 mg/L (W5).

Table 11 Total Iron – Water Quality Summary Statistics for 2005 – 2009

STATION	COUNT	MIN	MAX	MEAN	MEDIAN	95th PERCENTILE
W2	27	0.010	2.20	0.405	0.300	0.816
W3	27	0.010	4.66	0.510	0.200	1.943
W4	28	0.010	2.20	0.401	0.300	0.968
W5	22	0.050	6.09	0.702	0.387	1.092
W6	24	0.010	2.80	0.564	0.400	1.342
W7	22	0.050	2.20	0.315	0.130	0.966
W9	27	0.050	0.84	0.241	0.170	0.770
W10	23	0.029	1.20	0.285	0.110	0.988
W11	23	0.020	1.20	0.281	0.160	0.918
W12	25	0.030	0.70	0.198	0.100	0.607
W13	25	0.020	1.48	0.224	0.050	0.782
Y1	23	0.040	2.40	0.421	0.160	1.883
Y2	24	0.040	3.44	0.578	0.260	2.288

The CEQG for total lead is dependent on hardness, and Minnow Environmental Inc. calculated the guideline to range between 0.002 mg/L and 0.007 mg/L (depending on the station) (Minnow, 2008). Average concentrations (Table 12) range between 0.000153 mg/L and 0.000727 mg/L.

Table 12 Total Lead – Water Quality Summary Statistics for 2005 – 2009

STATION	COUNT	MIN	MAX	MEAN	MEDIAN	95th PERCENTILE
W2	27	0.0000220	0.0033	0.000239	0.000050	0.000640
W3	27	0.0000120	0.0038	0.000334	0.000100	0.001040
W4	28	0.0000110	0.0014	0.000209	0.000100	0.000795
W5	22	0.0000140	0.0010	0.000153	0.000100	0.000200
W6	24	0.0000230	0.0006	0.000161	0.000100	0.000374
W7	22	0.0000270	0.0111	0.000727	0.000100	0.001487
W9	27	0.0000250	0.0022	0.000290	0.000100	0.001420
W10	23	0.0000360	0.0005	0.000186	0.000146	0.000400
W11	23	0.0000025	0.0071	0.000500	0.000083	0.001180
W12	25	0.0000200	0.0016	0.000239	0.000200	0.000546
W13	25	0.0000400	0.0037	0.000414	0.000100	0.001260
Y1	23	0.0000240	0.0008	0.000213	0.000130	0.000590
Y2	24	0.0000500	0.0019	0.000374	0.000218	0.000985

Total mercury concentrations infrequently register above laboratory detection levels (MDL = 0.00001 mg/L). The CEQG for total mercury is 0.000026 mg/L and average total mercury has been estimated to range between 0.000006 mg/L and 0.000012 mg/L using ½ the MDL to calculate (Table 13).

Table 13 Total Mercury – Water Quality Summary Statistics for 2005 – 2009

STATION	COUNT	MIN	MAX	MEAN	MEDIAN	95th PERCENTILE
W2	19	0.0000050	0.0001	0.000009	0.000005	0.000014
W3	18	0.0000050	0.0001	0.000010	0.000008	0.000016
W4	19	0.0000050	0.0001	0.000009	0.000005	0.000014
W5	16	0.0000050	0.0001	0.000011	0.000008	0.000028
W6	17	0.0000050	0.0001	0.000010	0.000010	0.000018
W7	16	0.0000050	0.0001	0.000011	0.000010	0.000028
W9	18	0.0000050	0.0001	0.000012	0.000005	0.000052
W10	15	0.0000050	0.0001	0.000009	0.000005	0.000022
W11	16	0.0000050	0.0001	0.000009	0.000005	0.000020
W12	17	0.0000050	0.0001	0.000009	0.000005	0.000018
W13	17	0.0000050	0.0001	0.000009	0.000005	0.000018
Y1	16	0.0000050	0.0000	0.000006	0.000005	0.000010
Y2	17	0.0000050	0.0001	0.000009	0.000005	0.000018

The CEQG for total molybdenum is 0.073 mg/L and has not been exceeded at any of the stations. Average total molybdenum ranges between 0.00043 mg/L and 0.00441 mg/L.

Table 14 Total Molybdenum – Water Quality Summary Statistics for 2005 – 2009

STATION	COUNT	MIN	MAX	MEAN	MEDIAN	95th PERCENTILE
W2	27	0.00050	0.00900	0.00427	0.00500	0.00711
W3	27	0.00028	0.00113	0.00069	0.00050	0.00110
W4	28	0.00066	0.02600	0.00441	0.00400	0.00730
W5	22	0.00026	0.00100	0.00057	0.00050	0.00100
W6	24	0.00062	0.00700	0.00340	0.00379	0.00635
W7	22	0.00001	0.00100	0.00043	0.00050	0.00100
W9	27	0.00015	0.00400	0.00095	0.00068	0.00326
W10	23	0.00034	0.00300	0.00133	0.00118	0.00200
W11	23	0.00019	0.00200	0.00065	0.00050	0.00100
W12	25	0.00037	0.00300	0.00142	0.00134	0.00280
W13	25	0.00070	0.00500	0.00246	0.00263	0.00380
Y1	23	0.00050	0.00131	0.00097	0.00100	0.00120
Y2	24	0.00033	0.00138	0.00095	0.00100	0.00132

The CWQG for total nickel is dependent on hardness, and Minnow Environmental Inc. calculated the guideline to range between 0.065 mg/L and 0.15 mg/L (depending on the station) (Minnow, 2008). Average concentrations (Table 15) range between 0.001 mg/L and 0.00244 mg/L.

Table 15 Total Nickel – Water Quality Summary Statistics for 2005 – 2009

STATION	COUNT	MIN	MAX	MEAN	MEDIAN	95th PERCENTILE
W2	27	0.00050	0.005	0.00109	0.00090	0.00200
W3	27	0.00025	0.010	0.00149	0.00070	0.00580
W4	28	0.00025	0.006	0.00108	0.00072	0.00213
W5	22	0.00025	0.017	0.00212	0.00101	0.00773
W6	24	0.00025	0.009	0.00144	0.00105	0.00217
W7	22	0.00025	0.004	0.00155	0.00148	0.00210
W9	27	0.00025	0.007	0.00100	0.00080	0.00214
W10	23	0.00025	0.008	0.00110	0.00065	0.00266
W11	23	0.00025	0.010	0.00136	0.00100	0.00218
W12	25	0.00025	0.006	0.00103	0.00070	0.00200
W13	25	0.00025	0.005	0.00103	0.00064	0.00249
Y1	23	0.00025	0.009	0.00141	0.00063	0.00409
Y2	24	0.00025	0.030	0.00244	0.00095	0.00409

Total selenium concentrations are below the CEQG of 0.001 mg/L.

Table 16 Total Selenium – Water Quality Summary Statistics for 2005 – 2009

STATION	COUNT	MIN	MAX	MEAN	MEDIAN	95th PERCENTILE
W2	27	0.00008	0.0005	0.0002	0.0002	0.0005
W3	27	0.00002	0.0008	0.0002	0.0001	0.0003
W4	28	0.00007	0.0009	0.0002	0.0002	0.0006
W5	22	0.00002	0.0003	0.0001	0.0001	0.0003
W6	24	0.00006	0.0003	0.0002	0.0001	0.0003
W7	22	0.00005	0.0003	0.0002	0.0002	0.0003
W9	27	0.00006	0.0009	0.0002	0.0001	0.0005
W10	23	0.00008	0.0003	0.0002	0.0001	0.0003
W11	23	0.00005	0.0010	0.0002	0.0001	0.0003
W12	25	0.00005	0.0006	0.0002	0.0002	0.0005
W13	25	0.00009	0.0007	0.0002	0.0002	0.0005
Y1	23	0.00010	0.0009	0.0002	0.0002	0.0004
Y2	24	0.00010	0.0003	0.0002	0.0002	0.0003

Total zinc has not exceeded the CCME Guideline (0.03 mg/L) during 2005 to 2009 sampling. Average total zinc concentrations (Table 17) range between 0.004 mg/L and 0.007 mg/L.

Table 17 Total Zinc – Water Quality Summary Statistics for 2005 – 2009

STATION	COUNT	MIN	MAX	MEAN	MEDIAN	95th PERCENTILE
W2	27	0.0005	0.022	0.006	0.004	0.013
W3	27	0.0005	0.012	0.004	0.004	0.011
W4	28	0.0005	0.027	0.007	0.004	0.023
W5	22	0.0005	0.016	0.005	0.004	0.014
W6	24	0.0006	0.023	0.005	0.004	0.012
W7	22	0.0005	0.027	0.006	0.004	0.018
W9	27	0.0004	0.020	0.005	0.004	0.011
W10	23	0.0007	0.020	0.005	0.004	0.011
W11	23	0.0010	0.022	0.006	0.005	0.010
W12	25	0.0004	0.013	0.005	0.005	0.010
W13	25	0.0003	0.013	0.005	0.004	0.012
Y1	23	0.0005	0.014	0.005	0.005	0.009
Y2	24	0.0010	0.019	0.005	0.005	0.013

The CEQG for total ammonia is pH and water temperature dependent. The lowest applicable guideline determined by Minnow Environmental (May 2008) was 0.12 mg/L. Average total ammonia concentrations range between 0.021 mg/L and 0.028 mg/L (Table 18).

Table 18 Ammonia Nitrogen – Water Quality Summary Statistics for 2005 – 2009

STATION	COUNT	MIN	MAX	MEAN	MEDIAN	95th PERCENTILE
W2	27	0.0025	0.025	0.022	0.025	0.025
W3	27	0.0025	0.110	0.027	0.025	0.050
W4	28	0.0025	0.025	0.022	0.025	0.025
W5	22	0.0025	0.070	0.024	0.025	0.025
W6	24	0.0025	0.070	0.024	0.025	0.025
W7	22	0.0025	0.100	0.028	0.025	0.050
W9	27	0.0025	0.025	0.022	0.025	0.025
W10	23	0.0025	0.025	0.021	0.025	0.025
W11	23	0.0025	0.025	0.021	0.025	0.025
W12	24	0.0025	0.025	0.022	0.025	0.025
W13	24	0.0025	0.025	0.022	0.025	0.025
Y1	23	0.0025	0.025	0.021	0.025	0.025
Y2	24	0.0025	0.025	0.022	0.025	0.025

The CEQG for nitrate nitrogen is 2.9 mg/L, which has not been exceeded at any station. Average nitrate nitrogen concentrations range between 0.019 mg/L and 0.171 mg/L (Table 19).

Table 19 Nitrate Nitrogen – Water Quality Summary Statistics for 2005 – 2009

STATION	COUNT	MIN	MAX	MEAN	MEDIAN	95th PERCENTILE
W2	22	0.005	1.20	0.103	0.030	0.200
W3	21	0.005	2.00	0.125	0.010	0.200
W4	22	0.005	0.20	0.060	0.020	0.200
W5	18	0.005	0.10	0.031	0.010	0.100
W6	19	0.005	0.20	0.046	0.020	0.200
W7	18	0.005	0.05	0.019	0.010	0.050
W9	22	0.005	0.20	0.034	0.010	0.100
W10	17	0.005	0.30	0.064	0.040	0.276
W11	18	0.005	2.55	0.171	0.010	0.552
W12	18	0.010	0.20	0.041	0.020	0.115
W13	18	0.005	0.20	0.044	0.035	0.115
Y1	17	0.005	0.20	0.034	0.020	0.080
Y2	18	0.005	0.20	0.049	0.025	0.200

The CEQG for nitrite nitrogen is 0.06 mg/L; average nitrite nitrogen concentrations range between 0.013 mg/L and 0.020 mg/L (Table 20).

Table 20 Nitrite Nitrogen – Water Quality Summary Statistics for 2005 – 2009

STATION	COUNT	MIN	MAX	MEAN	MEDIAN	95th PERCENTILE
W2	22	0.0025	0.04	0.013	0.010	0.030
W3	21	0.0025	0.05	0.014	0.010	0.040
W4	22	0.0025	0.04	0.013	0.010	0.039
W5	18	0.0025	0.04	0.014	0.010	0.032
W6	19	0.0025	0.04	0.013	0.010	0.031
W7	18	0.0025	0.07	0.020	0.015	0.053
W9	22	0.0025	0.06	0.014	0.010	0.039
W10	17	0.0025	0.04	0.014	0.010	0.032
W11	18	0.0025	0.04	0.014	0.010	0.032
W12	18	0.0025	0.04	0.014	0.010	0.032
W13	18	0.0025	0.04	0.016	0.010	0.040
Y1	17	0.0025	0.04	0.014	0.010	0.040
Y2	18	0.0025	0.05	0.016	0.010	0.033

3.0 SURFACE WATER HYDROLOGY

Surface water hydrology relates the dynamics of flow in surface water systems with correlations drawn between precipitation and surface runoff. Discharge relays information such as topography, season, drainage, land-use, and soil conditions. Instantaneous flow measurements at Carmacks Copper are collected when conditions permit (ice free/sufficient flow, typically May through October) during water sampling events. Data loggers at stations W4 and W10 have also been used to monitor stream flow on a more continuous basis since 2006.

During 2009 spring freshet, the hydrology station at W10 was dislodged from the creek while the one at W4 was moderately affected. During the first 2009 site visit (May 20 and 21) conducted towards the end of spring freshet/thaw conditions, a hydrology logger and baralogger (Solinst models) were successfully installed at W4. The absence of a hydrology station at station W10 prevented the installation of a logger during that visit.

During the second site visit (July 10 to 12), new hydrology stations were constructed at W4 and W12. The W10 hydrology station was not re-established as W12 is the proposed point of compliance for receiving water quality standards. The data loggers were removed during the fourth and final site visit of 2009 (October 15 to 16).

3.1 PROTOCOL

Manual water flow measurements are taken using a Price 1210 Mini meter, Price 1205 AA meter (S00790), or Global Flow Probe FP101 (Serial #56269). Depending on water level and velocity, metering may not be possible, and bucket flows or the orange float methods may be used as a substitute. Flow measurements were obtained by following the appropriate protocol as described in ASTM International *Standard D 4409-95: Standard Test Method for Velocity Measurements of Water in Open Channels with Rotating Element Current Meters* and *Standard D 3858-95 Standard Test Method for Open-Channel Flow Measurement of Water by Velocity Area Method* as applicable.

3.2 RESULTS

Manual flow measurements collected from Williams Creek during 2006 to 2009 and subsequent calculations of discharge are shown on Figure 4. Figure 5 shows logger

data processed for discharge at station W4 as well as manual measurements collected between 2006 and 2009. Figure 6 shows logger data processed for discharge at stations W10 between 2006 and 2008 and W12 for 2009 as well as manual measurements.

Figure 4 Williams Creek Watershed Manual Measurements of Discharge 2006 to 2009

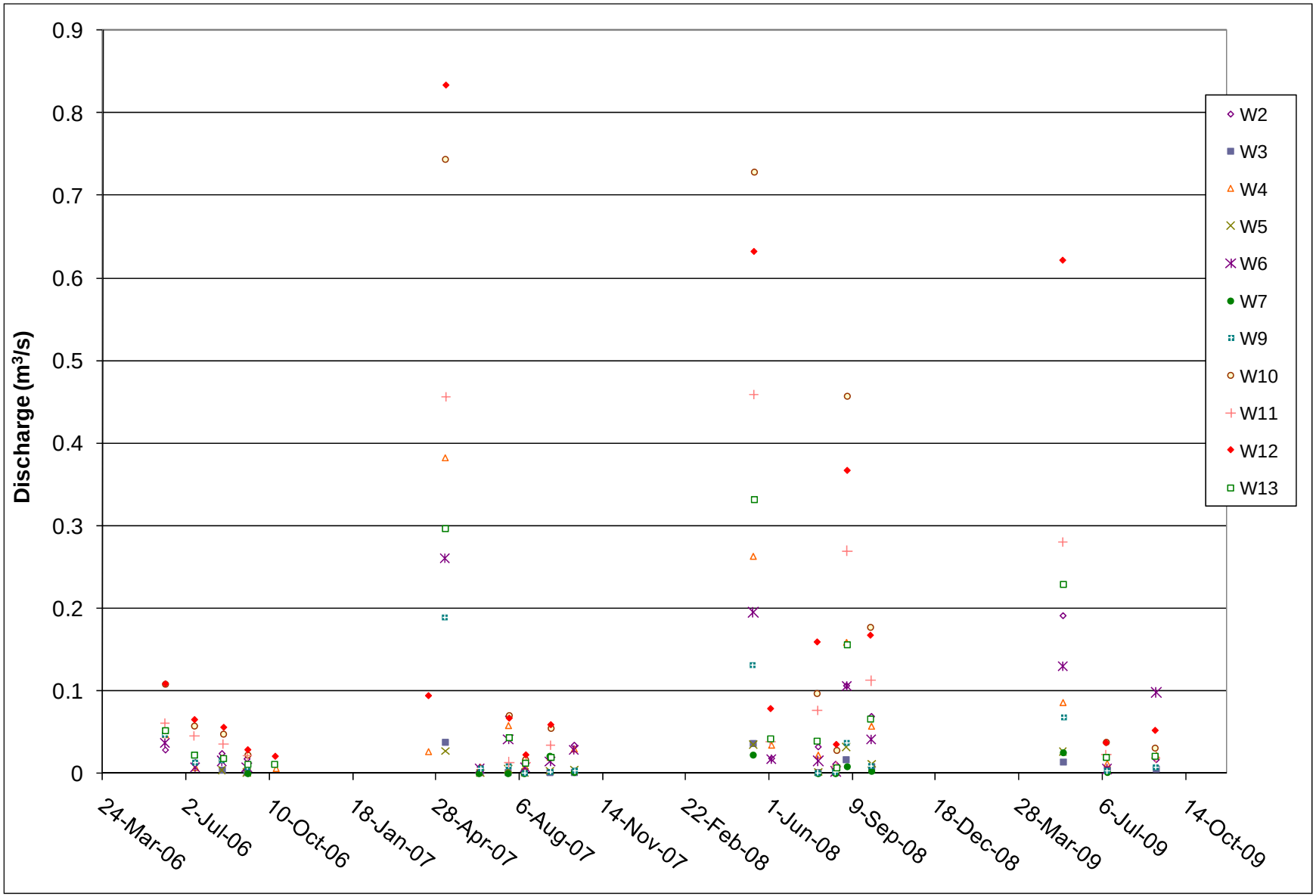


Figure 5 Williams Creek Station W4 Discharge for 2006 to 2009 Using Logger & Manual Methods

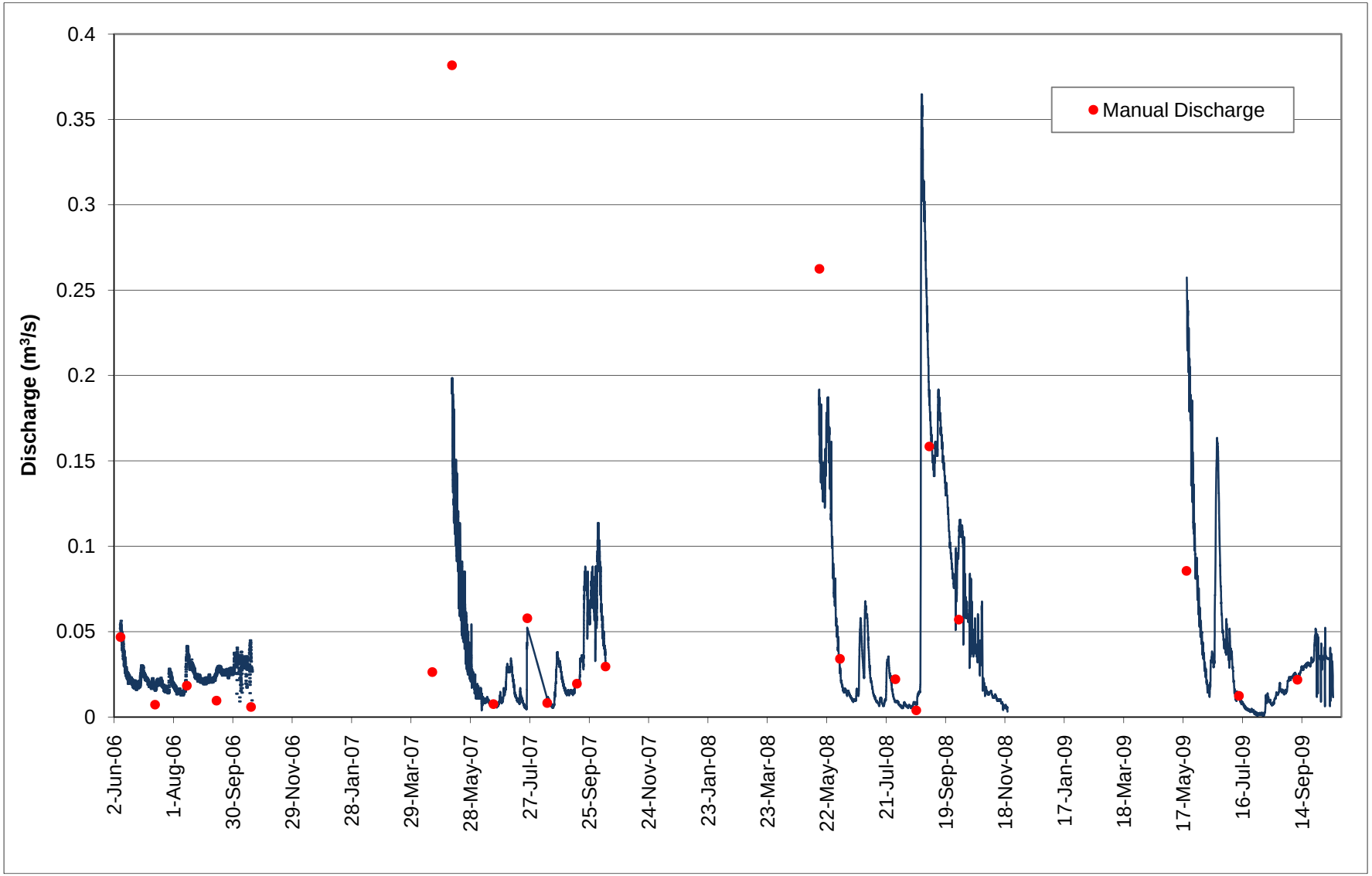
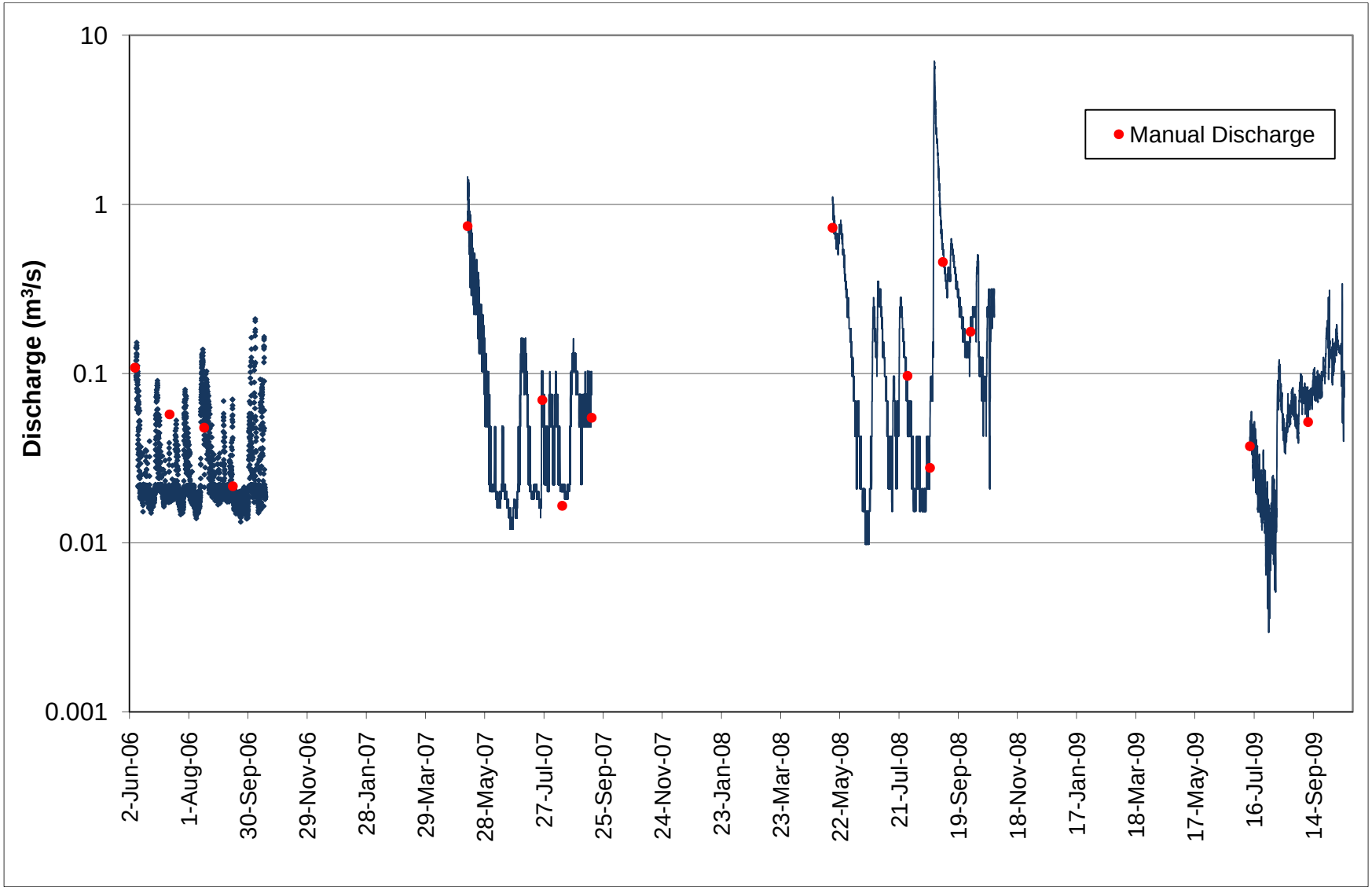


Figure 6 Williams Creek Stations W10 Discharge for 2006 to 2008 and W12 2009 Using Logger & Manual Methods



3.3 DISCUSSION

Figures 4 to 6 show peak flows occur during spring freshet with less dramatic increases in flow during the summer following rainfall events. A substantial increase in flow on August 25, 2008 was observed after a heavy rainfall event which resulted in 62.3 mm falling in little more than 24 hours. By October ice usually starts to form on the stream banks and beds and discharge can become elevated when ice that has formed melts during the day and break up occurs.

In 2006 and 2009 the data loggers were installed after freshet in lower Williams Creek, however, in 2007 and 2008 freshet was partially captured at W10. In 2007, the loggers were launched on May 10 at station W10; the following statistics are provided for the period of May 10 to June 10 2007:

- Minimum discharge = 0.016 m^3/s;
- Maximum discharge = 1.456 m^3/s; and
- Average discharge = 0.233 m^3/s.

In 2008, the loggers were launched on May 14 at station W10; the following summary statistics are provided for the period of May 14 to June 14, 2008:

- Minimum discharge = 0.015 m^3/s;
- Maximum discharge = 1.107 m^3/s; and
- Average discharge = 0.345 m^3/s.

4.0 CLIMATE

In 1994, Water Resources Division of DIAND established an automatic meteorological station at the site. The station monitors air and soil temperature, solar radiation, wind speed, and precipitation. The station is still being operated by Yukon Government, Water Resources Branch and continuous records are available from September 1994 to September 2008 present, except where gaps occur due to equipment malfunctions. Unfortunately there was a logger malfunction in 2009 and no data for this year was retrieved. Please refer to the 2008 *Environmental Monitoring Program and Data Summary – Revision No.4* for a summary of site temperature and precipitation.

A snow course station also exists at the site and is monitored by Yukon Government. The Williams Creek snow course station was surveyed by Yukon Government on February 23, 2010. Snow depth was measured at 53 cm with a water content of 96 mm. On February 24, 2009 snow depth was measured at 66 cm with a water content of 134 mm. This compares to snow depth on February 27, 2008 of 62 cm with an estimated water content of 103 mm. Average water content over 15 years of monitoring is 82 mm. As described in Yukon Government's Yukon Snow Survey Bulletin and Water Supply Forecast (March, 2010), the March 1 Yukon snowpack is generally below normal, however, a pocket of above normal snowpack exists around Carmacks.

Meteorological data continues to be collected by the Yukon Government Water Resources Branch, however, Western Copper has committed to also installing a meteorological on site. This should allow for continuous data collection going forward.

5.0 GROUNDWATER MONITORING

Monitoring wells are inspected during site visits and groundwater samples are collected where possible. Samples collected are sent to the laboratory for analysis of the same parameters as surface water samples including physical parameters (pH, conductivity, total suspended solids, total dissolved solids, turbidity, hardness); inorganic nonmetallic parameters (ammonium, nitrogen, phosphorous, orthophosphate, dissolved organic carbon, total inorganic carbon, total organic carbon); and total and dissolved metals. In-situ measurements (temperature, pH, conductivity, total dissolved solids, and dissolved oxygen) are also collected during sample collection.

5.1 MONITORING WELL SAMPLE STATION LOCATIONS & FREQUENCY

A total of 11 monitoring wells were established on site in 1996 in the heap leach pad area, waste rock storage area, and open pit area (see Figure 3):

- Leach pad MW96-A to E
- Waste rock storage area MW96-F, G, H & I
- Open pit MW96-J and K

During initial inspections and monitoring of these wells, a few were removed from the monitoring program; one from the leach pad area and all in the waste rock storage area:

- MW96-B: bailer lodged in well at about 29 m in September 2007;
- MW96-F: ice plug a few meters down;
- MW96-G: no PVC pipe (only casing);
- MW96-H: ice plug a few meters down;
- MW96-I: ice plug a few meters down.

Remaining monitoring wells are within the leach pad and open pit areas.

- MW96-A: set of samples obtained October 2009;
- MW96-C: set of samples collected May 2009, equipment malfunction in July 2009 and repairs made October 2009;
- MW96-D: no water observed in shallow well;
- MW96-E: set of samples obtained May and October 2009;
- MW96-J: water noted in October 2009 though low recharge rate combined with well depth prevented sample collection;
- MW96-K: water noted in October 2009 though low recharge rate combined with well depth prevented sample collection;
- HYD-WELL-1 or MW-01-07: installed late 2007 below heap leach pad sediment pond area, appears ice plugged at each visit, no samples able to be collected so far.

No water sample was collected from the camp potable water well in 2009 as the camp was not used by Western Copper.

Most of the existing monitoring wells will be decommissioned once project components are constructed. For the purposes of monitoring groundwater quality during operations of the Carmacks Copper mine, additional wells (or other complementary approaches) will be established on site, particularly downgradient of specific project components (i.e. heap leach area and waste rock storage area).

5.2 PROTOCOL

Sampling was undertaken using Standard Operating Procedures for the collection of groundwater samples and follow ASTM guides including the *D 4448-01: Standard Guide for Sampling Ground-Water Monitoring Wells*.

5.3 RESULTS

Table 21 shows the monitoring well locations, well depths, depth to water measured between 2006 and 2009, and includes whether or not the site was visited or if water was present.

As with surface water quality data, groundwater quality data collected since 2005 are stored in an EQWin database that is customized to manage environmental sampling data. Historic data is unavailable in its original format to be entered into the database.

Water quality summary graphs for certain parameters (arsenic, cadmium, copper, iron, lead, nickel, zinc) have been prepared for actively monitored wells and are presented in Figures 7 through 13.

Table 21 Monitoring Well Sample Locations, Events and Depth to Water Measurements 2006 - 2009

Monitoring Well #	MW96-A	MW96-B	MW96-C	MW96-D	MW96-E	MW96-F	MW96-H	MW96-I	MW96-J	MW96-K**	HYD-WELL-1 or MW-01-07	DW08-01	DW08-02
Easting	411395	411535	411946	412165	411385	411745	412453	412931	411950	412086	412219	411455	411404
Northing	6913718	6913433	6913059	6912838	6913271	6914708	6914635	6914367	6913899	6913459	6912688	6912473	6912458
Drilled Depth (m)	91.4	91.4	50.0	41.1	91.4	62.5	55.2	54.9	90.5	93.0			
Measured Depth (m)	89.67	91.97	50.0	10.38	93.25	6.59*	7.72*	2.81*	91.52	93.9			
Date													
Jun-06	62.09	42.22	40.38	No water	Not located	4.96	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Jul-06	62.14	42.53	No water	No water	Not located	No water	N/A	N/A	No water	N/A	N/A	N/A	N/A
Aug-06	62.43	42.34	42.06	No water	54.5	4.96	2.9	2.1	No water	N/A	N/A	N/A	N/A
Sep-06	64.53	42.14	40.45	No water	44.5	6.04	6.23	No water	91.58	N/A	N/A	N/A	N/A
Oct-06	62.65	43.01	42.64	No water	42.38	3.95*	No water	1.84	91.08	N/A	N/A	N/A	N/A
Apr-07	frozen	frozen	frozen	frozen	frozen	Little water	Not visited	Not visited	frozen	No water	N/A	N/A	N/A
May-07	no water	42.93	41.08		50.62	6.35	frozen	No water	91.57	No water	N/A	N/A	N/A
Jun-07	55.6	43.55	41.3	No water	52.8	6.44	1.84	No water	No water	No water	N/A	N/A	N/A
Jul-07	50.5	42.7	no water	No water	53.12	6.29	No water	2.11	No water	No water	N/A	N/A	N/A
Aug-07	48.2	43.52	41.4	No water	53.34	Little water	No water	No water	No water	No water	N/A	N/A	N/A
Sep-07	48.3	43.5	41.4	No water	53.55	Ice plug	No water	Ice plug	No water	No water	N/A	N/A	N/A
Oct-07	59.2	N/A***	19.5	No water	61.6	Ice plug	Ice plug	Ice plug	No water	No water	new well installed	N/A	N/A
May-08	7.18*	N/A***	41.17	Not visited	54.56	Not visited	Not visited	Not visited	Not visited	Not visited	Not visited	N/A	N/A
Jun-08	50.65	N/A***	40.96	No water	55.28*	Not visited	Not visited	Not visited	91.48	91.45	Not visited	N/A	N/A
Jul-08	47.87	N/A***	40.98	Not visited	54.8	Not visited	Ice plug	Not visited	Not visited	Not visited	plugged	N/A	N/A
Aug-08	61.35	N/A***	not recorded	No water	54.8	Not visited	Not visited	Not visited	No water	No water	plugged	5.18	6.68
Sep-08	64.35	N/A***	41.14	Not visited	55.43	Not visited	Not visited	Not visited	91.2	88.55	plugged	5.23	6.73
Oct-08	58	N/A***	51.08	No water	82	Not visited	Not visited	Not visited	75	83	frozen	6.5	6.8
Nov-08	No water	N/A***	waterra frozen	Not visited	Not visited	Not visited	Not visited	Not visited	Not visited	Not visited	Not visited	Not visited	Not visited
May-09	44.47*	N/A***	39.48	No water	51.3	Not visited	Not visited	Not visited	ice build-up	ice build-up	frozen	Not visited	Not visited
Jul-09	ice build-up	N/A***	38.57	No water	No water	Not visited	Not visited	Not visited	ice build-up	ice build-up	frozen	Not visited	Not visited
Oct-09	55.87	N/A***	47.53	No water	46	Not visited	Not visited	Not visited	90.61	91.6	Not visited	Not visited	Not visited

* Depth to ice

**Assumed buried by trenching until located in April 2007

*** Bailer jammed at ~29 m Sept07

Figure 7 Carmacks Copper Monitoring Wells, Total Arsenic

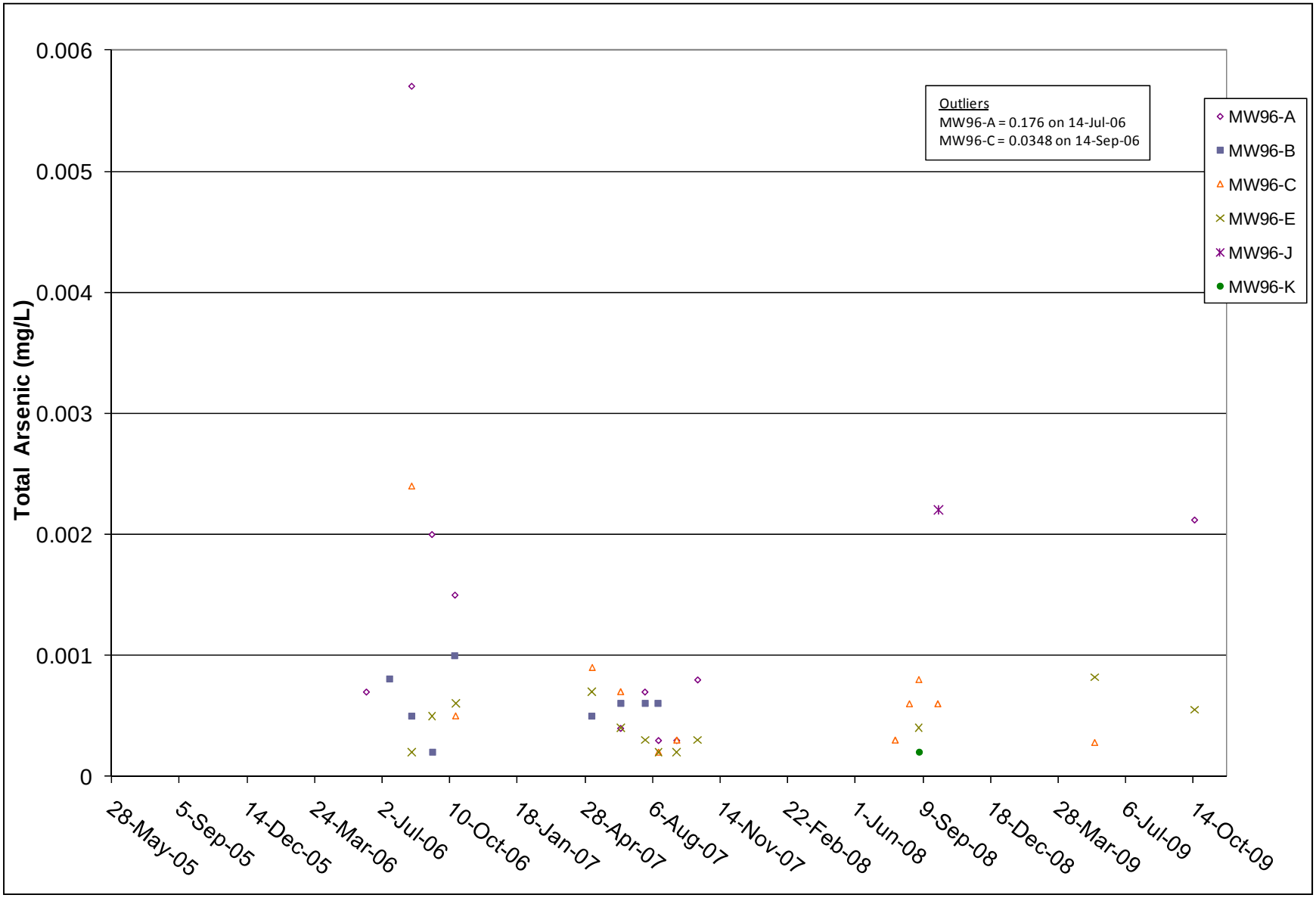


Figure 8 Carmacks Copper Monitoring Wells, Total Cadmium

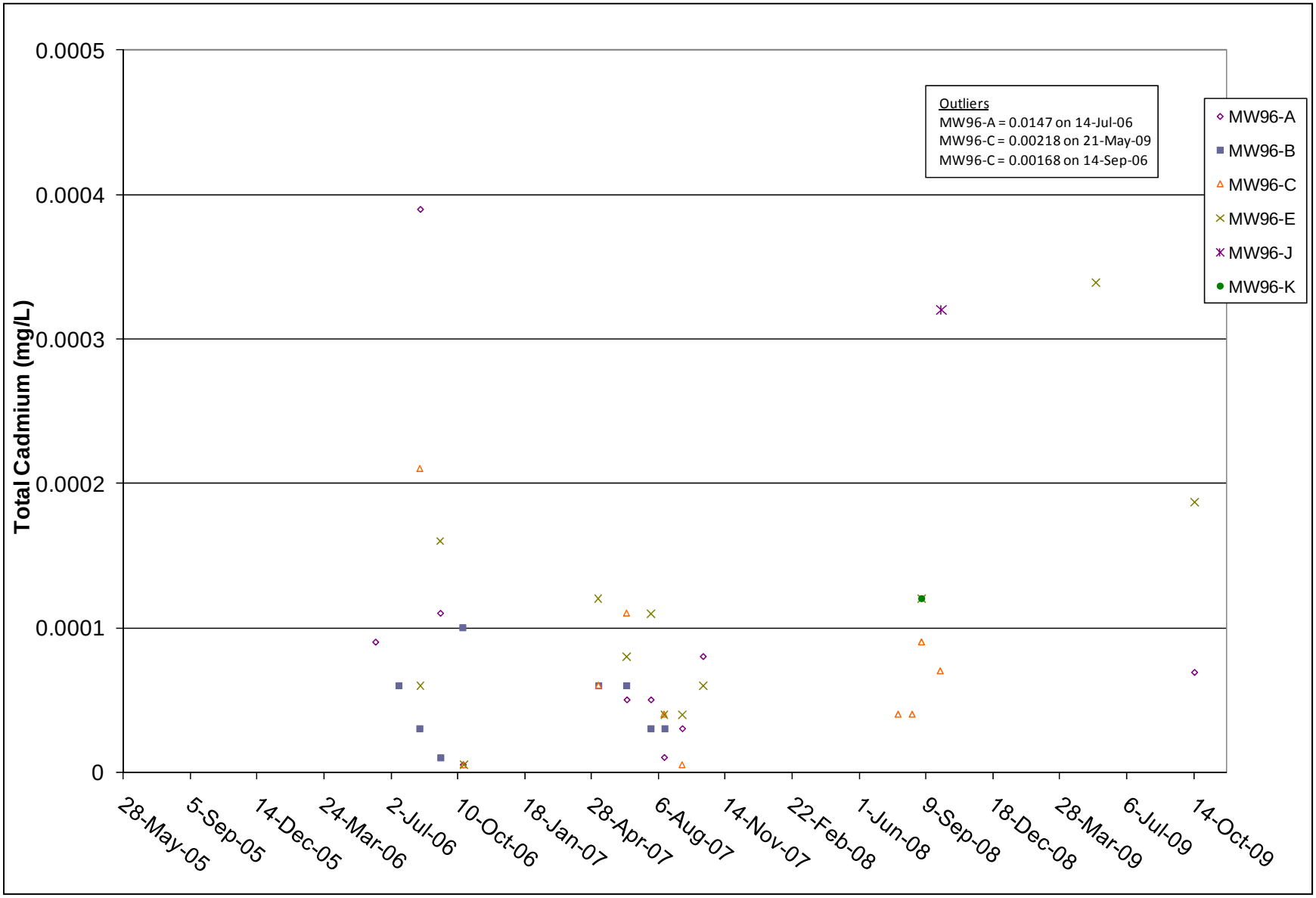


Figure 9 Carmacks Copper Monitoring Wells, Total Copper

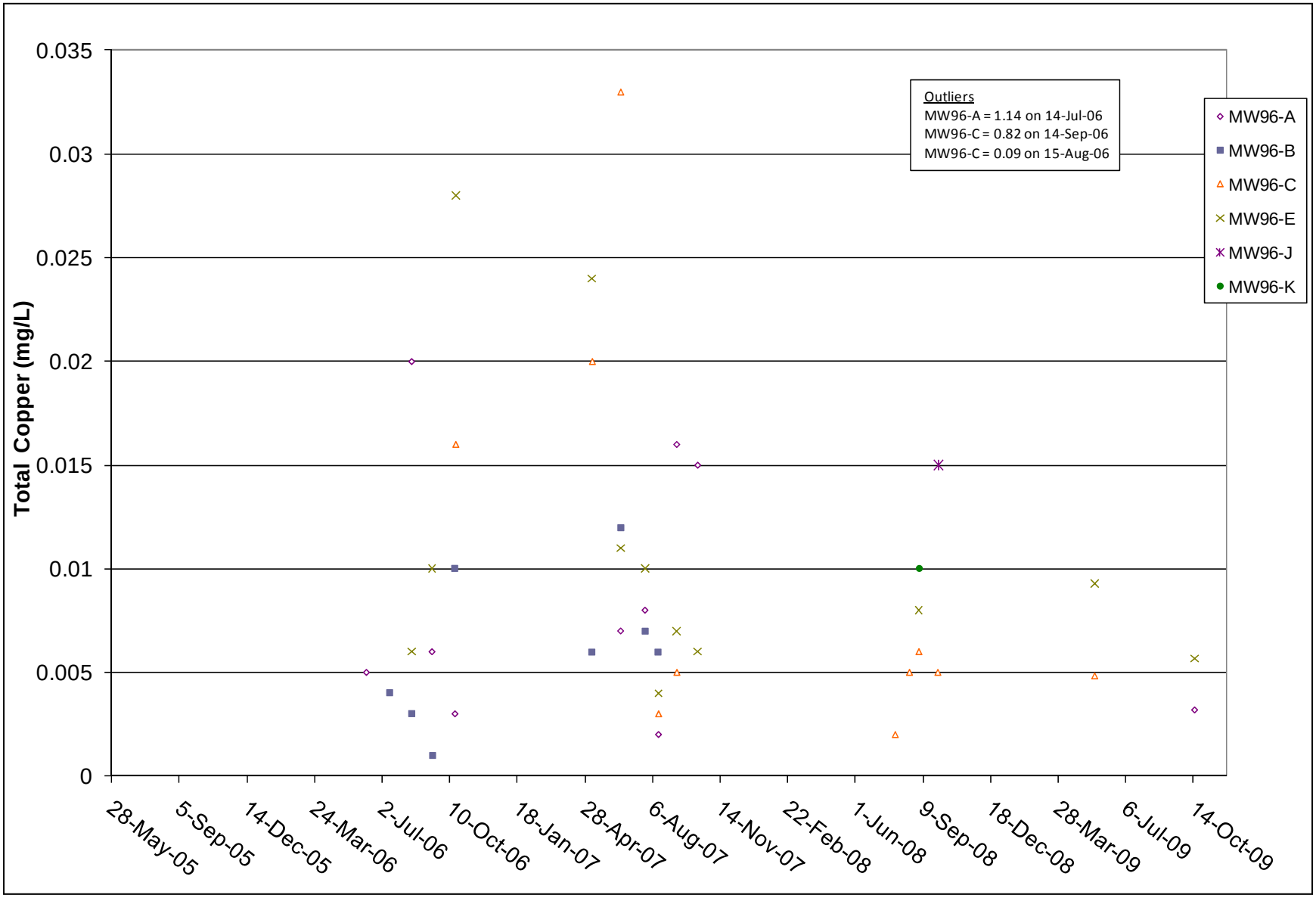


Figure 10 Carmacks Copper Monitoring Wells, Total Iron

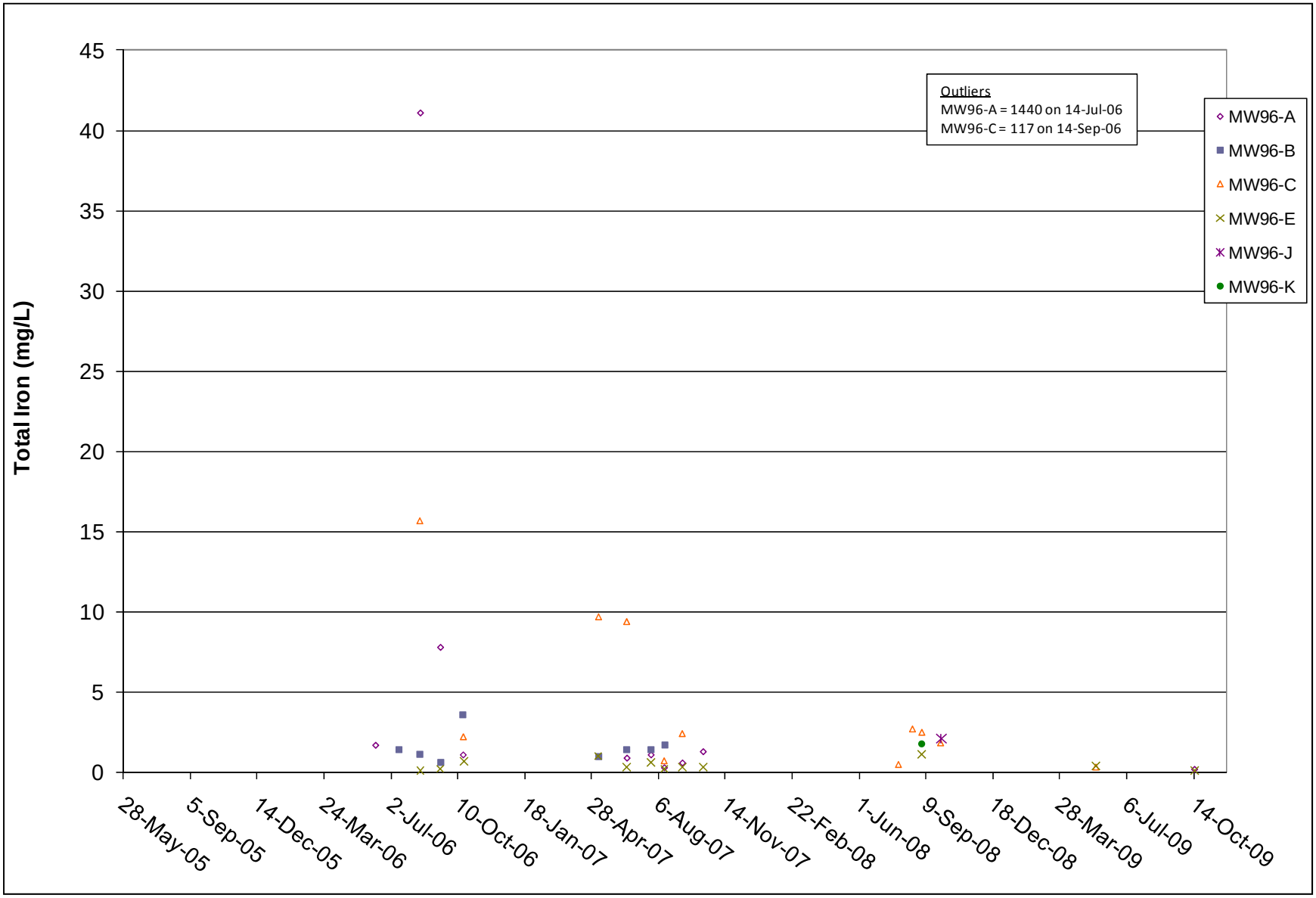


Figure 11 Carmacks Copper Monitoring Wells, Total Lead

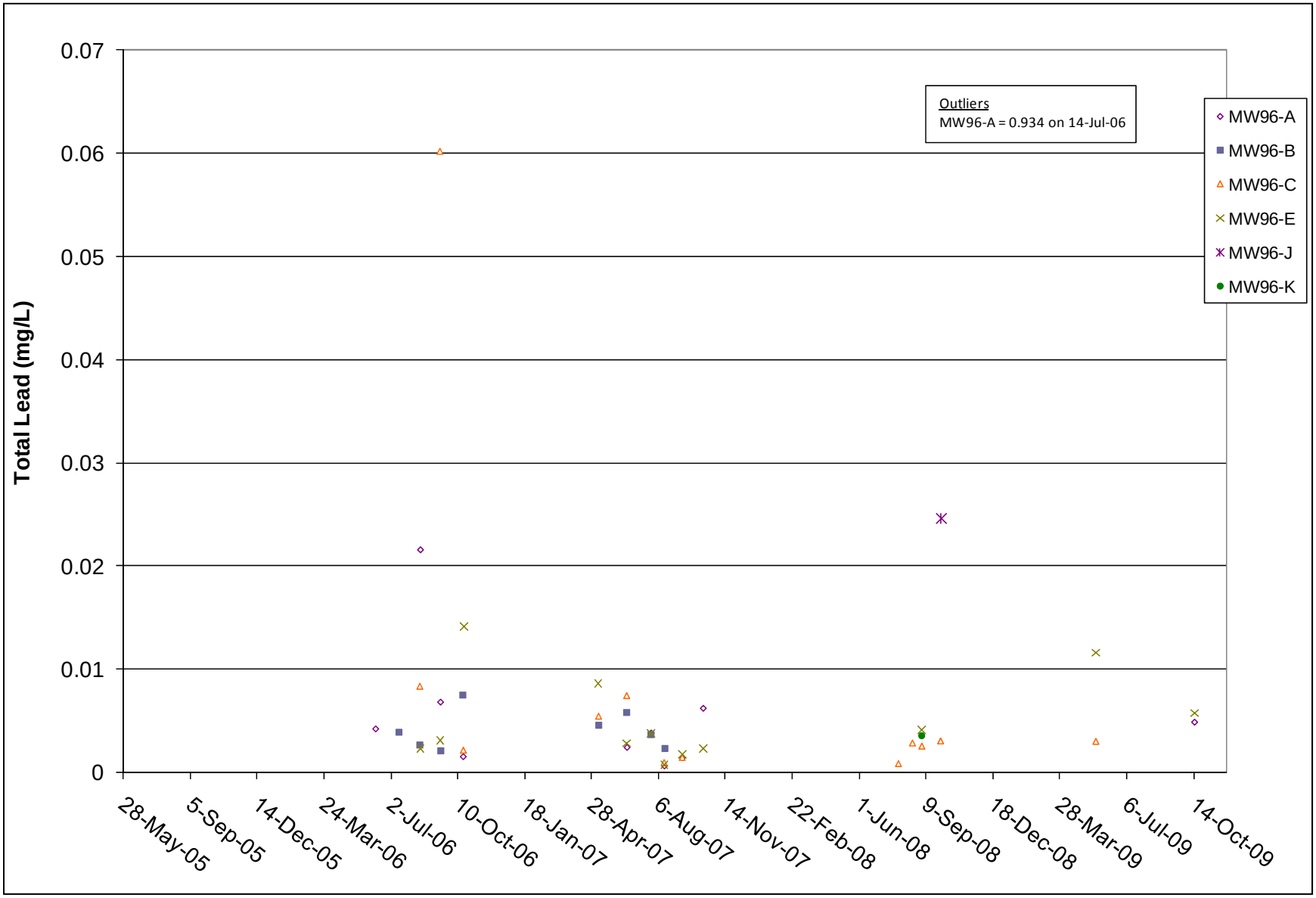


Figure 12 Carmacks Copper Monitoring Wells, Total Nickel

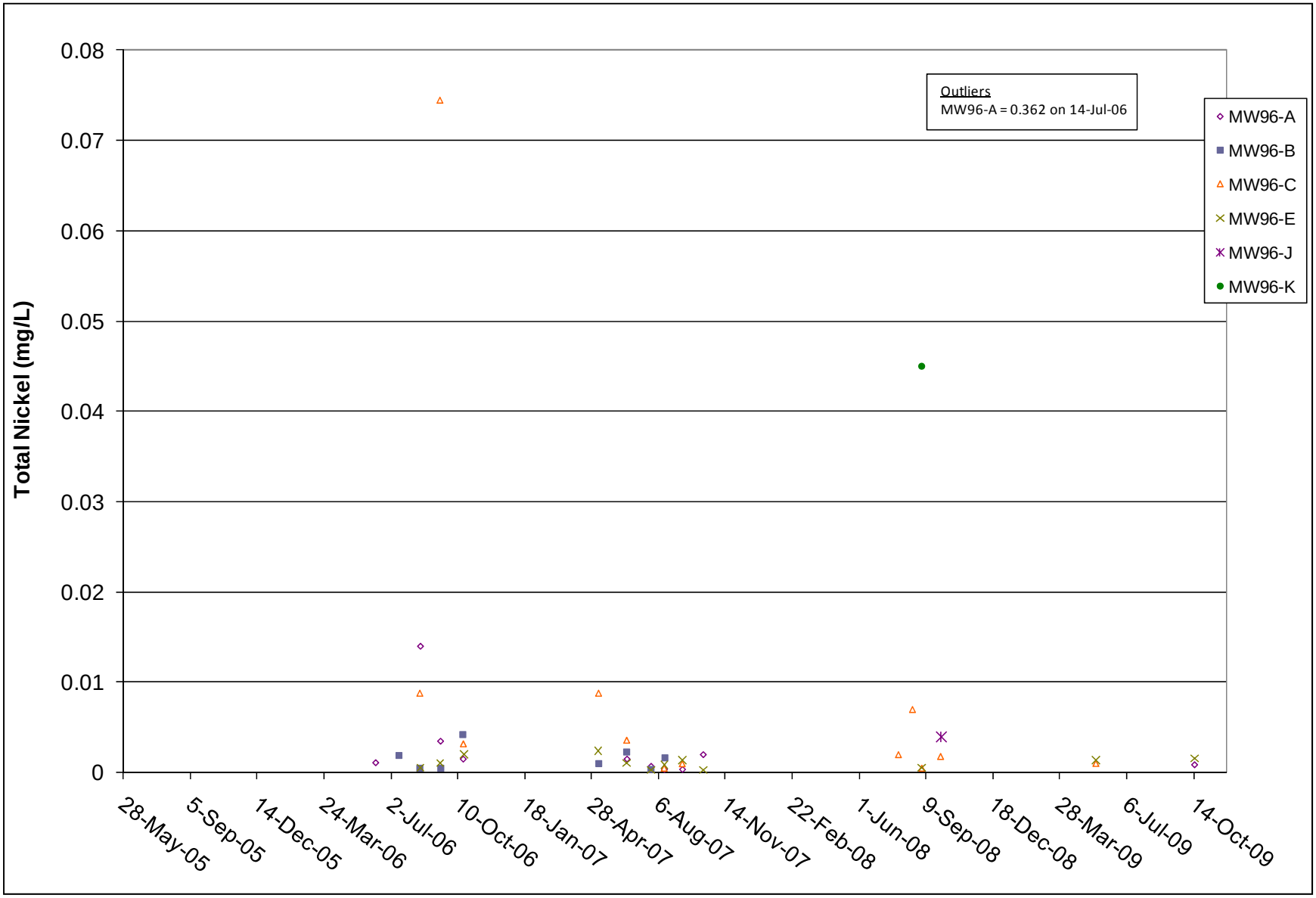
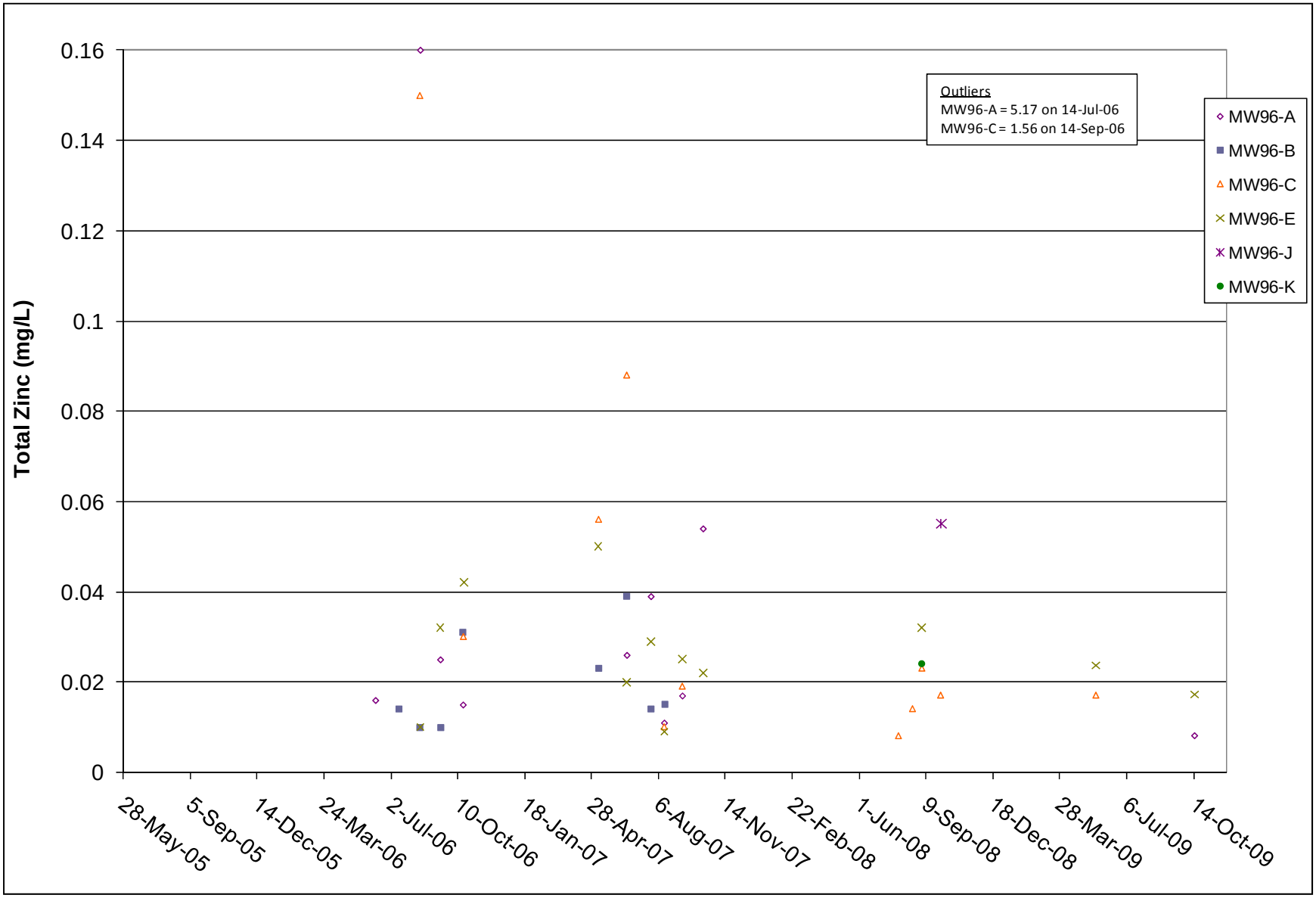


Figure 13 Carmacks Copper Monitoring Wells, Total Zinc



6.0 SEDIMENT SAMPLING

Regular sediment sampling has been carried out in conjunction with a water quality sampling event to establish baseline conditions. No sediment sampling took place in 2009; please refer to the 2008 *Environmental Monitoring Program Update and Data Summary – Revision No.4* for a summary of sediment quality data.

7.0 BENTHIC INVERTEBRATES

Benthic samples were last collected in conjunction with the September 2007 water sampling event at stations W4, W10, W11, W12 and W13 with results provided in the *Environmental Monitoring Program Update & Data Summary – Revision No. 3*.

8.0 FISHERIES INVESTIGATIONS

Two fisheries investigations were carried out in 2009 to confirm fish usage of the Williams Creek watershed. On July 11 and 12, Rem Ricks of Access Consulting Group conducted a fisheries investigation on Williams Creek and Nancy Lee Creek. The investigation employed minnow trapping practices, where 12 Gee-type minnow traps were distributed among six sample sites (W4, W9, W10, W11, W12 and W13). Two (2) Chinook fry (approximately 60 mm each) were captured at station W10, with no other fish captured at the other stations. Mr. Ricks conducted a second fisheries investigation on Williams Creek during the September site visit. The investigation employed the same minnow trapping practices as the July investigation. Twenty-four (24) Chinook fry (average fork length @ 61.1 mm) were captured at station W10. Results for all minnow trapping efforts are provided in Table 22.

Table 22 July and September 2009 Fisheries Investigations

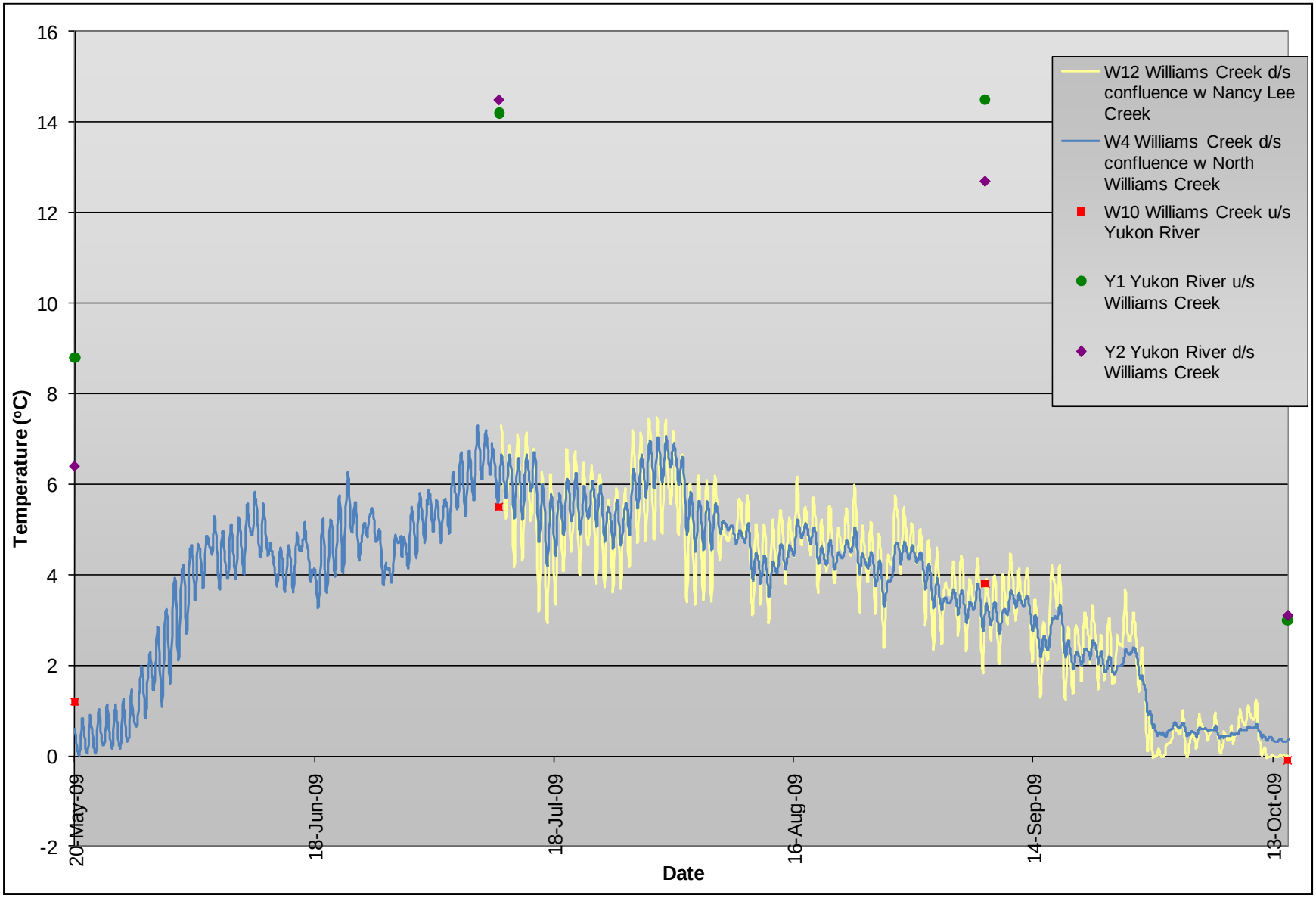
Date	Station	Water Body	# Traps	Soak (hrs)	Results
July 11	W4	Williams Creek	2	17 hr	Nil
July 11	W9	Williams Creek	2	32 hr	Nil
July 11	W10	Williams Creek	2	22.5	2 Ch @ 60 mm *
July 11	W11	Nancy Lee Creek	2	21 hr	Nil **
July 11	W12	Williams Creek	2	20 hr	Nil
July 11	W13	Williams Creek	2	20 hr	Nil
September 9	W4	Williams Creek	2	15.5	Nil
September 9	W9	Williams Creek	2	21	Nil
September 9	W10	Williams Creek	2	22	24 Ch; 1 SS*
September 9	W11	Nancy Lee Creek	2	21.5	Nil
September 9	W12	Williams Creek	2	21.5	Nil
September 9	W13	Williams Creek	2	21.5	Nil

Ch = Chinook salmon; SS = Slimy Sculpin
** this site is a short distance u/s from the Yukon River and the presence of Chinook salmon fry is to be expected.*
*** one adult Arctic grayling observed in a pool at this site.*

Results of the 2009 fisheries investigations are consistent with results from previous years, with no fish observed in the upper Williams Creek watershed. Water temperatures in this watershed can help explain why fish may find the habitat unsuitable as compared to the Yukon River. In addition to in-situ temperature measurements, data loggers installed at hydrology stations W4 and W12 record water temperature as well as water level. Figure 14 below shows temperatures recorded by the two data loggers as well as in-situ measurements taken at stations W10, Y1 and Y2.

As is shown in Figure 14, there is a significant difference in temperature between the Yukon River and Williams Creek. This temperature differential and diurnal temperature fluctuation in Williams Creek likely discourage the use of the system for rearing by fish.

Figure 14 2009 Williams Creek and Yukon River Temperature Measurements



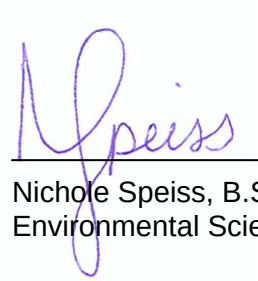
9.0 WILDLIFE SURVEYS

No wildlife surveys were conducted in 2009. November post-rut moose surveys including gender/age composition will be conducted annually for the first three years of project construction/operations after which surveys are planned for every three years.

10.0 CLOSING STATEMENT

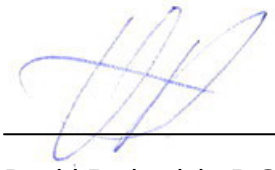
Access Consulting Group of Whitehorse, Yukon, has prepared this *2009 Environmental Monitoring Program Update and Data Summary – Revision No.5* for the Carmacks Copper Project. If you have any questions or require further details, please contact the undersigned.

Prepared By:



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Environmental Scientist

Reviewed By:



David Petkovich, B.Sc.
Senior Environmental Manager

11.0 REFERENCES

Access Consulting Group. 2008. Environmental Monitoring Program Update and Data Summary – Revision No.3.

Access Consulting Group. 2008. Environmental Monitoring Program, Construction Version – October 2008, Carmacks Copper Project.

Access Consulting Group. 2009. Environmental Monitoring Program Update and Data Summary – Revision No.4.

CCME (Canadian Council of Ministers of the Environment). 1999. Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment, Winnipeg. With Updates.

Minnow Environmental Inc. 2008. Evaluation of Water Quality and Development of Background-Based Site-Specific Water Quality Objectives for Williams Creek.

Water Resources Branch, Environment Yukon. 2010. Yukon Snow Survey Bulletin & Water Supply Forecast.

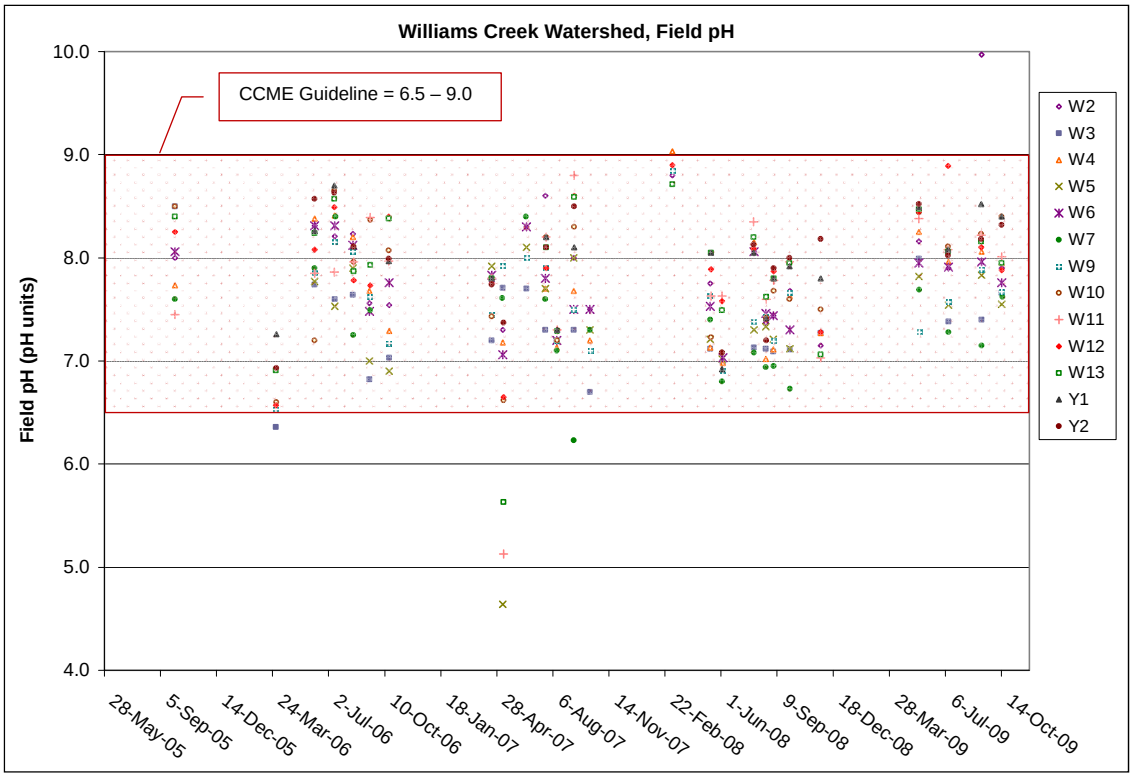
Western Copper Corporation

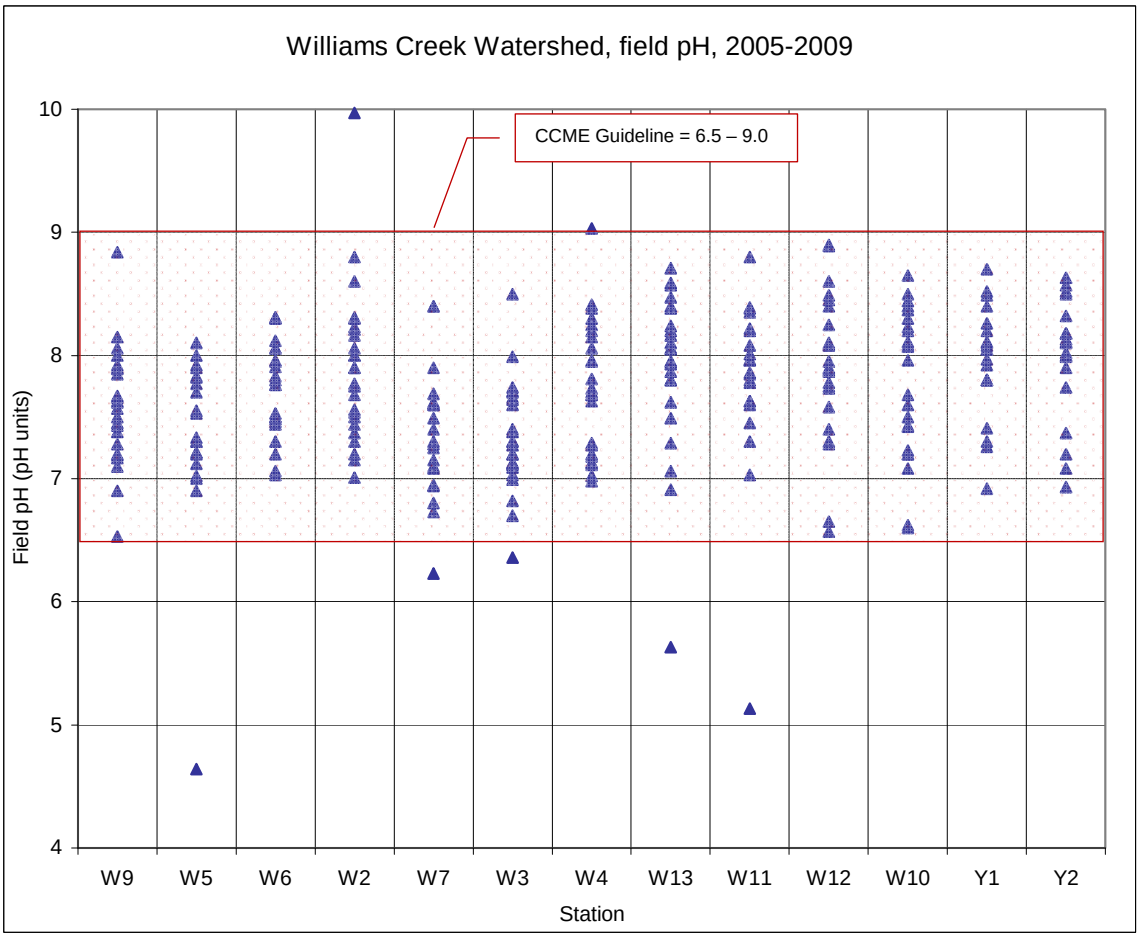
2009 ENVIRONMENTAL MONITORING PROGRAM UPDATE AND DATA SUMMARY – REVISION NO.5

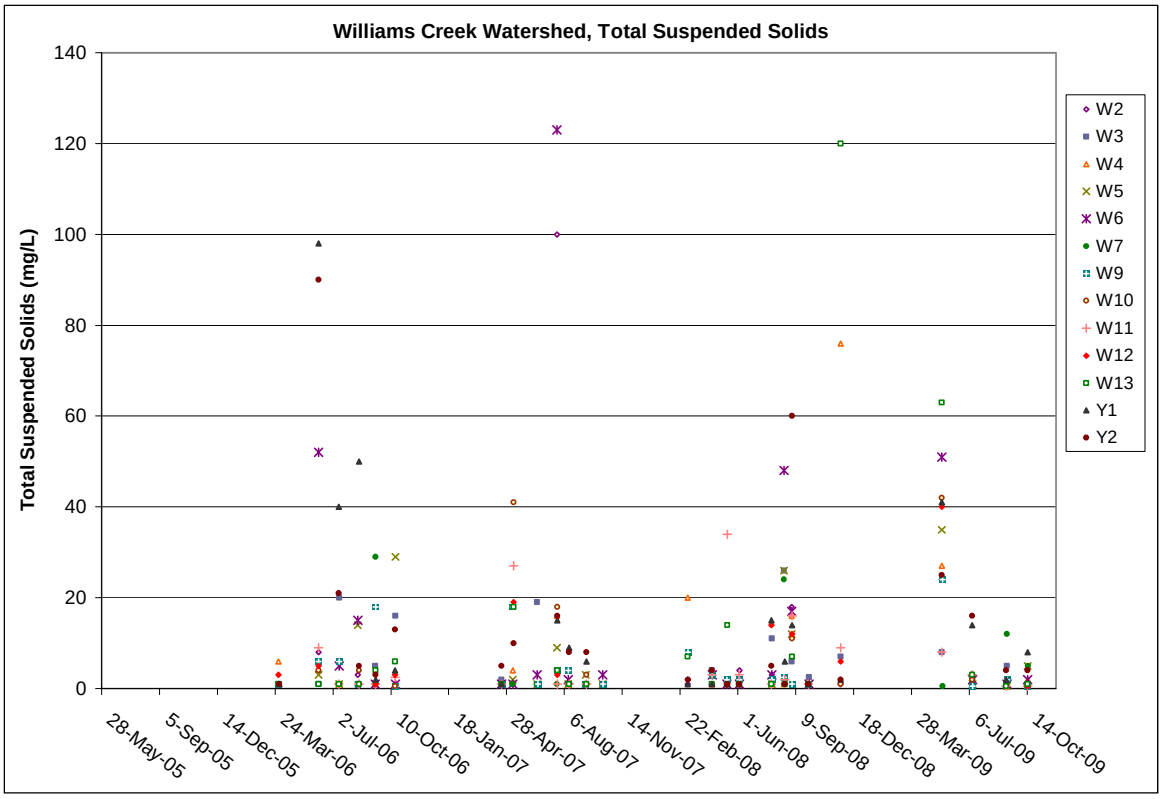
CARMACKS COPPER PROJECT
YUKON TERRITORY

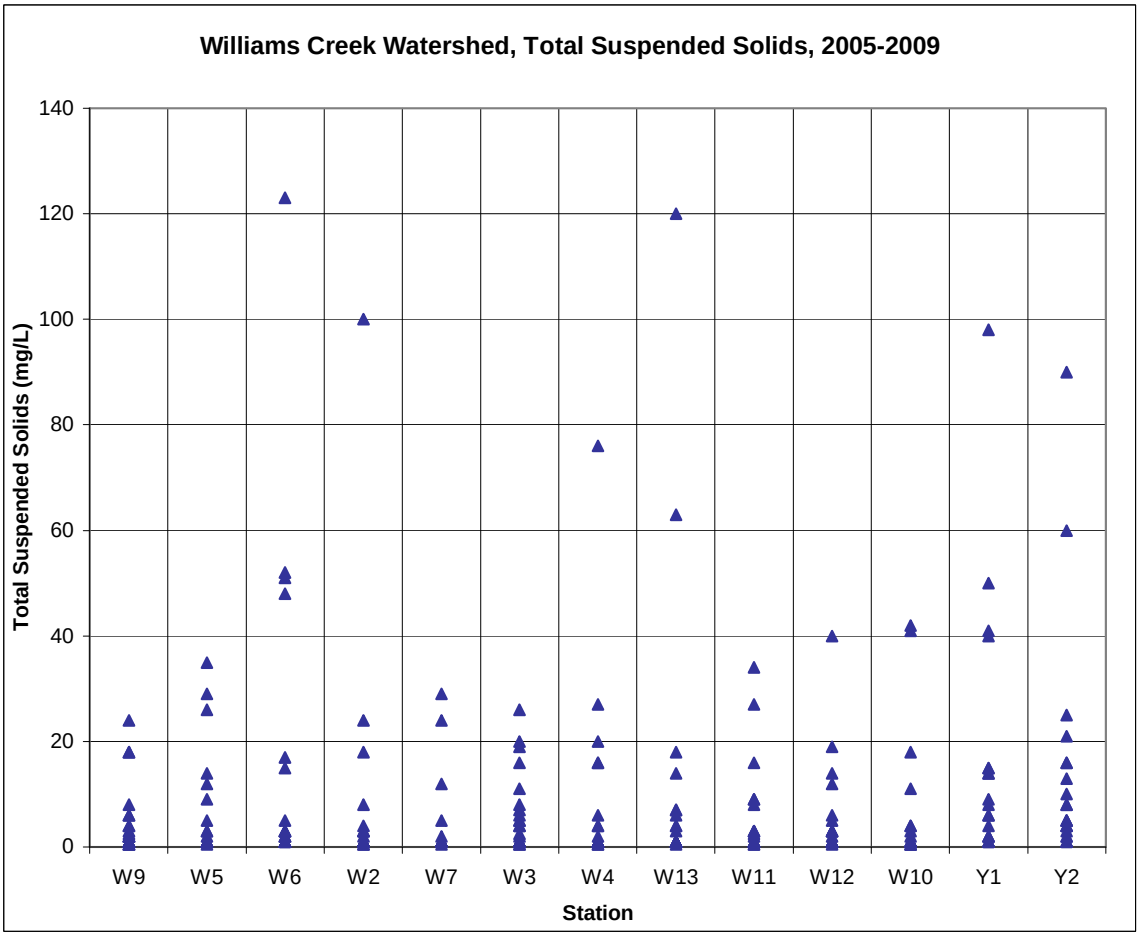
Appendix A

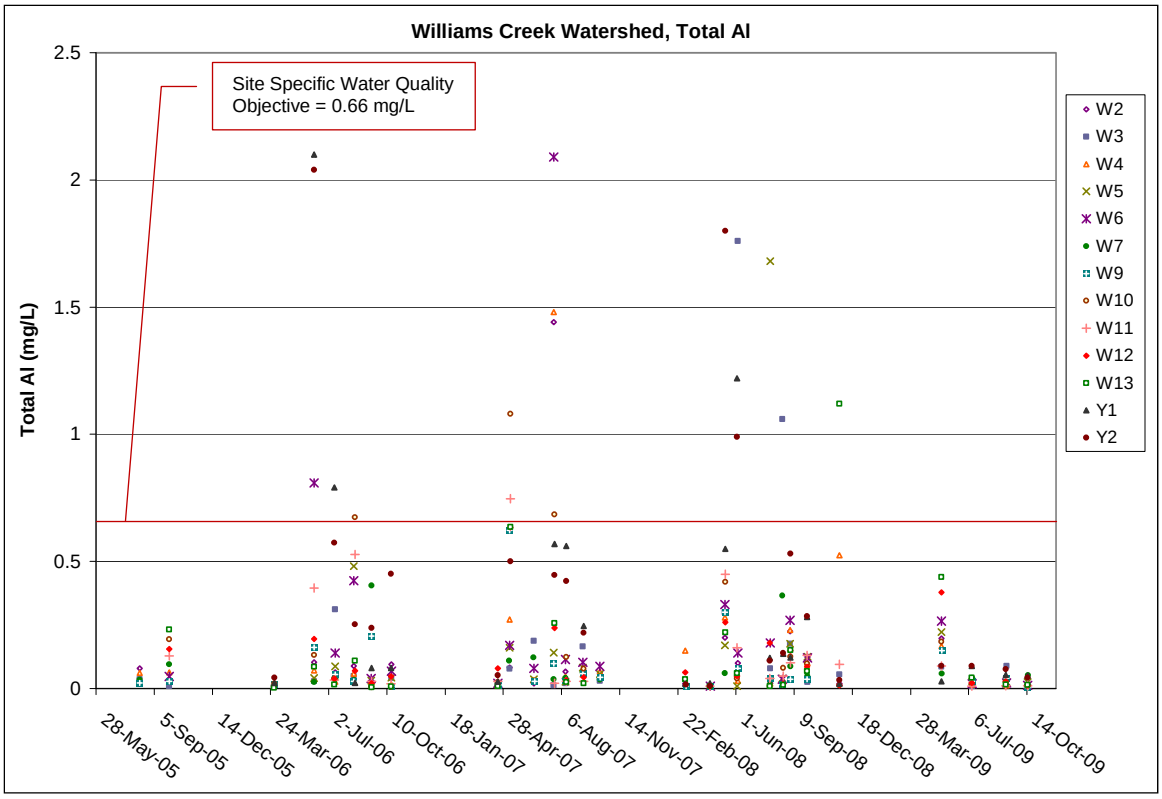
Water Quality Graphs for Williams Creek Watershed, 2005 to 2009

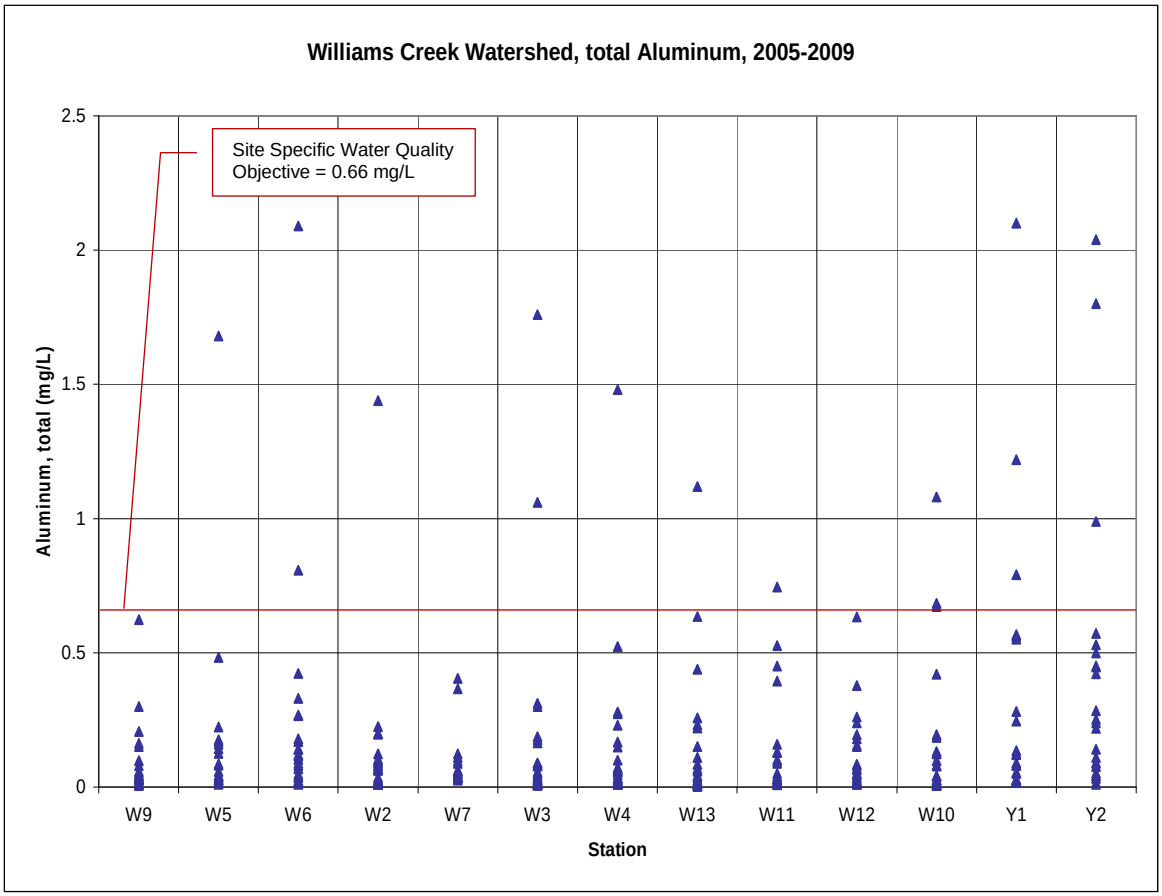

Williams Creek Watershed, Field pH
CCME Guideline = 6.5 – 9.0
Field pH (pH units)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
W2
W3
W4
W5
W6
W7
W9
W10
W11
W12
W13
Y1
Y2
28-May-05
5-Sep-05
14-Dec-05
24-Mar-06
2-Jul-06
10-Oct-06
18-Jan-07
28-Apr-07
6-Aug-07
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6-Jul-09
14-Oct-09

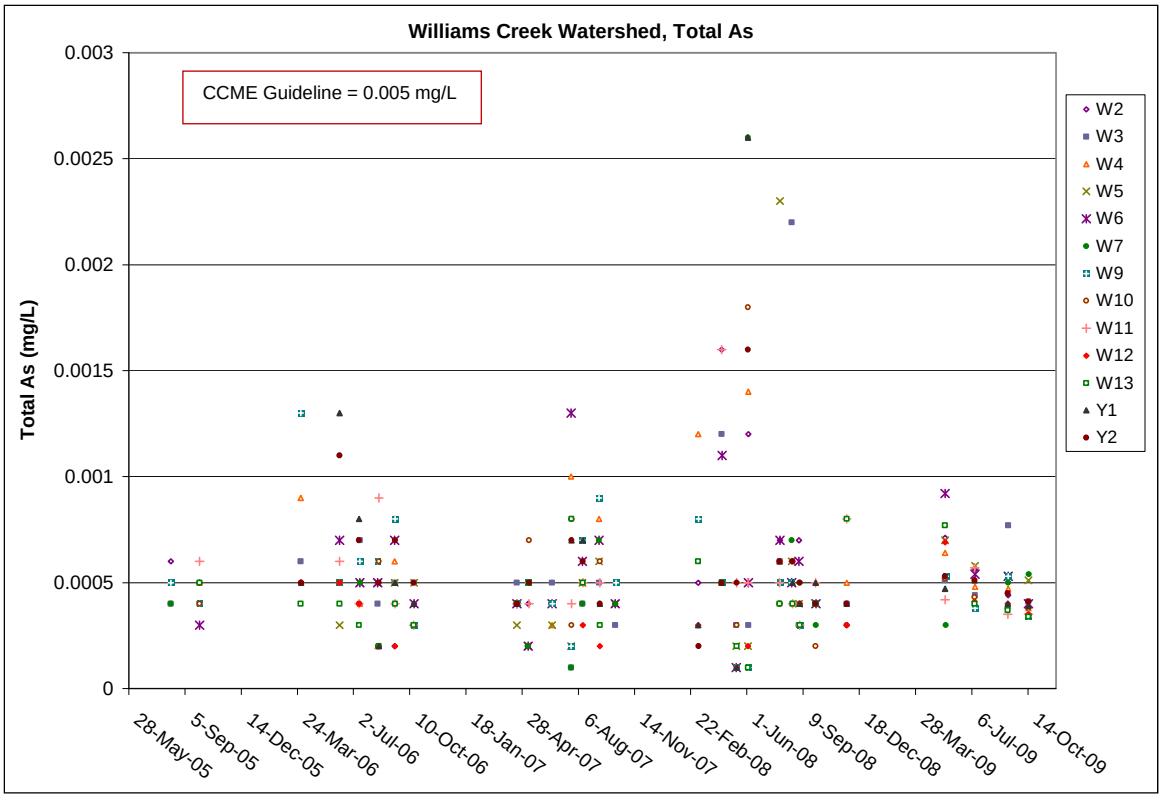

Williams Creek Watershed, field pH, 2005-2009
CCME Guideline = 6.5 – 9.0
Field pH (pH units)
10
9
8
7
6
5
4
W9
W5
W6
W2
W7
W3
W4
W13
W11
W12
W10
Y1
Y2
Station

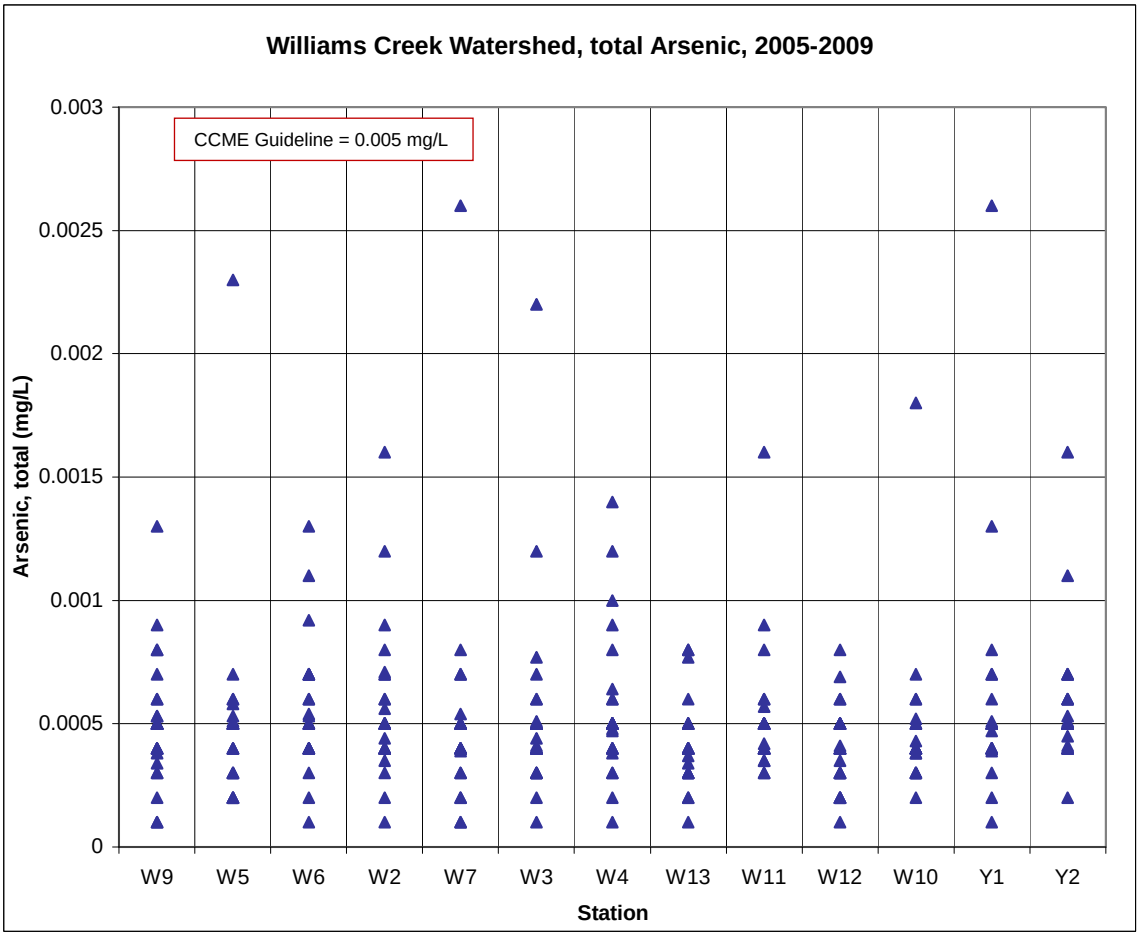

Williams Creek Watershed, Total Suspended Solids
Total Suspended Solids (mg/L)
140
120
100
80
60
40
20
0
28-May-05
5-Sep-05
14-Dec-05
24-Mar-06
2-Jul-06
10-Oct-06
18-Jan-07
28-Apr-07
6-Aug-07
14-Nov-07
22-Feb-08
1-Jun-08
9-Sep-08
18-Dec-08
28-Mar-09
6-Jul-09
14-Oct-09
W2
W3
W4
W5
W6
W7
W9
W10
W11
W12
W13
Y1
Y2

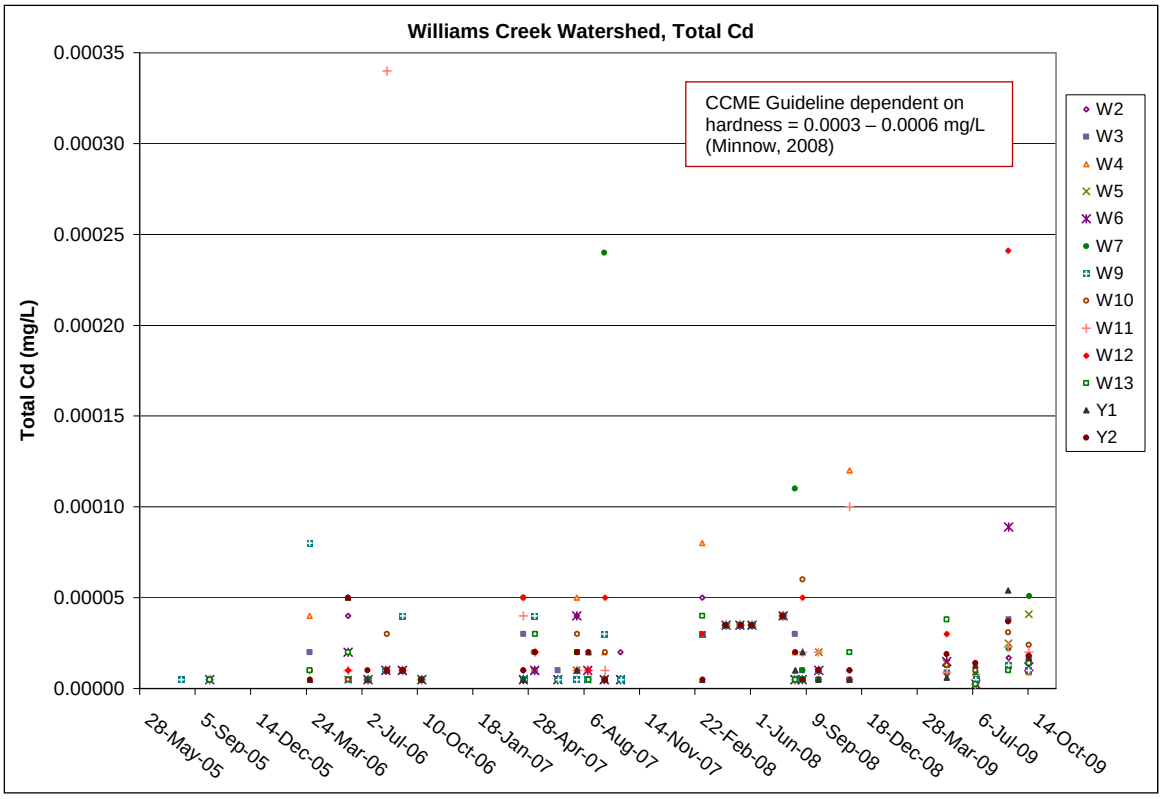

Williams Creek Watershed, Total Suspended Solids, 2005-2009
Total Suspended Solids (mg/L)
140
120
100
80
60
40
20
0
W9
W5
W6
W2
W7
W3
W4
W13
W11
W12
W10
Y1
Y2
Station

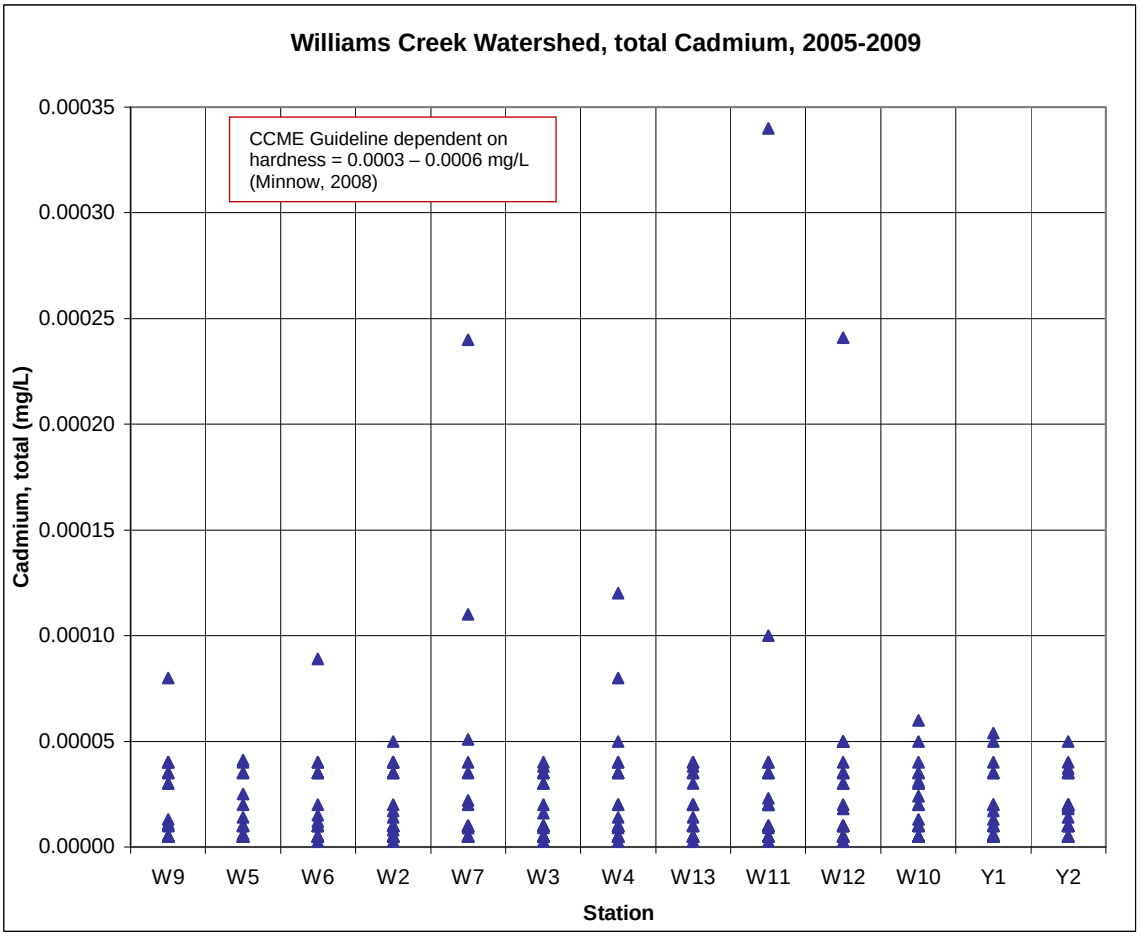

Williams Creek Watershed, Total Al
Site Specific Water Quality Objective = 0.66 mg/L
Total Al (mg/L)
2.5
2
1.5
1
0.5
0
W2
W3
W4
W5
W6
W7
W9
W10
W11
W12
W13
Y1
Y2
28-May-05
5-Sep-05
14-Dec-05
24-Mar-06
2-Jul-06
10-Oct-06
18-Jan-07
28-Apr-07
6-Aug-07
14-Nov-07
22-Feb-08
1-Jun-08
9-Sep-08
18-Dec-08
28-Mar-09
6-Jul-09
14-Oct-09

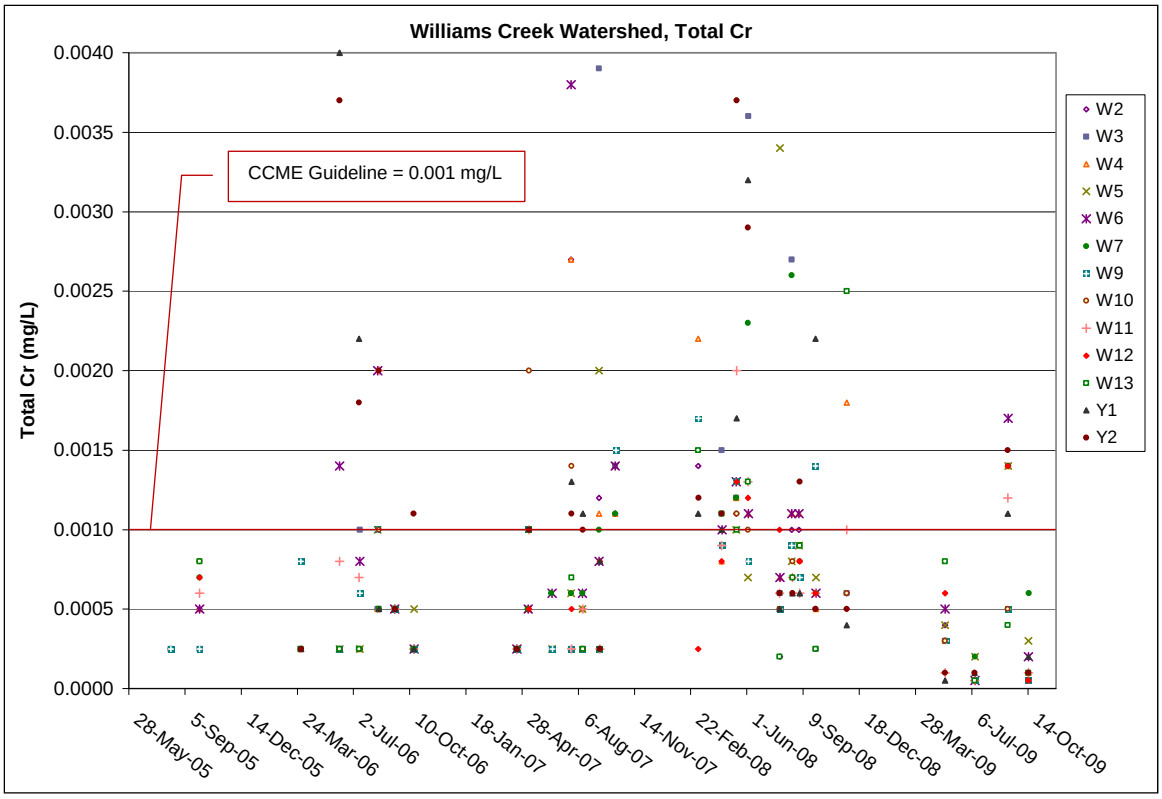

Williams Creek Watershed, total Aluminum, 2005-2009
Site Specific Water Quality Objective = 0.66 mg/L
Aluminum, total (mg/L)
2.5
2
1.5
1
0.5
0
W9
W5
W6
W2
W7
W3
W4
W13
W11
W12
W10
Y1
Y2
Station

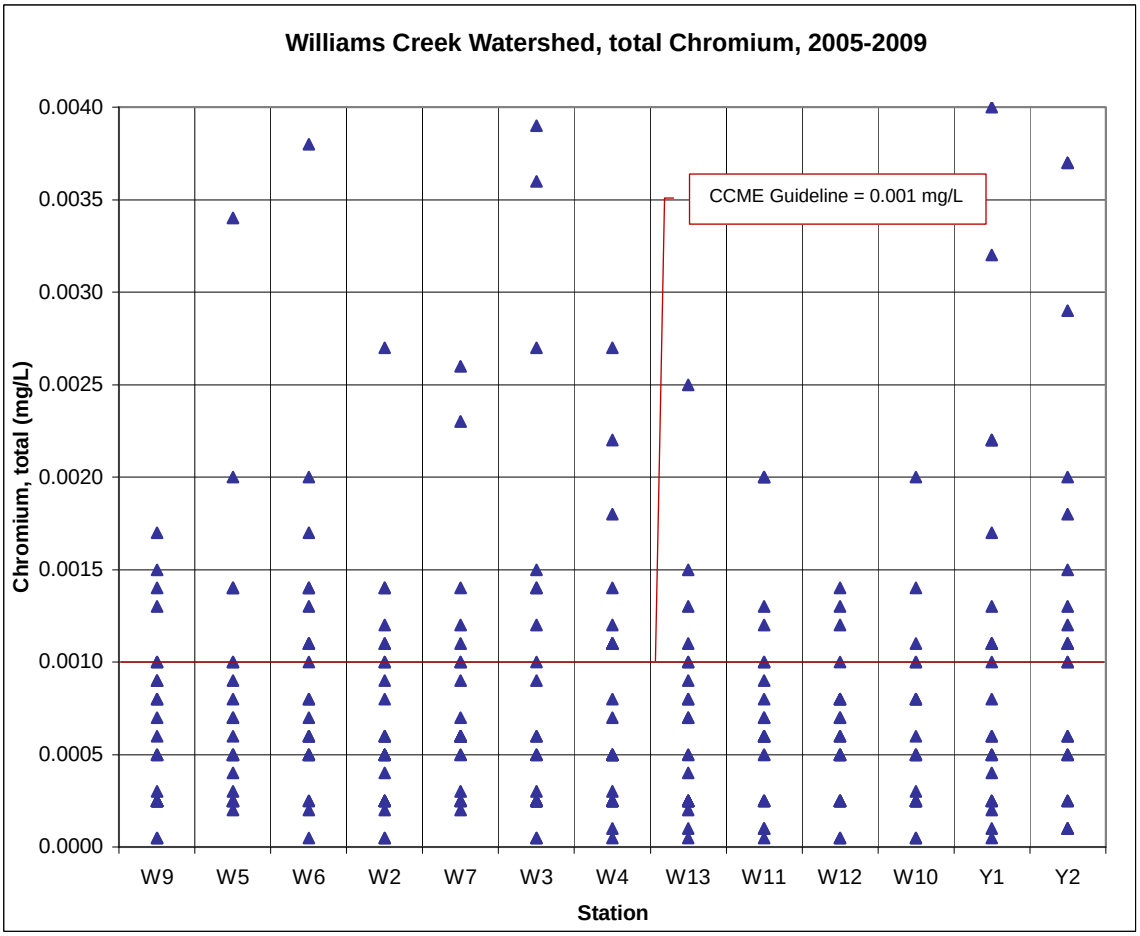

Williams Creek Watershed, Total As
CCME Guideline = 0.005 mg/L
Total As (mg/L)
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
28-May-05
5-Sep-05
14-Dec-05
24-Mar-06
2-Jul-06
10-Oct-06
18-Jan-07
28-Apr-07
6-Aug-07
14-Nov-07
22-Feb-08
1-Jun-08
9-Sep-08
18-Dec-08
28-Mar-09
6-Jul-09
14-Oct-09
W2
W3
W4
W5
W6
W7
W9
W10
W11
W12
W13
Y1
Y2

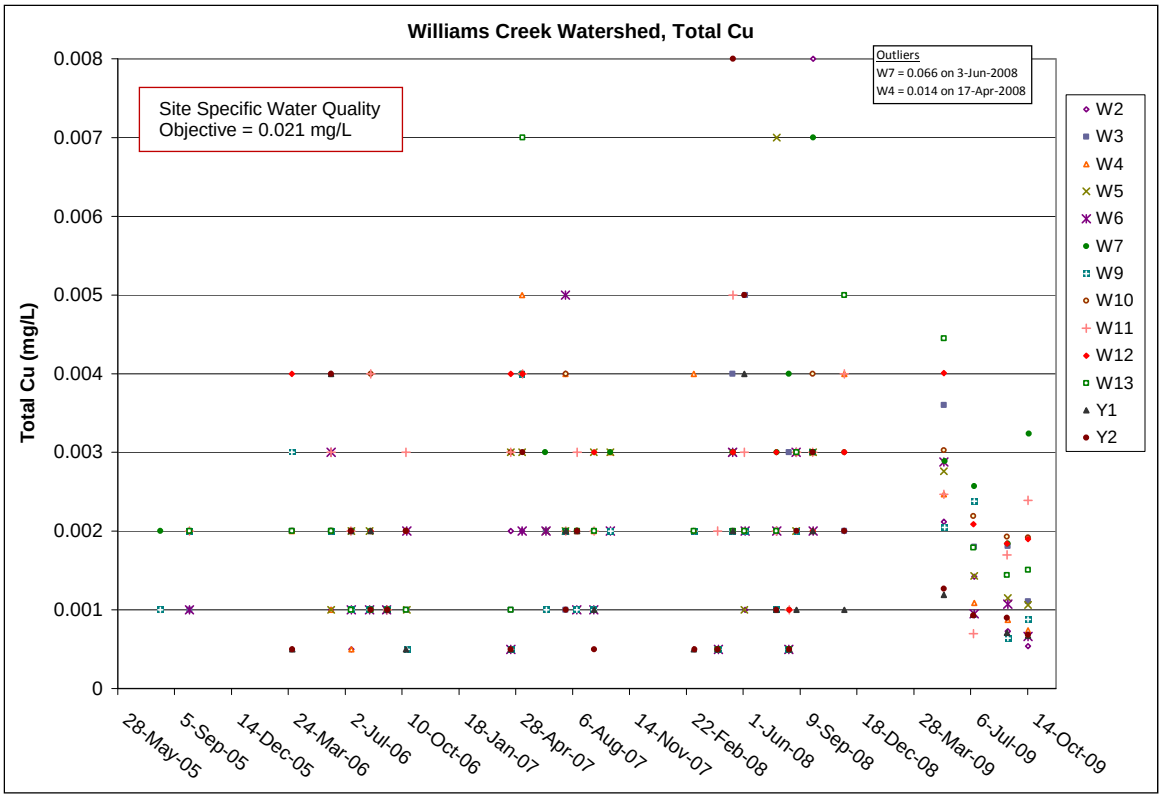

Williams Creek Watershed, total Arsenic, 2005-2009
CCME Guideline = 0.005 mg/L
Arsenic, total (mg/L)
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
W9
W5
W6
W2
W7
W3
W4
W13
W11
W12
W10
Y1
Y2
Station

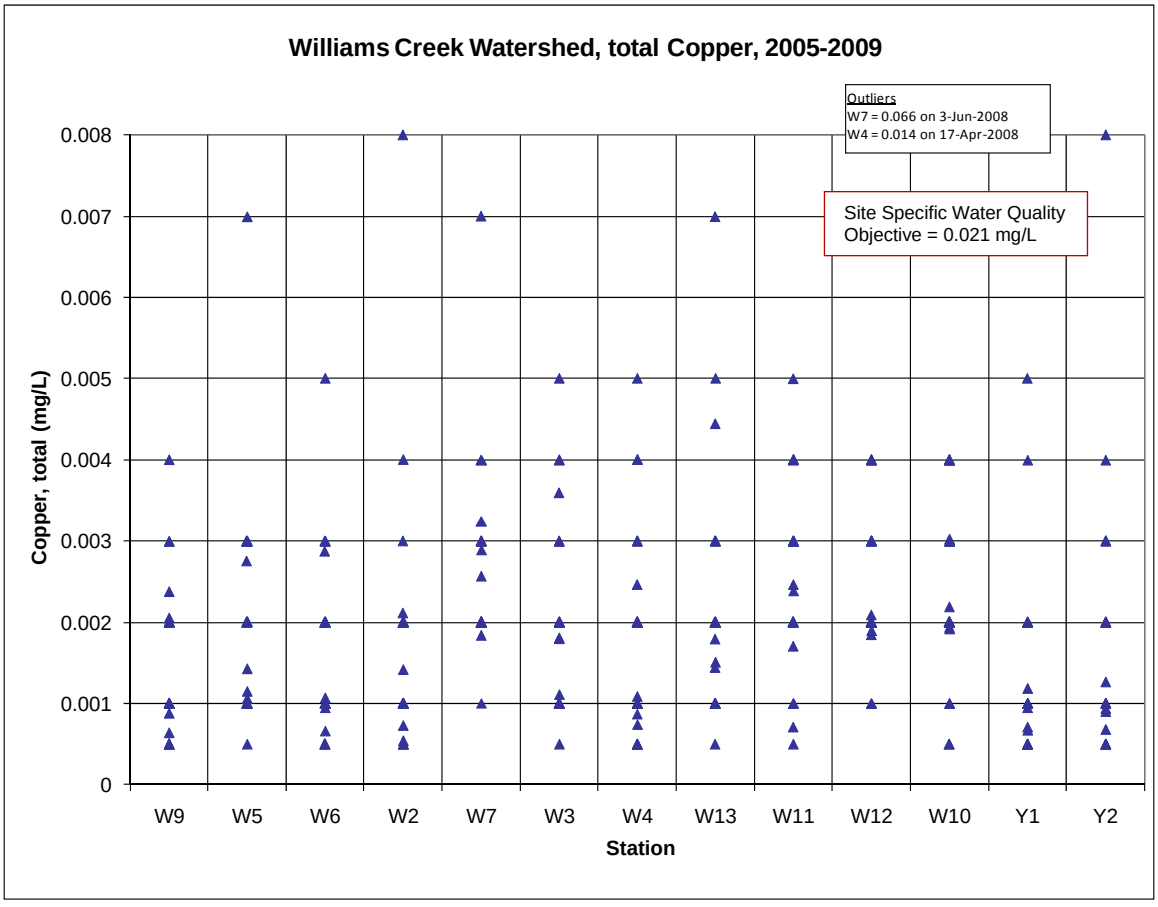

Williams Creek Watershed, Total Cd
Total Cd (mg/L)
0.00035
0.00030
0.00025
0.00020
0.00015
0.00010
0.00005
0.00000
CCME Guideline dependent on hardness = 0.0003 – 0.0006 mg/L (Minnow, 2008)
W2
W3
W4
W5
W6
W7
W9
W10
W11
W12
W13
Y1
Y2
28-May-05
5-Sep-05
14-Dec-05
24-Mar-06
2-Jul-06
10-Oct-06
18-Jan-07
28-Apr-07
6-Aug-07
14-Nov-07
22-Feb-08
1-Jun-08
9-Sep-08
18-Dec-08
28-Mar-09
6-Jul-09
14-Oct-09

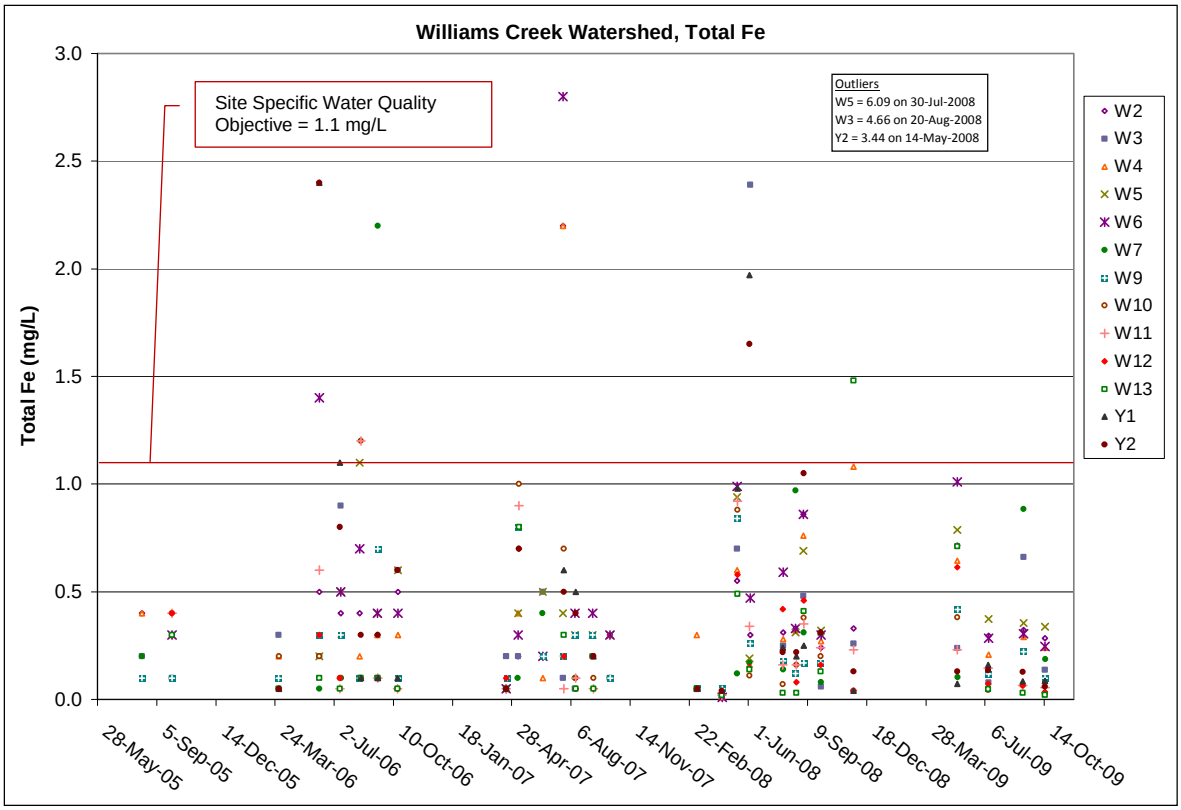

Williams Creek Watershed, total Cadmium, 2005-2009
Cadmium, total (mg/L)
0.00035
0.00030
0.00025
0.00020
0.00015
0.00010
0.00005
0.00000
CCME Guideline dependent on hardness = 0.0003 – 0.0006 mg/L (Minnow, 2008)
W9
W5
W6
W2
W7
W3
W4
W13
W11
W12
W10
Y1
Y2
Station

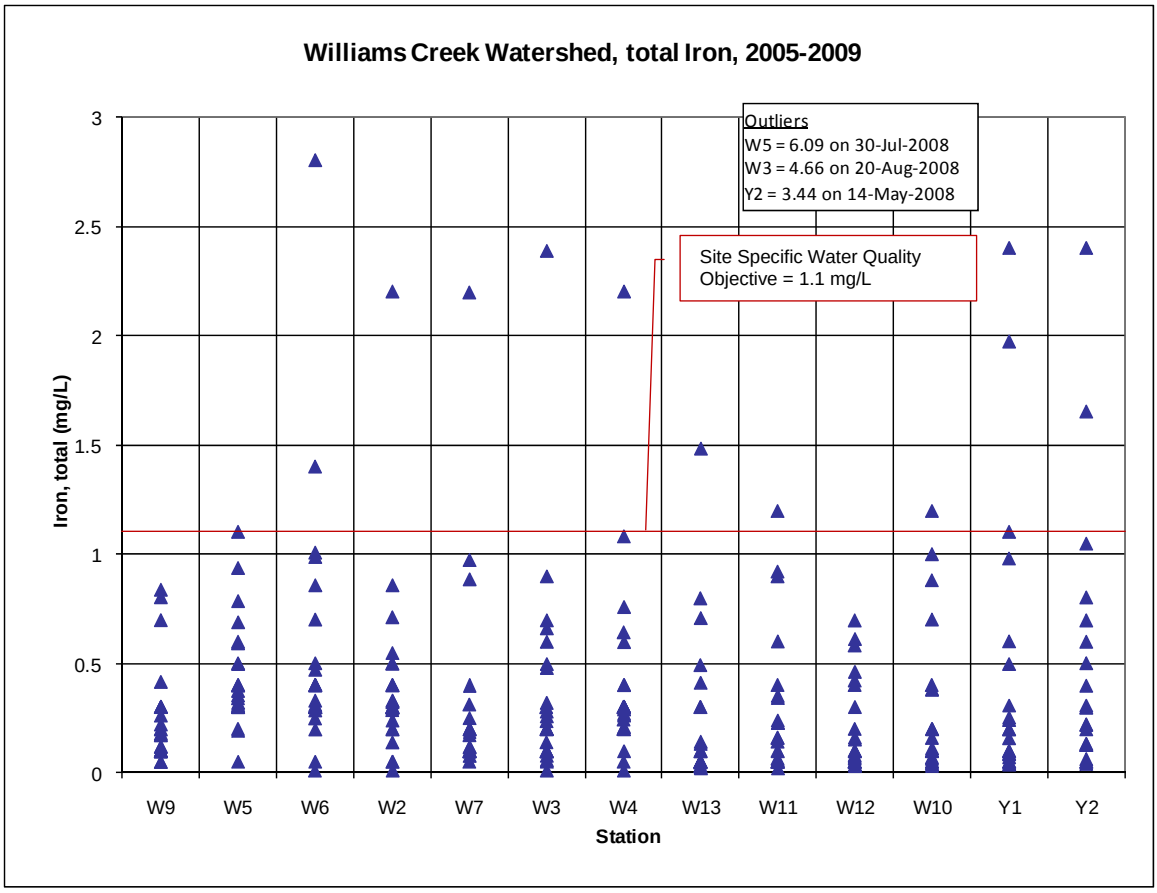

Williams Creek Watershed, Total Cr
Total Cr (mg/L)
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
CCME Guideline = 0.001 mg/L
W2
W3
W4
W5
W6
W7
W9
W10
W11
W12
W13
Y1
Y2
28-May-05
5-Sep-05
14-Dec-05
24-Mar-06
2-Jul-06
10-Oct-06
18-Jan-07
28-Apr-07
6-Aug-07
14-Nov-07
22-Feb-08
1-Jun-08
9-Sep-08
18-Dec-08
28-Mar-09
6-Jul-09
14-Oct-09

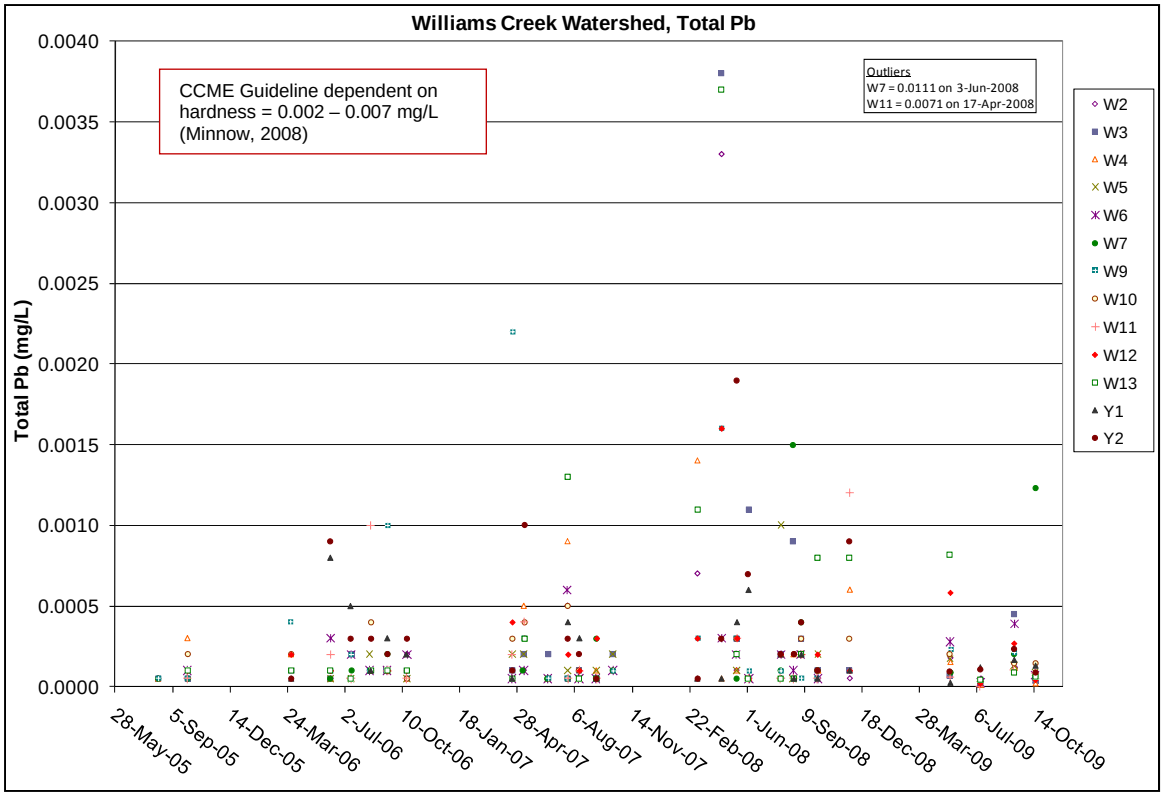

Williams Creek Watershed, total Chromium, 2005-2009
Chromium, total (mg/L)
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
CCME Guideline = 0.001 mg/L
W9
W5
W6
W2
W7
W3
W4
W13
W11
W12
W10
Y1
Y2
Station

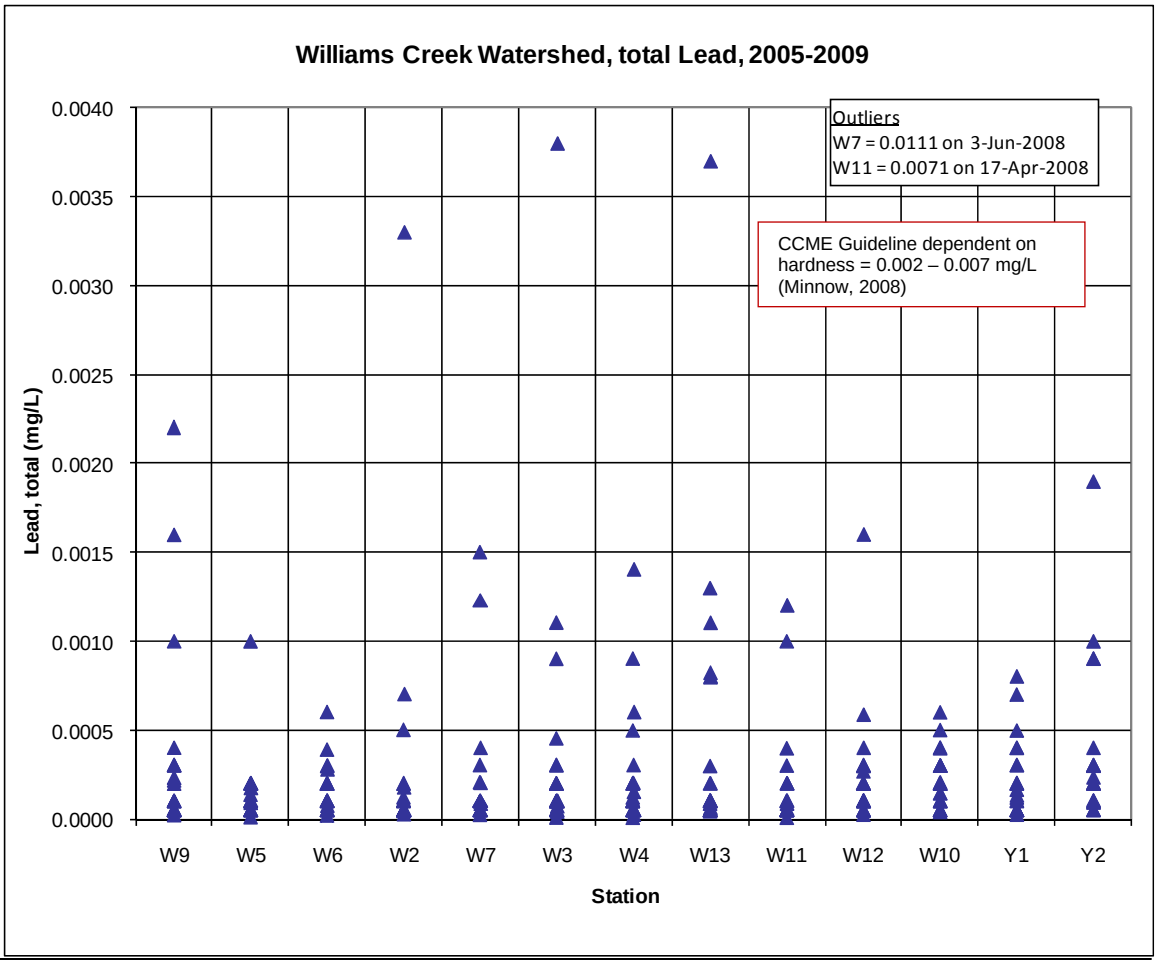

Williams Creek Watershed, Total Cu
Outliers
W7 = 0.066 on 3-Jun-2008
W4 = 0.014 on 17-Apr-2008
Site Specific Water Quality Objective = 0.021 mg/L
Total Cu (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
28-May-05
5-Sep-05
14-Dec-05
24-Mar-06
2-Jul-06
10-Oct-06
18-Jan-07
28-Apr-07
6-Aug-07
14-Nov-07
22-Feb-08
1-Jun-08
9-Sep-08
18-Dec-08
28-Mar-09
6-Jul-09
14-Oct-09
W2
W3
W4
W5
W6
W7
W9
W10
W11
W12
W13
Y1
Y2

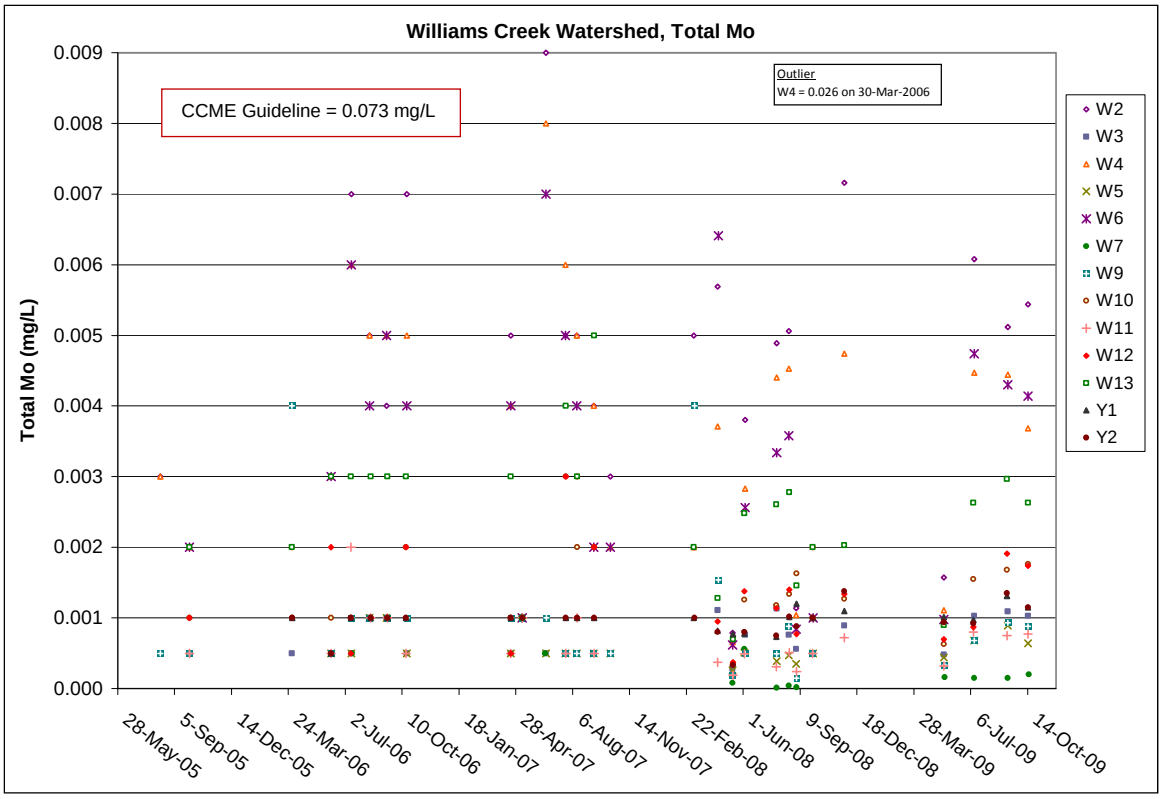

Williams Creek Watershed, total Copper, 2005-2009
Outliers
W7 = 0.066 on 3-Jun-2008
W4 = 0.014 on 17-Apr-2008
Site Specific Water Quality Objective = 0.021 mg/L
Copper, total (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
W9
W5
W6
W2
W7
W3
W4
W13
W11
W12
W10
Y1
Y2
Station

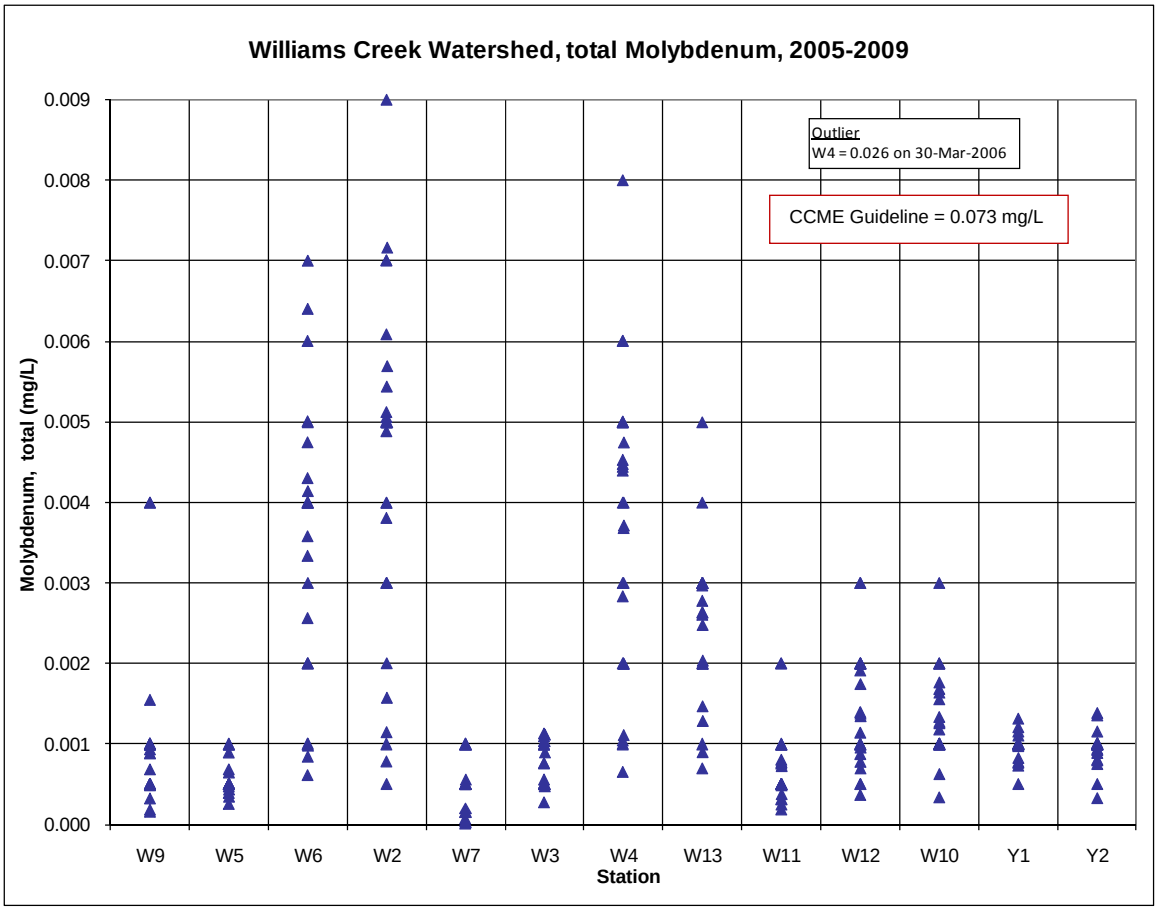

Williams Creek Watershed, Total Fe
Total Fe (mg/L)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Site Specific Water Quality
Objective = 1.1 mg/L
Outliers
W5 = 6.09 on 30-Jul-2008
W3 = 4.66 on 20-Aug-2008
Y2 = 3.44 on 14-May-2008
W2
W3
W4
W5
W6
W7
W9
W10
W11
W12
W13
Y1
Y2
28-May-05
5-Sep-05
14-Dec-05
24-Mar-06
2-Jul-06
10-Oct-06
18-Jan-07
28-Apr-07
6-Aug-07
14-Nov-07
22-Feb-08
1-Jun-08
9-Sep-08
18-Dec-08
28-Mar-09
6-Jul-09
14-Oct-09

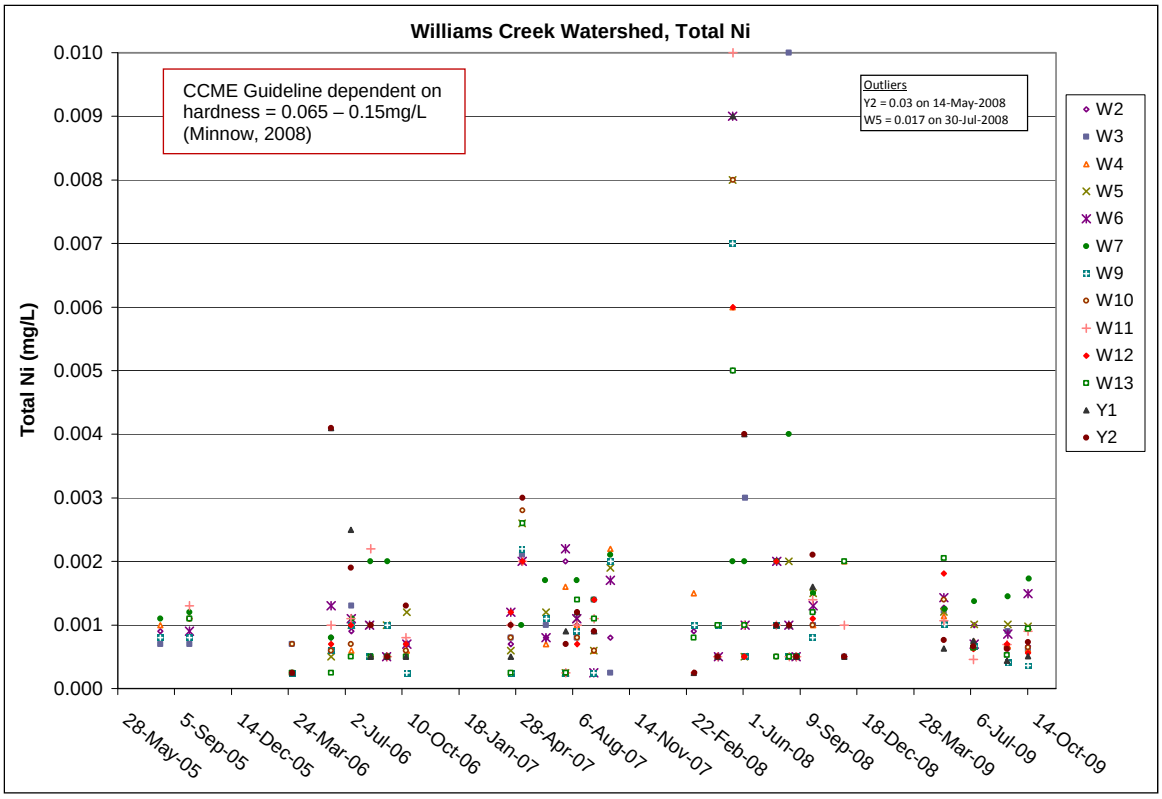

Williams Creek Watershed, total Iron, 2005-2009
Iron, total (mg/L)
3
2.5
2
1.5
1
0.5
0
Outliers
W5 = 6.09 on 30-Jul-2008
W3 = 4.66 on 20-Aug-2008
Y2 = 3.44 on 14-May-2008
Site Specific Water Quality
Objective = 1.1 mg/L
W9
W5
W6
W2
W7
W3
W4
W13
W11
W12
W10
Y1
Y2
Station

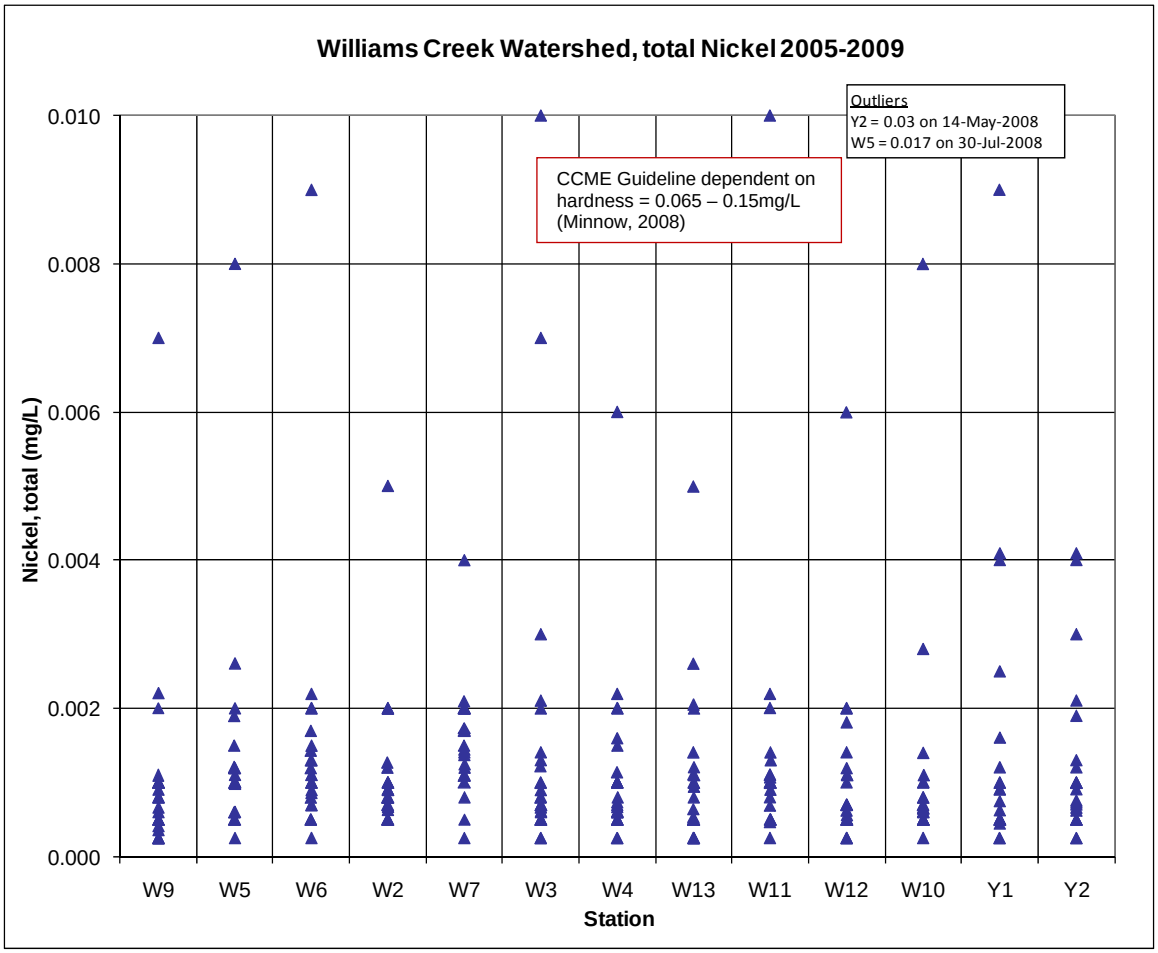

Williams Creek Watershed, Total Pb
CCME Guideline dependent on hardness = 0.002 – 0.007 mg/L (Minnow, 2008)
Outliers
W7 = 0.0111 on 3-Jun-2008
W11 = 0.0071 on 17-Apr-2008
Total Pb (mg/L)
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
28-May-05
5-Sep-05
14-Dec-05
24-Mar-06
2-Jul-06
10-Oct-06
18-Jan-07
28-Apr-07
6-Aug-07
14-Nov-07
22-Feb-08
1-Jun-08
9-Sep-08
18-Dec-08
28-Mar-09
6-Jul-09
14-Oct-09
W2
W3
W4
W5
W6
W7
W9
W10
W11
W12
W13
Y1
Y2

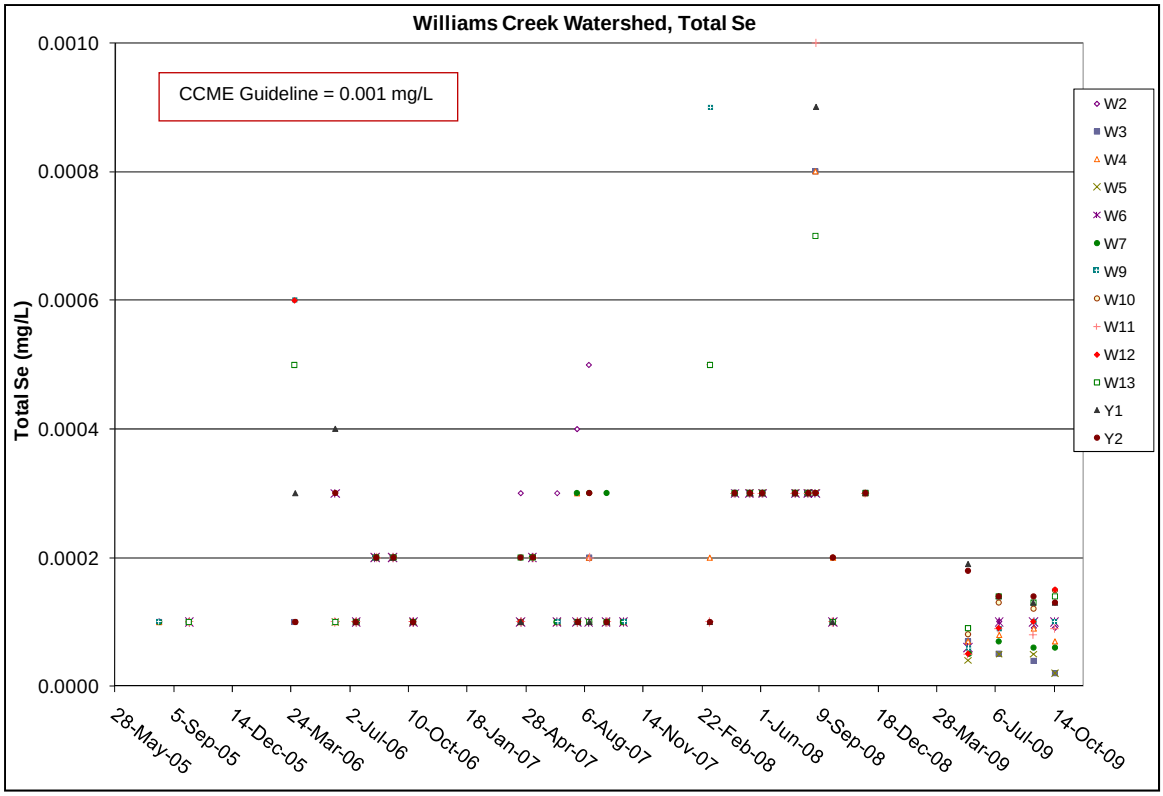

Williams Creek Watershed, total Lead, 2005-2009
Outliers
W7 = 0.0111 on 3-Jun-2008
W11 = 0.0071 on 17-Apr-2008
CCME Guideline dependent on hardness = 0.002 – 0.007 mg/L (Minnow, 2008)
Lead, total (mg/L)
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
W9
W5
W6
W2
W7
W3
W4
W13
W11
W12
W10
Y1
Y2
Station

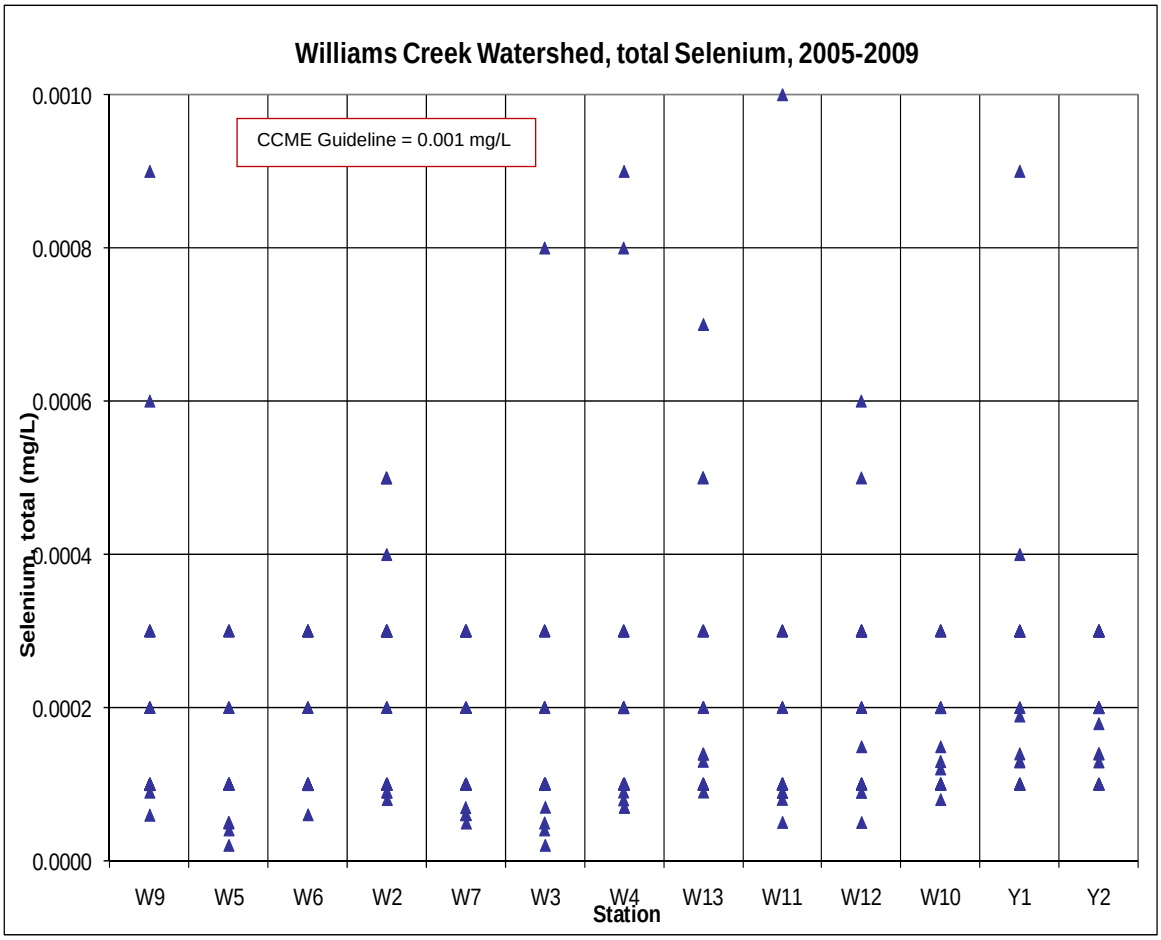

Williams Creek Watershed, Total Mo
Outlier
W4 = 0.026 on 30-Mar-2006
CCME Guideline = 0.073 mg/L
Total Mo (mg/L)
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
28-May-05
5-Sep-05
14-Dec-05
24-Mar-06
2-Jul-06
10-Oct-06
18-Jan-07
28-Apr-07
6-Aug-07
14-Nov-07
22-Feb-08
1-Jun-08
9-Sep-08
18-Dec-08
28-Mar-09
6-Jul-09
14-Oct-09
W2
W3
W4
W5
W6
W7
W9
W10
W11
W12
W13
Y1
Y2

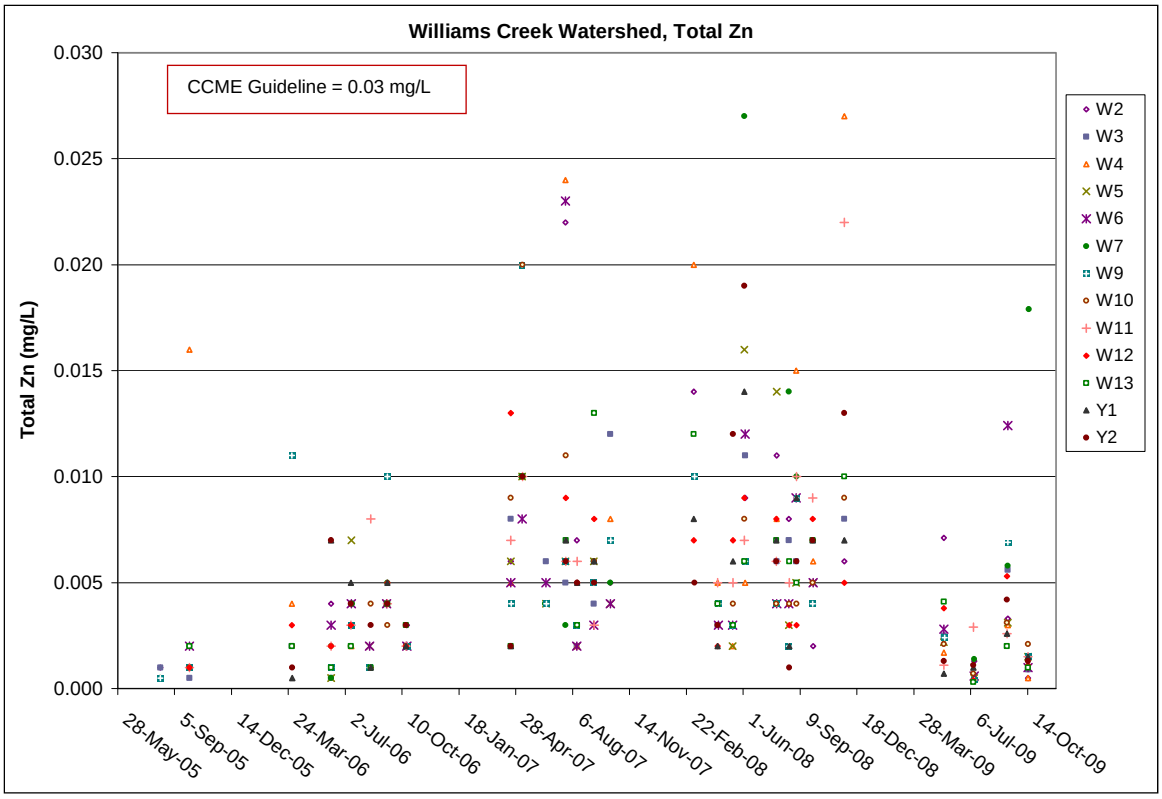

Williams Creek Watershed, total Molybdenum, 2005-2009
Outlier
W4 = 0.026 on 30-Mar-2006
CCME Guideline = 0.073 mg/L
Molybdenum, total (mg/L)
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
W9
W5
W6
W2
W7
W3
W4
W13
W11
W12
W10
Y1
Y2
Station

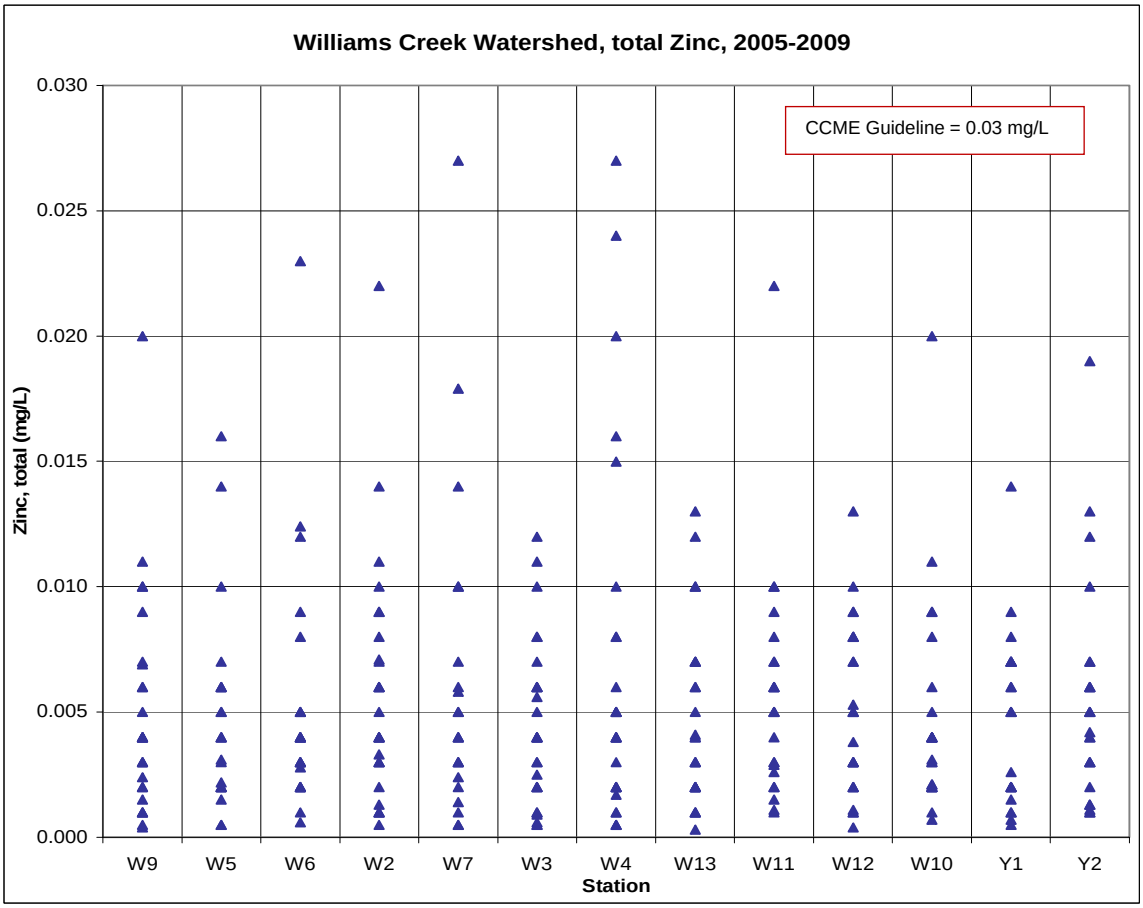

Williams Creek Watershed, Total Ni
CCME Guideline dependent on hardness = 0.065 – 0.15mg/L (Minnow, 2008)
Outliers
Y2 = 0.03 on 14-May-2008
W5 = 0.017 on 30-Jul-2008
Total Ni (mg/L)
0.010
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
28-May-05
5-Sep-05
14-Dec-05
24-Mar-06
2-Jul-06
10-Oct-06
18-Jan-07
28-Apr-07
6-Aug-07
14-Nov-07
22-Feb-08
1-Jun-08
9-Sep-08
18-Dec-08
28-Mar-09
6-Jul-09
14-Oct-09
W2
W3
W4
W5
W6
W7
W9
W10
W11
W12
W13
Y1
Y2

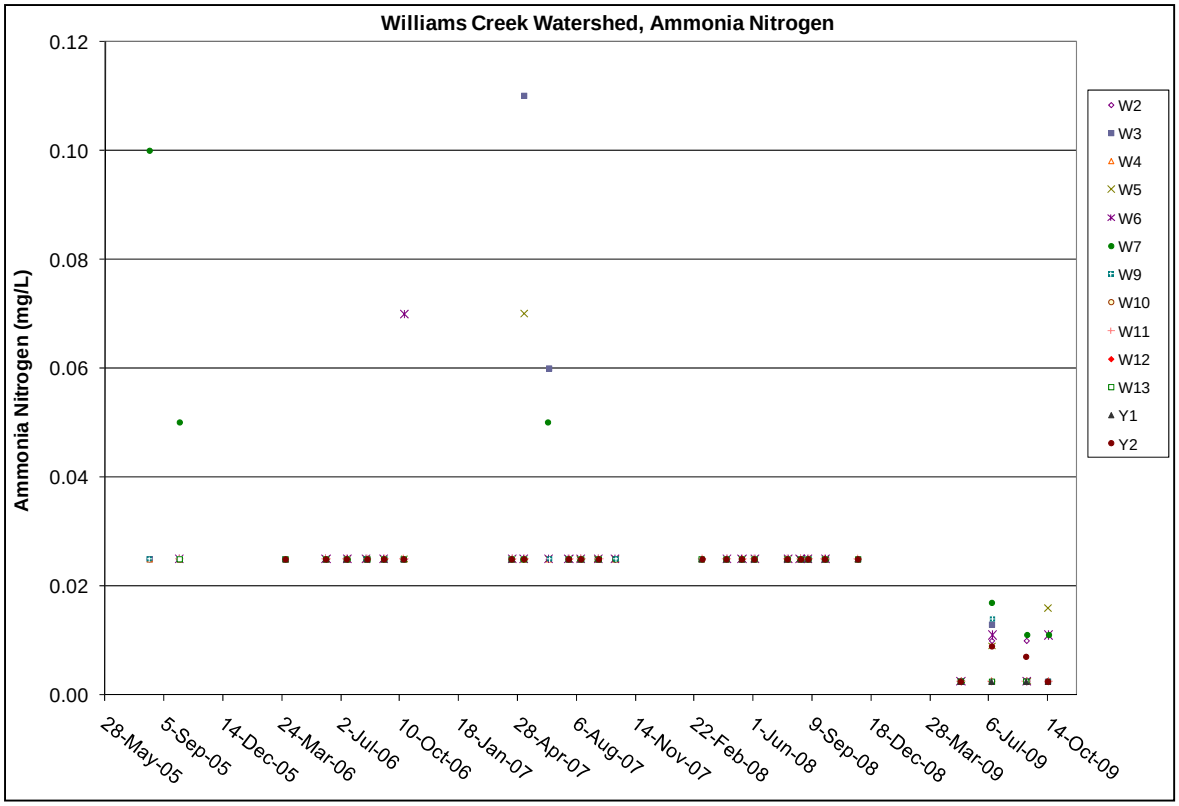

Williams Creek Watershed, total Nickel 2005-2009
Outliers
Y2 = 0.03 on 14-May-2008
W5 = 0.017 on 30-Jul-2008
CCME Guideline dependent on hardness = 0.065 – 0.15mg/L (Minnow, 2008)
Nickel, total (mg/L)
0.010
0.008
0.006
0.004
0.002
0.000
W9
W5
W6
W2
W7
W3
W4
W13
W11
W12
W10
Y1
Y2
Station

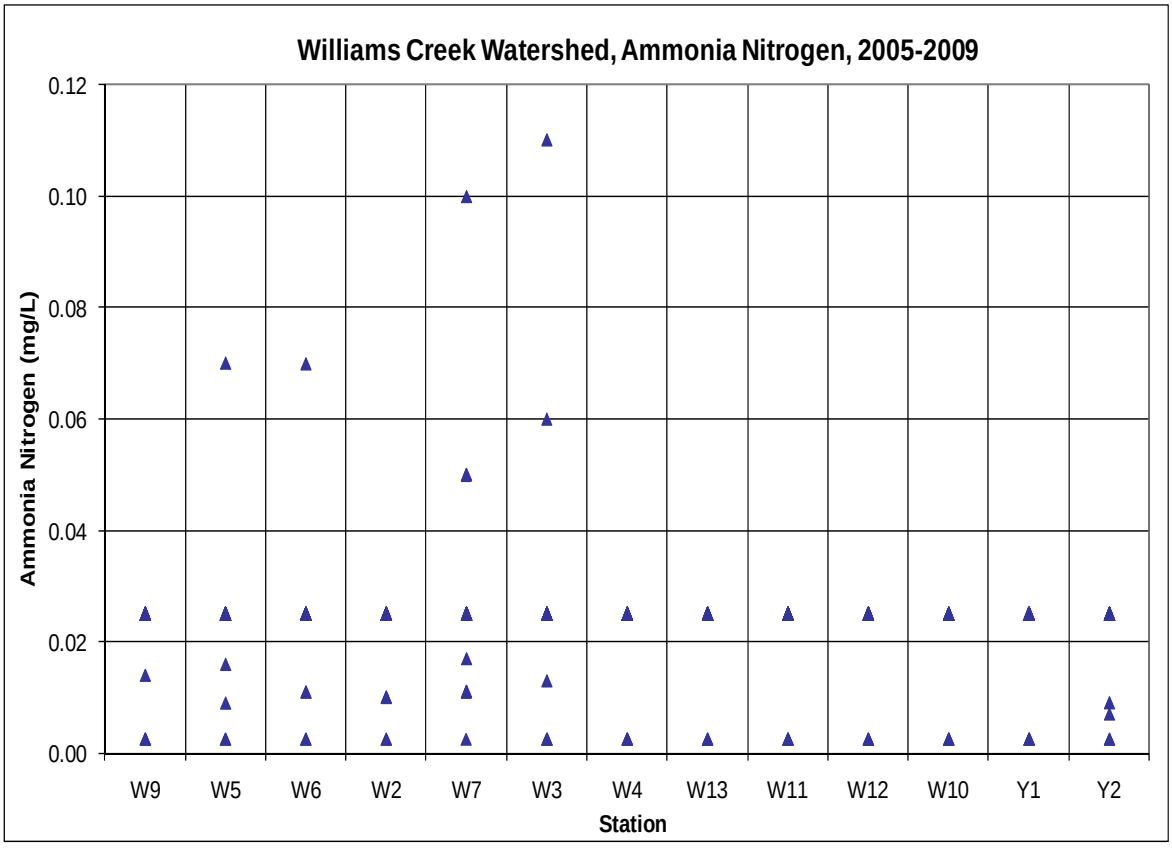

Williams Creek Watershed, Total Se
CCME Guideline = 0.001 mg/L
Total Se (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
W2
W3
W4
W5
W6
W7
W9
W10
W11
W12
W13
Y1
Y2
28-May-05
5-Sep-05
14-Dec-05
24-Mar-06
2-Jul-06
10-Oct-06
18-Jan-07
28-Apr-07
6-Aug-07
14-Nov-07
22-Feb-08
1-Jun-08
9-Sep-08
18-Dec-08
28-Mar-09
6-Jul-09
14-Oct-09

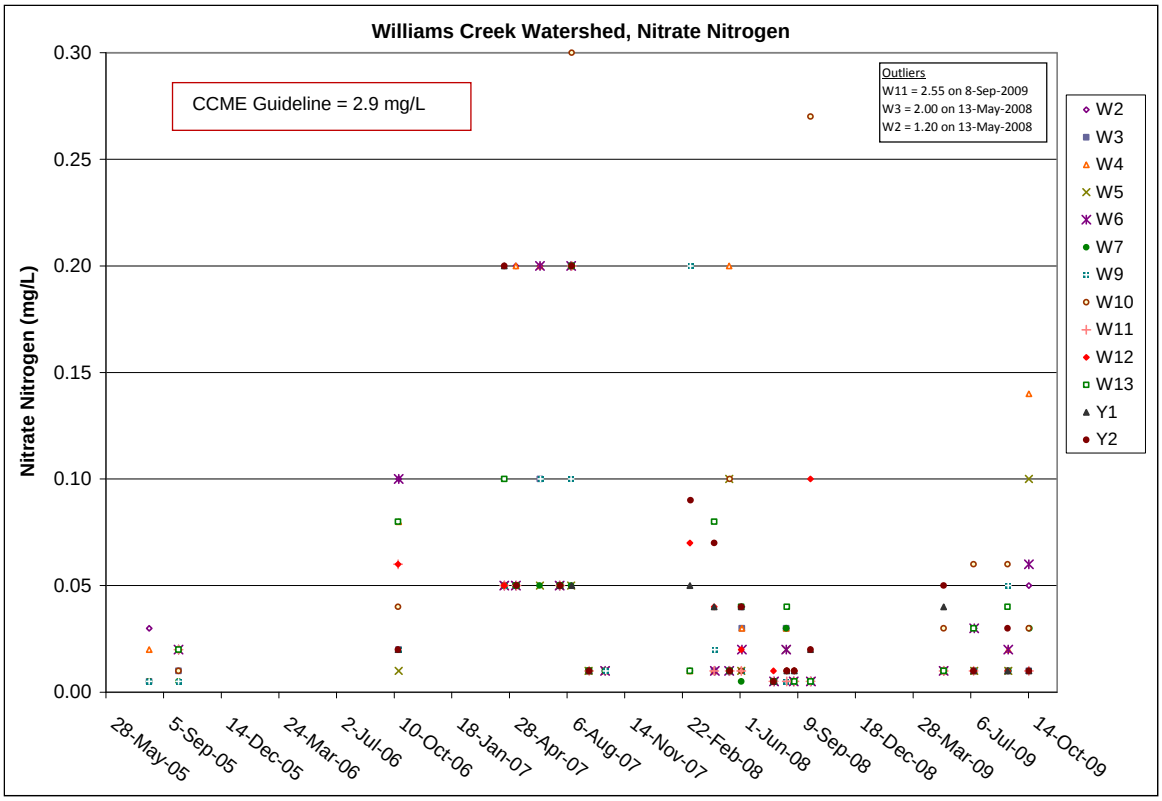

Williams Creek Watershed, total Selenium, 2005-2009
CCME Guideline = 0.001 mg/L
Selenium, total (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
W9
W5
W6
W2
W7
W3
W4
W13
W11
W12
W10
Y1
Y2
Station

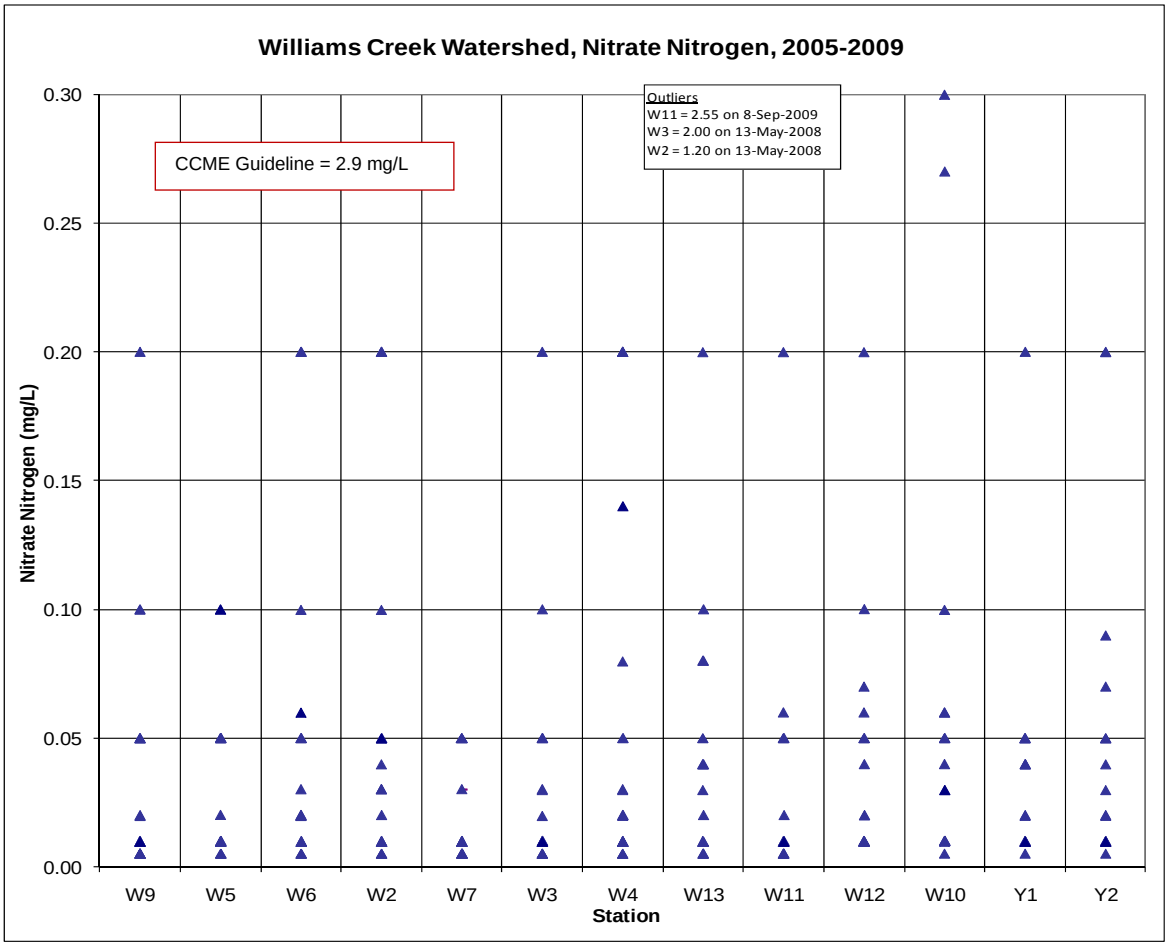

Williams Creek Watershed, Total Zn
CCME Guideline = 0.03 mg/L
Total Zn (mg/L)
0.030
0.025
0.020
0.015
0.010
0.005
0.000
W2
W3
W4
W5
W6
W7
W9
W10
W11
W12
W13
Y1
Y2
28-May-05
5-Sep-05
14-Dec-05
24-Mar-06
2-Jul-06
10-Oct-06
18-Jan-07
28-Apr-07
6-Aug-07
14-Nov-07
22-Feb-08
1-Jun-08
9-Sep-08
18-Dec-08
28-Mar-09
6-Jul-09
14-Oct-09

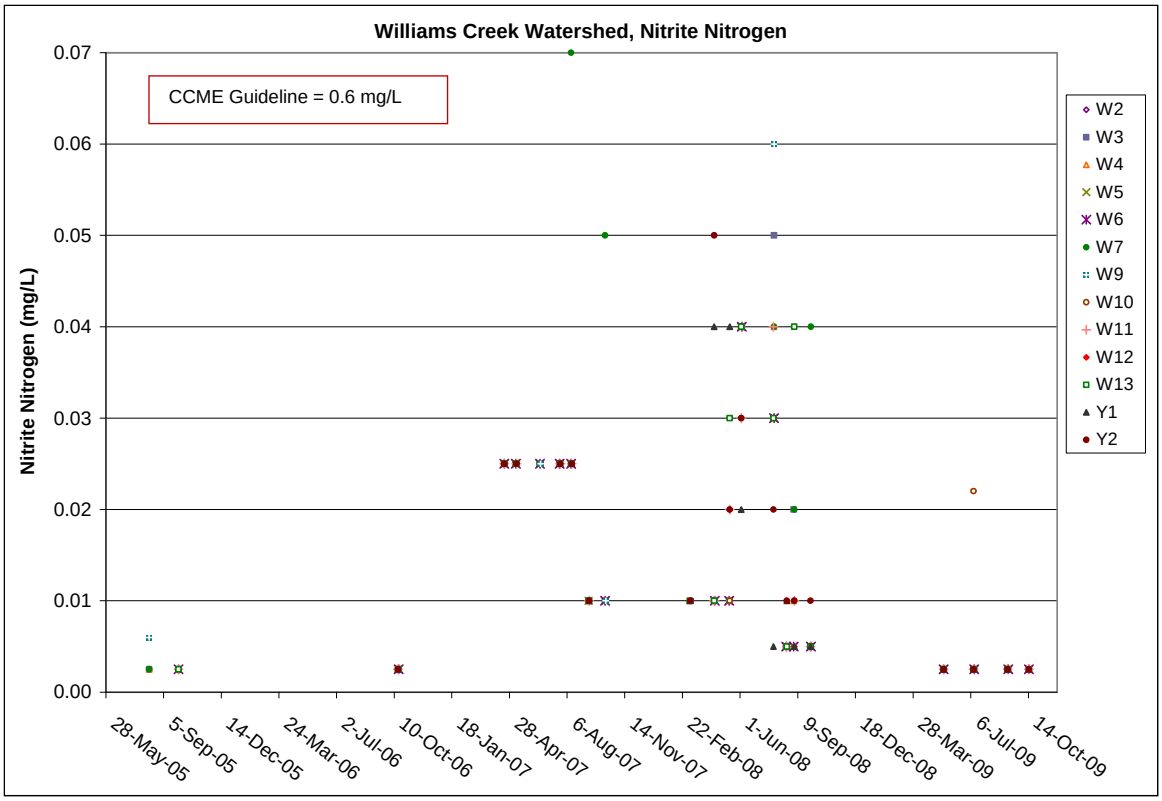

Williams Creek Watershed, total Zinc, 2005-2009
CCME Guideline = 0.03 mg/L
Zinc, total (mg/L)
0.030
0.025
0.020
0.015
0.010
0.005
0.000
W9
W5
W6
W2
W7
W3
W4
W13
W11
W12
W10
Y1
Y2
Station

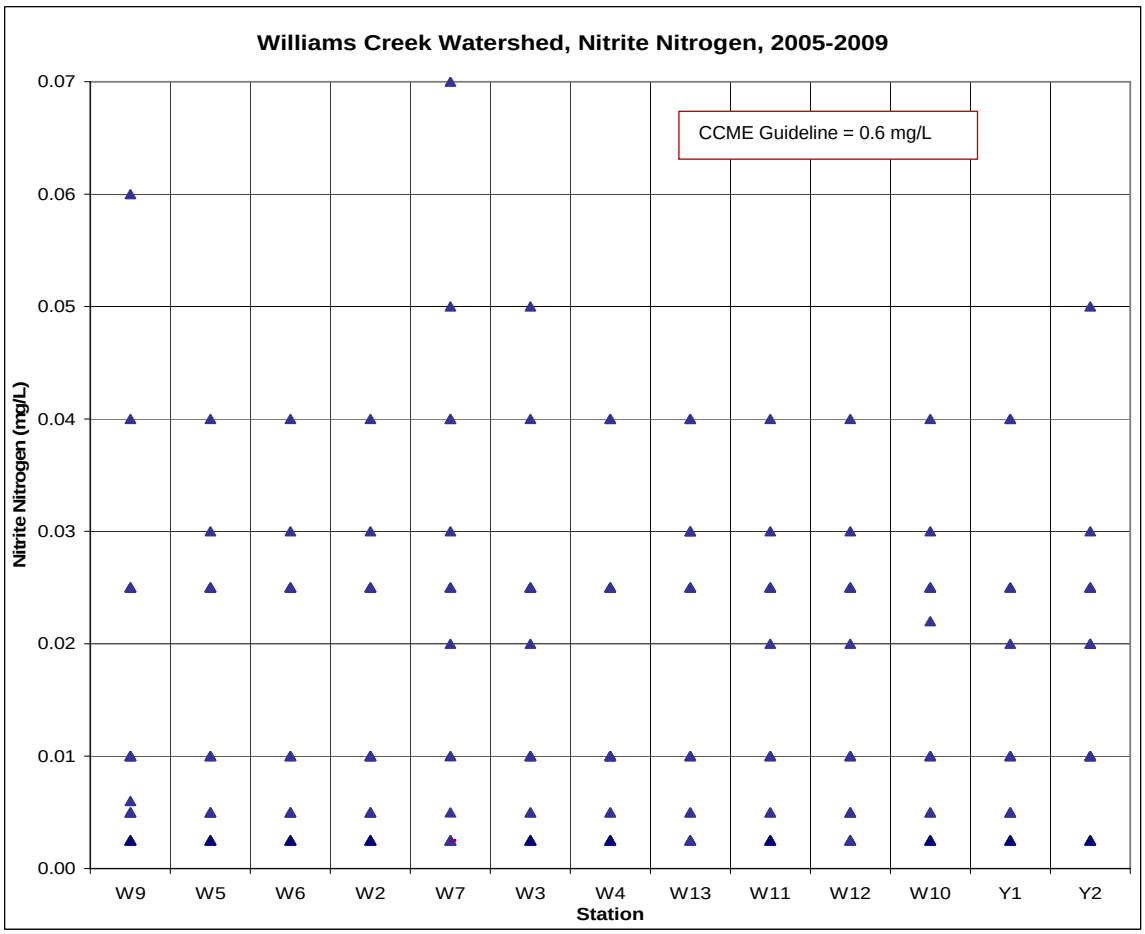

Williams Creek Watershed, Ammonia Nitrogen
Ammonia Nitrogen (mg/L)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
28-May-05
5-Sep-05
14-Dec-05
24-Mar-06
2-Jul-06
10-Oct-06
18-Jan-07
28-Apr-07
6-Aug-07
14-Nov-07
22-Feb-08
1-Jun-08
9-Sep-08
18-Dec-08
28-Mar-09
6-Jul-09
14-Oct-09
W2
W3
W4
W5
W6
W7
W9
W10
W11
W12
W13
Y1
Y2


Williams Creek Watershed, Ammonia Nitrogen, 2005-2009
Ammonia Nitrogen (mg/L)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
W9
W5
W6
W2
W7
W3
W4
W13
W11
W12
W10
Y1
Y2
Station


Williams Creek Watershed, Nitrate Nitrogen
CCME Guideline = 2.9 mg/L
Outliers
W11 = 2.55 on 8-Sep-2009
W3 = 2.00 on 13-May-2008
W2 = 1.20 on 13-May-2008
Nitrate Nitrogen (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
28-May-05
5-Sep-05
14-Dec-05
24-Mar-06
2-Jul-06
10-Oct-06
18-Jan-07
28-Apr-07
6-Aug-07
14-Nov-07
22-Feb-08
1-Jun-08
9-Sep-08
18-Dec-08
28-Mar-09
6-Jul-09
14-Oct-09
W2
W3
W4
W5
W6
W7
W9
W10
W11
W12
W13
Y1
Y2


Williams Creek Watershed, Nitrate Nitrogen, 2005-2009
CCME Guideline = 2.9 mg/L
Outliers
W11 = 2.55 on 8-Sep-2009
W3 = 2.00 on 13-May-2008
W2 = 1.20 on 13-May-2008
Nitrate Nitrogen (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
W9
W5
W6
W2
W7
W3
W4
W13
W11
W12
W10
Y1
Y2
Station


Williams Creek Watershed, Nitrite Nitrogen
CCME Guideline = 0.6 mg/L
Nitrite Nitrogen (mg/L)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
28-May-05
5-Sep-05
14-Dec-05
24-Mar-06
2-Jul-06
10-Oct-06
18-Jan-07
28-Apr-07
6-Aug-07
14-Nov-07
22-Feb-08
1-Jun-08
9-Sep-08
18-Dec-08
28-Mar-09
6-Jul-09
14-Oct-09
W2
W3
W4
W5
W6
W7
W9
W10
W11
W12
W13
Y1
Y2


Williams Creek Watershed, Nitrite Nitrogen, 2005-2009
CCME Guideline = 0.6 mg/L
Nitrite Nitrogen (mg/L)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
W9
W5
W6
W2
W7
W3
W4
W13
W11
W12
W10
Y1
Y2
Station

Western Copper Corporation

2009 ANNUAL QUARTZ MINING LICENCE REPORT

SUBMITTED TO YUKON GOVERNMENT, ENERGY MINES AND RESOURCES

YUKON QUARTZ MINING LICENCE QML-0007

Appendix C

Assessment of Hydrogeological Conditions During Operation and Closure (March 2009)

REPORT ON

ASSESSMENT OF HYDROGEOLOGICAL CONDITIONS DURING OPERATION AND CLOSURE CARMACKS COPPER PROJECT, YUKON

Submitted to:

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EXECUTIVE SUMMARY

A revised hydrogeologic assessment was carried out for the Carmacks Copper Project, Yukon, (the 'Site') as a result of new information available for the Site and to provide additional input to the updated engineering design for the project. The Site is located in the Yukon Territory, approximately 38 km northwest of the town of Carmacks. The assessment comprised the construction of a three-dimensional numerical groundwater flow model and then simulation of current and future conditions at the Site reflecting operation of the proposed mine and closure scenarios.

The Site is characterized by a regional groundwater flow system within bedrock. Groundwater is recharged at higher elevations in the upland areas and flows towards the valleys of Nancy Lee Creek, Williams Creek, Merrice Creek, and the Yukon River. In the Site vicinity, groundwater flow direction is towards Williams Creek. Overall, the water table mimics ground surface topography and the depth to groundwater generally increases with increasing ground surface elevation. The presence of permafrost may have resulted in the development of perched water tables in some areas; however, these are assumed to be isolated and discontinuous. The permafrost likely acts as a barrier to infiltration in some areas, thereby reducing recharge and potentially resulting in the overall depression of the regional water table.

Hydraulic conductivity of the bedrock is inferred to be generally depth-dependent such that it ranges between approximately $2x10^{-8}$ m/s and $5x10^{-6}$ m/s where bedrock is less than approximately 100 m depth, and between approximately $5x10^{-10}$ m/s and $1x10^{-8}$ m/s where bedrock is greater than 100 m depth. This decrease in hydraulic conductivity with depth is commonly observed in igneous bedrock, where increases in confining pressure with depth results in reduction in fracture aperture and/or closing of some fractures. At least one water-conductive feature was intersected by boreholes drilled by Golder in May 2008 in the proposed pit area. These feature(s) may be related to known north-south trending faults within the proposed open pit area.

The numerical model took into consideration the operation of the proposed mine pit over a six-year period, the cessation of pit dewatering at the end of this period, and the subsequent formation of the pit lake. In addition, the model took into consideration the operation of two water supply wells over an eight-year period for plant and camp operations, and the general design of the Heap Leach Facility (HLF). This facility will be fully lined facility to prevent water/solution losses to the subsurface.

This revised assessment was successful in meeting all of the project objectives. To this end, this report has concluded the following:

- Pit inflow (*i.e.*, groundwater discharge into the pit) is predicted to commence in approximately the fourth year of pit mining, and the average annual pit inflow rate is predicted to progress from near zero to 900 m^3/d over the last three years of pit mining (Years 4 to 6). Based on a limited uncertainty analysis, the pit inflow rate could range from 600 m^3/d to 1,200 m^3/d at the final stage of pit development (at Year 6). If additional water-conductive features exist within the proposed pit area than the ones considered in this study, then the pit inflow could be as much as 400 m^3/d greater than predicted for each feature encountered. The above estimates do not include the effects of potential surface water runoff into the pit, and water resulting from direct precipitation over the pit footprint.

- The total flow in Williams Creek is comprised of runoff, baseflow, and direct precipitation. Baseflow is the component of total flow that originates from groundwater discharge into the creek, whereas runoff is the component of total flow generated by snow melt and storm events within the Williams Creek watershed. The baseflow to Williams Creek in the vicinity of the Site is predicted to be reduced by up to 20% during the eight years of mine operations. Based on a limited uncertainty analysis, the baseflow could be reduced by between 15% and 45% at the final stage of mine pit operations (at Year 6). Using an approximation of total average annual flow in Williams Creek that discharges into the Yukon River (based on limited stream flow data and the assumption that the creek is frozen throughout winter), this baseflow reduction is expected be on the order of a few percent of this approximation. Following Site closure, the baseflow in the Site vicinity is expected to recover to near pre-mining levels within a few years.

- Pit operations are predicted to reduce hydraulic heads in the vicinity of the mine workings (*i.e.*, the pit acts as a sink for groundwater flow), although the prominent area of high hydraulic heads to the southwest of the Site remains relatively similar to pre-mining conditions.

- The extent of the drawdown cone generated by the mine pit, defined using the 1 m drawdown contour, is predicted to extend laterally in the bedrock to a maximum distance of approximately 800 m (in the southwest direction) from the pit. Based on a limited uncertainty analysis, the extent of the drawdown cone could be up to 1100 m from the pit.

- A pit lake is predicted to develop when pit mine operations cease and the pit undergoes closure. The lake water level is predicted to reach quasi-static conditions within approximately six years post mine pit closure (*i.e.*, approximately Year 12 from the start of mine operations), at an elevation of approximately 720 masl. Based on a limited uncertainty analysis, the static lake level elevation could range between 710 and 760 masl.

- The HLF design includes a double-composite liner system and leak detection and collection system to minimize any potential leakage from the facility into the natural environment. However, the model was used to predict travel times and directions of a potential leak that reaches the saturated groundwater zone. The predicted minimum travel time for a potential leak to reach Williams Creek was approximately 7 years. Based on a limited uncertainty analysis and conservative assumptions, the travel time to either Williams Creek or the open pit could range between 4 and 10 years, once the leak has reached the saturated groundwater zone. Potential leaks from the HLF are not predicted to report to the water supply wells considered in this study.

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1.0 INTRODUCTION

A revised hydrogeologic assessment was carried out for the Carmacks Copper Project, Yukon, (the 'Site') as a result of new information available for the Site, and to provide additional input to the updated engineering design for the project. The Site is located in the Yukon Territory, approximately 38 km northwest of the town of Carmacks (Figure 1). The assessment comprised the construction of a three-dimensional numerical groundwater flow model and then the simulation of current and future conditions at the Site reflecting operation of the proposed mine and closure scenarios.

2.0 BACKGROUND

A preliminary hydrogeologic assessment of the Site was completed in May 2007 (Golder 2007) to provide a preliminary evaluation of baseline groundwater conditions beneath the proposed Heap Leach Facility (HLF) area, and to assess the potential changes in the groundwater flow conditions in this area as a result of development of the proposed open pit. At the time of the preliminary assessment, pertinent information regarding Williams Creek, the area of the proposed open pit (*i.e.,* groundwater levels and hydraulic conductivity of the bedrock), and the groundwater conditions in the vicinity of William's Creek, was not available. As most of this information is now available as a result of the Hydrogeological Drilling and Testing Program and the Groundwater Exploration Program conducted in April and May 2008 by Golder (2008a and 2008c), respectively, and the Environmental Monitoring Program conducted by Access Consulting Group (Access 2008) in 2006 and 2007, the conceptual understanding of the Site's hydrogeological conditions was updated and a new three-dimensional numerical model was developed.

3.0 OBJECTIVES

The objectives for the revised hydrogeologic assessment were to provide estimates of:

1. The pre-mining groundwater discharge rate (baseflow) to Williams Creek;

2. Groundwater inflow rate to the proposed open pit at progressive stages of mine development, and the magnitude and extent of the associated drawdown cone for the ultimate pit configuration;

3. The potential effects of pit dewatering and proposed pumping of the water supply wells for camp and plant operations on baseflow to Williams Creek;

4. The potential migration route and travel time of a hypothetical leak from the proposed HLF to the underlying groundwater; and,

5. The formation of a pit lake after cessation of mine dewatering during mine closure.

4.0 AVAILABLE DATA

The data used to update the conceptual understanding of Site's hydrogeological conditions (*i.e.*, the conceptual model) is listed below. This data was also used as input for the new three-dimensional numerical model or to calibrate the model.

- Topographic data from the Yukon Department of Environment, Information Management & Technology Branch (consists of digital elevation model (DEM) data interpolated from the digital 1:50,000 Canadian National Topographic Database (NTDB Edition 2));

- Geologic, structural, and hydraulic data from six angled boreholes (GA-08-01 to -06) drilled in the area of the proposed open pit as part of Golder's (2008a) Hydrogeological Drilling and Testing Program conducted in April and May 2008. Multi-level hydrogeological (packer) testing was conducted on these boreholes to determine the spatial distribution in hydraulic conductivity and groundwater levels in the proposed mine pit area;

- Hydraulic data from three multi-level vibrating wire piezometers installed in one deep borehole (HYD-WELL-2) drilled downgradient of the proposed HLF area and adjacent to Williams Creek;

- Pumping test response data and hydraulic parameter estimates from a water supply well (BH01-08) and an observation well (BH02-08) installed near the camp and Williams Creek, and approximately 600 m southwest of the proposed HLF area. The wells were installed and tested in May 2008 as part of Golder's (2008c) Groundwater Exploration Program (see Appendix I for borehole/well logs). As part of this work, Golder also conducted a preliminary evaluation of the historical pumping test data (dated September 11, 1995) for an existing active water well at the Site (WW95-1, also known as Williams Creek Water Well);

- Groundwater levels and hydraulic conductivity estimates from eleven 1996 bedrock monitoring wells (Wells A though K) reported by Knight and Piésold (1996), and groundwater levels collected by Access over several months between 2006 and 2007 for those monitoring wells installed in the areas of the proposed HLF and proposed waste rock storage area (WRSA) (Wells A through I);

- Geologic cross-sections through the proposed HLF produced by Knight and Piésold (1996) and geologic information obtained from Golder (2008e);

- Stream flow rates measured by Access (2008) over several months in 2006 and 2007 at several stations along Williams Creek;

- Climate data from the Williams Creek Climate Station and water balance analysis results (Golder 2008b);

- Mine operation details that were provided by Western Copper Corporation (WCC), including the original open pit sequence plan, and the updated final open pit configuration; and,

- The number of water supply well(s), the required groundwater withdrawal rates for plant and camp operation, and the location and design of the proposed HLF area and the proposed WSRA, were obtained from various Golder studies (Golder 2008b, 2008f, 2008g).

Figure 2 presents the site plan showing locations of proposed mine facilities, boreholes, and monitoring wells. Figure 3 shows the hydraulic heads measured at the borehole and monitoring well locations. Figure 4 shows a summary of available hydraulic conductivity measurements in bedrock. This summary was derived from the single-well response test results for the bedrock monitoring wells (Knight Piésold 1996), the packer test results for the six angled boreholes in the area of the proposed open pit (Golder 2008a), and the pumping test results for the water wells (Golder 2008c).

5.0 SITE DESCRIPTION AND GEOLOGY

Ground surface at the Site generally slopes to the south and east towards Williams Creek and to the northeast towards its tributary, North Williams Creek (Figure 2). A topographical high is located in the center of the Site in the area of the proposed open pit. The ground surface elevation ranges from approximately 930 m at the top of the mound to 660 m at the confluence of Williams Creek and North Williams Creek to the east.

The Site is located in the discontinuous permafrost zone. Near the toe of the HLF embankment and beneath the sediment pond where the soil thickness is greatest, permafrost was encountered to a depth of 30 m (Knight Piésold 1995, Golder 2008e). At one of these locations (where the top of permafrost was identified at a depth of approximately 8 m below grade), a perched water table was identified above the permafrost. Permafrost was also found in the area of the proposed WRSA extending beyond 35 m below the ground surface.

Bedrock compositions range from granodiorite to diorite and the mineralization is found within the gneiss. The unconsolidated deposits that overlie competent bedrock consist of: organic/ash, glaciofluvial/glaciolacustrine deposits, well graded glacial till, and/or weathered/decomposed bedrock (Knight Piésold 1996, and Golder 2008e) Overburden thickness increases in the valley and in closer proximity to Williams Creek. The overburden thickness within the proposed pit area is limited to approximately 5 m or less

(Golder 2008d). Overburden thickness can range between approximately less than 1 m to about 38 m within the proposed HLF area, and can range between 1 and 70 m within the proposed WRSA (Knight Piésold 1996 and Golder 2008e).

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 (Golder 2008d). The Carmacks copper-gold deposit lies within the Yukon Cataclastic Terrane. The deposit area is underlain by intrusive and meta-intrusive rocks of the Upper Triassic Granite Mountain Batholith. In general terms, the regional bedrock structural setting is mostly described to be poorly understood as a result of limited bedrock outcrop exposures. A few geological structures in the form of faults are known to occur within the planned open pit vicinity, and striking north/north-east-south/southwest (see Figure 2). However, the dip orientation of these faults is uncertain currently (Golder 2008d).

6.0 CONCEPTUAL MODEL

The Site is characterized by a regional groundwater flow system within bedrock. Groundwater is recharged by precipitation at higher elevations in the upland areas and flows towards the valleys of Nancy Lee Creek, Williams Creek, Merrice Creek, and the Yukon River. In the Site vicinity, groundwater flow direction is towards Williams Creek. Overall, the water table mimics ground surface topography and the depth to groundwater generally increases with increasing ground surface elevation, as shown on Figure 3. Based on groundwater levels in the monitoring wells, the depth to groundwater in the proposed HLF area ranged from 12 m to 65 m, and in the proposed Waste Rock Storage Area (WRSA) ranged from 2 m (near the creek) to 50 m. In the vicinity of the proposed open pit area, the depth to groundwater exceeded 91 m. The presence of permafrost may have resulted in the development of perched water tables in some areas; however, these are assumed to be isolated and discontinuous. The permafrost likely acts as a barrier to infiltration in some areas, thereby reducing recharge and potentially resulting in the overall depression of the regional water table.

As presented on Figure 4, hydraulic conductivity of the bedrock is inferred to be generally depth-dependent such that it ranges between approximately $2x10^{-8}$ m/s and $5x10^{-6}$ m/s where bedrock is less than approximately 100 m depth, and it ranges between approximately $5x10^{-10}$ m/s and $1x10^{-8}$ m/s where bedrock is greater than 100 m depth (see Figure 4). This decrease in hydraulic conductivity with depth is commonly observed in igneous bedrock, where increase in confining pressure with depth results in reduction in fracture aperture and/or closing of some fractures. The data in Figure 4 also suggests that at least one water-conductive feature (with transmissivity of $1x10^{-5}$ to $9x10^{-5}$ m^2/s) was intersected by boreholes GA01 and GA05. Based on the approximate locations of faults presented in Figure 2, these feature(s) may be related to the north-south trending faults within the proposed open pit area. The vertical orientation of these faults, however, is unknown.

7.0 PLANNED SITE OPERATIONS AND CLOSURE

The hydrogeological assessment took into consideration the following planned Site operations and closure conditions:

- Operation and continual dewatering of the proposed mine pit over a six-year period. The pit development sequence considered in this assessment was based on the annual pit shell progression maps developed in March 2007 (by Independent Mining Consultants Inc (IMC) on behalf of WCC) and the revised final pit layout developed in March 2008.

- Cessation of pit dewatering at the end of the six-year mine pit operation time, and subsequent formation of the pit lake.

- Operation of two water supply wells for camp and plant operations over an eight-year period (*i.e.,* throughout the six years of mine pit operations and an additional two years to accommodate HLF operations). The existing water well, BH01-08, and a supplementary new water well (referred to as DW3 herein and assumed to be located approximately 600 m southwest of BH01-08) would be utilized. Based on the estimated mean monthly groundwater requirements outlined in Golder (2008b; Table 6-2), the total combined annual groundwater withdrawal rate from these wells was estimated to be 92,000 m^3 (see Appendix I). An alternative option being considered for the supplementary well is the use of an existing water well located southeast and directly downgradient of the HLF area (WW95-1). For the purposes of this assessment, an average pumping rate of 194 m^3/d and 56 m^3/d was assumed applicable to BH01-08 and the supplementary well, respectively (combined average pumping rate of 250 m^3/d), based on the annual groundwater withdrawals of 70,810 m^3 and 20,440 m^3 for DW08-1 and the supplementary well, respectively (total annual withdrawal of 91,250 m^3). These annual groundwater withdrawal rates were based on the cumulative of the estimated mean monthly withdrawal rates (see Appendix I), with the assumption that BH01-08 would be pumped at its maximum sustainable yield (398 m^3/d; Golder 2008c) during peak water demand periods (with the remaining demand to be supplied by the supplementary well); and that both wells would be pumped continuously, with a minimum combined pumping rate of 12 m^3/d (0.5 m^3/hr or 2 USgpm), to prevent freeze-up of the water supply system prior to and during the winter season.

- The HLF and Events Pond would be fully lined to prevent infiltration of precipitation or solution beneath these areas into the subsurface. As such, groundwater recharge through infiltration of precipitation or artificial sources would not occur in the HLF area over its operational life of 8 years and over several years post closure of the facility. For the purposes of this assessment it was assumed that for the first 20-year period from the start of mine operations (includes the start of HLF operations), leaks from the HLF area into the subsurface, if any, would be negligible in volume.

8.0 NUMERICAL HYDROGEOLOGIC MODEL

The conceptual model of groundwater conditions at the Site, discussed in Section 6.0, was used as a basis for the development of a three-dimensional numerical hydrogeologic model. Following construction and calibration, this model was used to predict hydrogeologic conditions near the proposed open pit and HLF area during and after mining.

8.1 Model Construction

8.1.1 Model Code Selection

The numerical code used for the construction of the groundwater model for the Site must be able to adequately represent key characteristics of Site's hydrogeologic regime. Considering this, FEFLOW, a finite element modelling code from WASY Institute in Germany (Diersch, 2005) was utilized. FEFLOW is capable of simulating transient groundwater flow in three-dimensions in heterogeneous porous media. FEFLOW is superior to groundwater models that are based on finite difference approach, such as MODFLOW, as the finite element mesh allows the Site's hydrostratigraphy to be more accurately represented while providing sufficient spatial resolution for accurate predictions in areas of interest (*i.e.*, near pumping wells).

8.1.2 Model Domain and Mesh

Figure 5 presents the extent of the model domain and Figure 6 presents the details of the finite element mesh. The model domain was bounded by the Yukon River to the northeast, Merrice Creek to the south and east, Nancy Lee Creek to the west and north, and the upland area between Nancy Lee Creek and Merrice Creek to the southwest. Horizontally, the model extends approximately 11 km in the east-west direction and 12 km in the north-south direction, and is centered on the Site.

Saturated unconfined groundwater flow was simulated using a finite element mesh consisting of prisms (*i.e.*, 3D elements consisting of triangles on the lateral planes and quadrilaterals on the vertical plane). Thin element zones (zones which are one-element wide) were included in the mesh design to represent the location and the assumed vertical orientation of the water-conductive features that may be related to the faults within the vicinity of the proposed open pit. The mesh was allowed to deform during a simulation such that the model surface conformed to the position of the predicted watertable, while maintaining the initial stratigraphic information and the associated material properties.

Mesh spacing varied from approximately 50 m in the area of the proposed pit to about 100 m elsewhere in the model, thus permitting steep hydraulic gradients to be simulated, which are expect to develop near the pit in response to dewatering. Overall, the model spanned an area of approximately 88 km^2.

Vertically, the model was divided into three layers. The initial elevation of model top was set to the topographic elevation. The respective (initial) thickness of these layers was 100 m each. The base of the model was set approximately 100 m beneath the planned maximum depth of the proposed open pit.

8.1.3 Boundary Conditions

Three types of boundary conditions were used in the model: specified head, specified flux, and no-flow (zero flux). The locations of these boundaries are presented on Figure 7.

Specified head boundaries were used to simulate the major creeks and rivers, including Williams Creek on the south side of the Site. The water level elevations in these water bodies were based on the topographic data. Specified head boundaries, constrained to only allow outflow of groundwater, and set to ground elevation, were applied along small ephemeral tributaries, such as North Williams Creek located on the north side of the Site. These boundaries represented seepage faces that occur if/when the water table reaches the ground surface along these tributaries.

Specified flux boundaries were used to represent groundwater recharge from precipitation. These boundaries were assigned everywhere in the top layer of the model, Recharge rates were adjusted during model calibration, as discussed in Section 8.2. In addition, specified flux boundaries were used to represent pumping wells BH01-08, DW-3, and WW95-1 during transient model calibration.

No flow boundaries (zero flux) were applied along an inferred groundwater divide in the upland area between Nancy Lee Creek and Merrice Creek on the southwest side of the model domain. This boundary type was also assigned at the model base under the assumption that groundwater flow at greater depth would have a negligible influence on model predictions.

8.2 Model Calibration

The hydrogeologic model was calibrated in steady-state to baseline (pre-mining) conditions as well as to transient response observed during two pumping tests at the Site. During model calibration the model was run repeatedly and model input parameters were iteratively adjusted until model predicted hydraulic heads and fluxes matched field observations reasonably well.

8.2.1 Static Hydraulic Heads and Baseflow

The model was calibrated in steady-state mode to pre-mining conditions using static hydraulic heads measured in the aforementioned bedrock monitoring wells and boreholes (based on multi-level packer testing), and using June-to-October 2006 and 2007 streamflow data for Williams Creek summarized by Access (2008). The static hydraulic heads were recorded in April 2008 for the boreholes, and were recorded in May-June-July 2007 for the monitoring wells, except for two wells (MW96-D and MW96-G) with hydraulic heads recorded in March 1996 due to the absence of data in subsequent years at these locations. Although the data used to calibrate the model was obtained from different periods, the error associated with the temporal variation in hydraulic heads was not anticipated to be significant for the purposes of reproducing general groundwater flow directions at the Site by the model.

For baseflow calibration, two streamflow gauging stations on Williams Creek were selected (W4 and W13, located between the confluences of North Williams Creek and Nancy Lee Creek) as, when compared to other stations, they covered the longest stretch of creek with the fewest tributaries (*i.e.*, only one small tributary). The difference in low flows measured between these two stations was assumed to correspond to baseflow (the contribution from one small, possibly ephemeral, tributary, mid-way along the stretch of creek between W4 and W13 was unknown but was assumed to be negligible during the low flow season).

During model calibration, adjustments were made to the hydraulic conductivity of the bedrock and to the flux values representing groundwater recharge from infiltration of precipitation, within realistic limits, until the model provided a good match to the hydraulic heads and baseflow measured at the Site.

Figure 8 provides a comparison of hydraulic heads calculated by the calibrated model for the pre-pumping conditions and measured hydraulic heads. The mean error and mean absolute error between predicted and measured values are 2 m and 7 m, respectively. This indicates that, on average, model predicted heads are 2 m higher than the measured values and that the model predictions are within +/- 7 m from the measured values. The weighted root-mean-square error is approximately 8%. Considering the scale of the model (88 km^2), the magnitude of drawdown expected during mine dewatering (approximately 80 m), and potential errors introduced by measurements that were collected at various time periods, these calibration results are considered to be reasonable for the purposes of predicting groundwater conditions during and after mining.

The baseflow predicted by the calibrated model for Williams Creek between stations W4 and W13 was approximately 900 m^3/d. This value falls within the range of streamflow rates measured during low flow periods between these stations (134 m^3/d to 1,265 m^3/d), suggesting that hydrogeologic parameters assigned within the catchment of this creek are reasonable.

Figure 9 presents the hydrogeologic conditions in bedrock predicted by the calibrated model for pre-mining conditions. In agreement with the conceptual model, the predicted groundwater flow direction at the Site is towards the east under an overall average horizontal hydraulic gradient of approximately 0.08. This flow is predicted to occur in response to groundwater recharge to the overburden or exposed weathered bedrock, primarily in the upland areas to the west of the Site. As presented on the cross-section on Figure 9, the calibrated model correctly reproduces slightly downward groundwater flow near the upland areas and upward groundwater flow near Williams Creek.

8.2.2 Transient Responses to Pumping Tests

Following steady-state calibration, the model was calibrated in transient mode to the observed drawdown response during a constant rate pumping test conducted by Golder in May 2008 at pumping well BH01-08 with observation well BH02-08. The location of the water well and observation well is shown on Figure 2.

The May 2008 pumping test involved 51 hours of pumping at a rate of approximately 382 m^3/d (70 USgpm) followed by 31 hours of recovery (Golder 2008c). The pumping test was simulated by assigning a specified flux boundary, based on the pumping rate, at the location of BH01-08. The simulated pumping test ran to an end time of 10 days and the drawdown predicted in the pumping well and observation well was compared to the measured drawdown.

Figure 10 shows a comparison of model predicted drawdown versus measured drawdown in the pumping well and observation well. There is good agreement between the predicted and measured drawdown for the observation well. However, due to frictional losses expected in the pumping well, a close match between predicted and observed drawdown was not expected for the pumping well. Rather, the predicted drawdown in the pumping well was expected to be less than observed but was expected to retain the approximate shape of the observed drawdown curve. Overall, the results of calibration to the May 2008 pumping test are considered good. The hydrogeologic parameters that were changed for the area immediately near the pumping well and observation well resulting from this calibration were transferred to the steady-state model as part of the iterative model calibration process.

Although a pumping test was conducted formerly by Aqua Tech in September 1995 at pumping well WW95-1 with observation well RC-92-01 (inclined well), the associated drawdown response data could not be used for transient model calibration purposes. This is because of the absence of design data for RC-92-01 and the likelihood of high well loss in the drawdown response at the pumping well during this test.

8.2.3 Calibrated Model Parameters

Figure 11 provides a summary of hydrogeologic parameters arrived at during model calibration. The calibrated recharge was equivalent to 9% of the average annual precipitation (*i.e.*, 9% of 338 mm/yr or 30 mm/yr or $8.3x10^{-5}$ m/d). The calibrated specific storage and specific yield was 0.0001 m^{-1} and 0.01 m/m respectively. Hydraulic conductivity of bedrock less than 100 m depth (model layer 1) was set to $2x10^{-7}$ m/s and was refined in three zones within the Site area, as shown on Figure 11. Hydraulic conductivity of bedrock greater than 100 m depth (model layers 2 and 3) was set to $2x10^{-8}$ m/s. The transmissivity of the water-conductive features in the vicinity of the proposed open pit was set to $2x10^{-4}$ m^2/s (*i.e.*, hydraulic conductivity of $4x10^{-6}$ m/s and effective width of 50 m). The hydraulic conductivity distribution at the Site is in good agreement with values estimated from single-well-response testing and multi-level packer testing and inferred from the drawdown response during pumping tests (see Section 4.0 and Figure 4).

8.2.4 Summary

Overall, the good calibration results for the pre-mining hydraulic heads, baseflow, general groundwater flow patterns, and drawdown response during pumping indicate that the calibrated model can provide reasonable predictions of pit inflows with sufficient accuracy for mine feasibility planning.

9.0 SIMULATION APPROACH FOR PRE-MINING, MINING AND CLOSURE

The calibrated groundwater model was used to simulate pre-mining, and planned mining and closure conditions to address the objectives listed in Section 3.0. To this end ten simulations were conducted, as summarized in Appendix II. The simulations used the final hydraulic heads from the steady state calibrated model as the initial (head) condition and the following additional model inputs to account for the planned Site operations and closure conditions described previously (Section 7.0):

- Constrained specified-head boundaries (to allow outflow of groundwater only when the pit shell extended below the water table) were applied on the top of the model in the area of the planned pit. The head values assigned to these boundaries varied over time to represent the annual pit development/dewatering sequence over the 6-year period of planned mine operations, and the cessation of dewatering during mine closure beyond the 6-year period. This, combined with the deforming mesh method used in FEFLOW, allowed for accurate representation of pit geometry throughout the mine life.

- Application of a time-dependent high hydraulic conductivity zone ($K=1x10^{-3}$ m/s) in the final pit area (at its maximum extent) to approximately represent an open pit that can flood after the six-year mining period.

- Specified flux boundaries were used to represent the operation of the pumping wells BH01-08 and DW3 (or WW95-1, depending on the simulation scenario) based on the planned pumping rates described in Section 7.0.

- Specified flux boundaries that represent groundwater recharge in the area of the HLF area were set to zero flux to account for the effect of the liner.

- Specified flux boundaries that represent groundwater recharge in the area of the planned pit were changed to –62 mm/yr ($-1.7x10^{-4}$ m/d) at the end of mining (beyond Year 6) during the subsequent development of the pit lake. This value represents the net water loss based on the difference in the average annual precipitation rate (338 mm/yr) and the average annual evaporation rate for open water (400 mm/y) for the Site (Golder 2008b).

10.0 RESULTS

10.1 Predicted Pit Inflow and Baseflow to Williams Creek

The model predicted annual average pit inflow rates over the planned operational life of the proposed open pit are presented in Table 1 below. These results indicate that over the first three years of pit operation (Years 1 to 3), the pit base is predicted to remain above the regional water table. Over the fourth year of pit operations, the pit base is predicted to reach and subsequently lie within the saturated groundwater zone. The annual average pit inflow rate is predicted increase from approximately 10 m^3/d to 900 m^3/d over the last three years of pit mining operations (Years 4 to 6).

TABLE 1: Predicted Pit Inflow and Reduction in Baseflow to Williams Creek

Year	Predicted Pit Inflow (m^3/d)	Predicted Reduction in Baseflow to Williams Creek (%)	
			Influence of Pit Operations Alone
1	0	14 (8 to 33)	0
2	0	14 (8 to 34)	0
3	0 (0 to 100)	15 (9 to 34)	0
4	10 (0 to 300)	15 (9 to 35)	0
5	600 (400 to 800)	16 (10 to 38)	1
*6	900 (600 to 1200)	23 (15 to 45)	8
7		23 (15 to 43)	8
**8		22 (14 to 25)	6
9		6 (2 to 6)	6
10		5 (2 to 5)	5

Year	Predicted Pit Inflow (m^3/d)	Predicted Reduction in Baseflow to Williams Creek (%)	
			Influence of Pit Operations Alone
11		5 (2 to 5)	4
12		4 (2 to 4)	4
15		3	3
20		3	3

Notes:
1. ( ) uncertainty results based on limited sensitivity analysis discussed in Section 11.0
2. Pre-mining average annual baseflow to Williams Creek is estimated to be on the order of 1,500 m^3/d or less between locations X and X' on Figure 9.

*Proposed last year of mine pit operations – Year 6

**Proposed Last year of water well operations – Year 8

The average baseflow to Williams Creek in the Site vicinity (between locations X and X' along Williams Creek on Figure 9) is estimated to be on the order of 1,500 m^3/d or less during pre-mining conditions. The model predicted average annual reduction to baseflow during Site operations (includes water well operations and pit mining, as described in Section 7.0) and post closure is presented in Table 1 above. These results indicate that over the eight years of planned water well pumping (*i.e.,* groundwater extraction for camp and plant operations) the baseflow to Williams Creek is predicted to be reduced by up to 20%. Following Site closure, the baseflow is expected to recover within a few years to approximately the pre-mining value. The results in Table 1 also indicate that the baseflow reduction is primarily due to the operation of the water wells. The mine pit operation alone is predicted to cause a delayed (starting at Year 6) and relatively small reduction in baseflow of up to 8% of the pre-mining baseflow.

10.2 Predicted Water Table and Drawdown during Site Operations

Figure 12 present hydrogeologic conditions predicted at the final stage of open pit development (*i.e.,* Year 6). Although the prominent area of high hydraulic heads to the southwest of the Site remains relatively similar to pre-mining conditions (see Figure 9), pit dewatering is predicted to reduce hydraulic heads in the vicinity of the mine workings (*i.e.,* the pit acts as a sink for groundwater flow).

The associated extent of the drawdown cone, defined using the 1 m drawdown contour, is predicted to extend laterally in the bedrock to a maximum distance of approximately 800 m (in the southwest direction) from the proposed open pit, as shown on Figure 13. The drawdown cone associated with water well BH01-08 (pumping at an average rate of 194 m^3/d) is predicted to extend approximately 300 m upgradient and north of the well where it merges with the drawdown cone generated by the open pit. Because of the low

pumping rate for the supplementary water well (DW3; pumping at an average rate of 56 m^3/d), the drawdown associated with this well is predicted to be less than 1 m, and thus is not shown on Figure 13. The extent of the drawdown cone for the pit is not predicted to change significantly if the supplementary water well is selected to be WW95-1, located southeast and downgradient of the HLF area, instead of DW3.

Additional simulations were conducted to compare the effect of the proposed monthly pumping schedules (see Appendix I) for the two active water wells on the extent of the drawdown cone, relative to that generated using average pumping rates for these wells. The proposed schedules indicate a peak groundwater withdrawal period between January and March (610 m^3/d), and a low groundwater withdrawal period between May and September (between 14 and 55 m^3/d). The results presented on Figure 14 A and Figure 14 B indicate that the size of the drawdown cones associated with the water wells vary to some extent from those generated using average pumping rates. At the end of the low groundwater withdrawal period, the active water wells are predicted to have drawdowns that are less than 1 m, and thus are not shown on Figure 14. At the end of the peak groundwater withdrawal period, the extent of the drawdown cones for the active water wells, defined using the 1 m drawdown contour, are predicted to extend several hundred meters from each well. However, the shape and size of the drawdown cone generated by the open pit is generally similar for both water well pumping scenarios (*i.e.,* monthly varying rates vs. average rates).

10.3 Predicted Pit Lake Development during Mine Pit Closure

Groundwater flow conditions at the Site are expected to revert back to quasi-pre-mining conditions after completion of pit mining and plant operations, except in the immediate vicinity of the pit and the HLF area, as shown on Figure 15. The predicted surface water level in the pit is predicted to reach quasi-static conditions within approximately six years following mine pit closure (*i.e.,* approximately Year 12 from the start of mine operations), at an elevation of approximately 720 masl, as shown on Figure 15.

The water table elevation below the HLF area is predicted by the model to be slightly depressed, and possibly up to 10 m lower, relative to pre-mining levels, as a result of the influence of the pit lake, and, to a lesser extent, the influence of the liner in the HLF.

10.4 Predicted Pathway and Travel Time for Potential Leaks from HLF Area

The HLF has been designed with a double-composite liner system and leak detection and collection system to minimize any potential leakage from the facility into the natural environment. However, the particle tracking solution in FEFLOW was used to evaluate

the potential pathway and the predicted minimum travel time for a potential leak from the proposed HLF to reach Williams Creek and/or the open pit from the start of Site operations. Imaginary particles were placed along the base of the HLF that tracked groundwater flow in transient mode using groundwater velocities predicted by FEFLOW. This allowed delineation of pathlines from the HLF to potential receptors. For this evaluation, the effective porosity assumed for the bedrock was 0.005. This value was based on the lower end of the range reported in the literature for competent granite (<0.01 to 0.015; as reported in Dunne and Leopold, 1978), and as such is expected to provide conservatively low travel times. For the purposes of this evaluation, the leak solution was assumed to be chemically inert (*i.e.*, does not undergo any chemical reactions); therefore it was assumed to migrate in the saturated groundwater zone at the average groundwater velocity. The travel time for the leak solution to migrate through the unsaturated zone below the HLF to the water table was not considered, again providing an overall conservative estimate of the travel time. In all likelihood the travel times would be greater than predicted by the model.

The groundwater pathway below the HLF, as determined from particle tracking, is shown on Figure 16. The predicted minimum travel time for a potential leak from the HLF to reach Williams Creek was approximately 7 years. The predicted minimum travel time to the open pit was approximately 6 years; however, because mine pit operations are planned to cease after six years, it remains uncertain whether potential leaks from the HLF will discharge into the pit or pit lake.

If water well WW95-1, located southeast and downgradient of the HLF area, is used as the supplementary water supply well instead of the proposed new water well DW3 (see Section 7.0), then the minimum travel time for a potential leak from below the HLF to reach Williams Creek is also predicted to be approximately 7 years. This scenario was predicted to have a similar groundwater pathway and travel time to the open pit as the base case scenario described above.

Potential leaks from the HLF are not predicted to report to the water supply wells considered in this study.

11.0 MODEL LIMITATIONS AND UNCERTAINTY

The accuracy of the numerical model and the uncertainty associated with the predictive results are a function of the uncertainty in the input data, the accuracy in the conceptual understanding of the Site hydrogeology, the reasonableness of the model assumptions, and the quality of the model calibration. This uncertainty is inherent in any hydrogeologic assessment, as it is simply not practical to drill boreholes at dense enough spacing that would allow identification and testing of all heterogeneities, discontinuities, etc. Rather than rigorously quantifying the uncertainties regarding the model results, the

calibrated model was used to make reasonably conservative estimates and predictions from an impact perspective. In addition, a limited sensitivity analysis was conducted by means of six additional simulations (described in Appendix II) which assumed one of the following:

- The water-conductive features in the vicinity of the proposed pit area may not be hydraulically active;
- The specific storage of the aquifer may be an order of magnitude lower ($0.00001\ m^{-1}$);
- The hydraulic conductivity of the deep bedrock (*i.e.,* bedrock greater than 100 m depth) may be two to three times greater than the upper range of hydraulic conductivity estimated from multi-level packer testing;
- The hydraulic conductivity of all the bedrock (shallow and deep) may be two to three times greater than estimated from slug tests and multi-level packer testing; or,
- The hydraulic conductivity of the water-conductive features in the vicinity of the proposed pit area may two to three times greater than estimated from multi-level packer testing.

The results of this limited sensitivity analysis suggests that:

- The pit inflow rates could vary from 600 m^3/day to 1200 m^3/day at the final stage of pit development;
- At the final stage of mine operations, groundwater extraction by the water wells for camp and plant operations and mine pit operations could reduce baseflow to Williams Creek in the Site vicinity by between 15% and 45%;
- The maximum extent of the drawdown cone in bedrock that will be generated by the open pit could range between 800 m and 1100 m from the proposed open pit, based on the 1m contour interval for drawdown, (see Figure 14 C);
- The static surface water elevation in the pit lake could vary between 710 masl and 760 masl; and,
- The minimum travel time for a potential leak from the HLF to reach Williams Creek could range between approximately 4 and 10 years. In addition, the potential leak could report to the open pit in as early as 5 years.

The range of model predictions presented in this study does not incorporate all uncertainties associated with Site hydrogeologic conditions. For example, the potential existence of other, unknown, laterally extensive and highly permeable water-conductive features in bedrock in the vicinity of mine facilities could alter groundwater flow patterns and baseflow to Williams Creek during groundwater extraction and would affect pit inflows. The existing model indicates that inflow from one such feature, if it exists, would be on the order of 300 to 400 m^3/d. Two water-conductive features were assumed to exist within the proposed open pit area, based on the location of known faults and the results of multi-level packer tests (see Section 5.0 and 6.0). If a third feature were to exist within the proposed pit area, then the pit inflow rate could range between 900 and 1,600 m^3/d.

12.0 CONCLUSIONS

The primary focus of this hydrogeological assessment of the Carmacks Copper Project was to revise the previous, preliminary hydrogeologic assessment as a result of new information available for the Site, and to provide additional input to the updated engineering design for the Carmacks Copper Project. This revised assessment was successful in meeting all of the project objectives. To this end, this report has concluded the following:

- Pit inflow (*i.e.*, groundwater discharge into the pit) is predicted to commence in approximately the fourth year of pit mining, and the average annual pit inflow rate is predicted to progress from near zero to 900 m^3/d over the last three years of pit mining (Years 4 to 6). Based on a limited uncertainty analysis, the pit inflow rate could range from 600 m^3/d to 1,200 m^3/d at the final stage of pit development (at Year 6). If additional water-conductive features exist within the proposed pit area than the ones considered in this study, then the pit inflow could be as much as 400 m^3/d greater than predicted for each feature encountered.

- The total flow in Williams Creek is comprised of runoff, baseflow, and direct precipitation. Baseflow is the component of total flow that originates from groundwater discharge into the creek, whereas runoff is the component of total flow generated by snow melt and storm events within the Williams Creek watershed. The baseflow to Williams Creek in the vicinity of the Site is predicted to be reduced by up to 20% during the eight years of mine operations. Based on a limited uncertainty analysis, the baseflow could be reduced by between 15% and 45% at the final stage of mine pit operations (at Year 6). Using an approximation of total average annual flow in Williams Creek that discharges into the Yukon River (based on limited stream flow data and the assumption that the creek is frozen throughout winter), this baseflow reduction is expected be on the order of a few percent of this approximation. Following Site closure, the baseflow is expected to recover to near pre-mining levels within a few years.

- Pit operations are predicted to reduce hydraulic heads in the vicinity of the mine workings (*i.e.*, the pit acts as a sink for groundwater flow), although the prominent area of high hydraulic heads to the southwest of the Site remains relatively similar to pre-mining conditions.

- The extent of the drawdown cone generated by the mine pit, defined using the 1 m drawdown contour, is predicted to extend laterally in the bedrock to a maximum distance of approximately 800 m (in the southwest direction) from the pit. Based on a limited uncertainty analysis, the extent of the drawdown cone could be up to 1100 m from the pit.

- A pit lake is predicted to develop when pit mine operations cease and the pit undergoes closure. The lake's water level is predicted to reach quasi-static conditions within approximately six years post mine pit closure (*i.e.*, approximately Year 12 from the start of mine operations), at an elevation of approximately 720 masl. Based on a limited uncertainty analysis, the static lake level elevation could range between 710 and 760 masl.

- The HLF design includes a double-composite liner system and leak detection and collection system to minimize any potential leakage from the facility into the natural environment. However, the model was used to predict travel times and directions of a potential leak that reaches the saturated groundwater zone. The predicted minimum travel time for a leak to reach Williams Creek was approximately 7 years. Based on a limited uncertainty analysis and conservative assumptions, the travel time to either Williams Creek or the open pit could range between 4 and 10 years, once the leak has reached the saturated groundwater zone. A potential leak from the HLF is not predicted to report to the water supply wells considered in this study.

13.0 CLOSURE

We trust this report satisfies your current requirements. If you have any questions or require further assistance, please do not hesitate to contact the undersigned.

GOLDER ASSOCIATES LTD.

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Senior Hydrogeologist

Reviewed by:

ORIGINAL SIGNED

Fiona Esford, M.Sc., P.Eng.
Project Manager

ORIGINAL SIGNED

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Associate, Senior Hydrogeologist

CGR/FE/WZ/jc
Attachments
\\BUR1-S-FILESRV2\FINAL\2007\1413\07-1413-0077\REP 0311_09 CARMACKS- 3D GROUNDWATER MODELLING REPORT - FINAL\REP 0311_09 CARMACKS - 3D GROUNDWATER MODELLING REPORT - FINAL.DOC

14.0 REFERENCES

Access Consulting Group, 2008. Western Copper Corporation. Carmacks Copper Project. Report re: *Environmental Monitoring Program Update and Data Summary – Revision No. 3.* June 2008.

Diersch, H. –J.G., 2005. FEFLOW finite element subsurface flow and transport simulation system, Reference Manual, User's Manual and White Papers Vol. I, II, III, IV, WASY – Institute for Water Resources Planning and Systems Research, Berlin.

Dunne T., and Leopold L.B., 1978. Water in Environmental Planning. Copyright © 1978 by W.H. Freeman and Company, New York.

Golder 2007. Western Copper Corporation. Carmacks Copper Project. Memorandum re: *Preliminary Hydrogeologic Assessment, Heap Leach Pad Zone*. (Project No. 06-1413-077; Doc No. 045) May 16, 2007.

Golder 2008a. Western Copper Corporation. Carmacks Copper Project. Memorandum re: *Hydrogeological Testing Program*. (Project No. 07-1413-0077 (4100); Doc No. 0067) May 26, 2008.

Golder 2008b. Western Copper Corporation. Carmacks Copper Project. Report re: *Site Water Balance*. (Project No. 07-1413-0077(7300); Doc No. 0068) June 12, 2008.

Golder 2008c. Western Copper Corporation. Carmacks Copper Project. Memorandum re: *Interim Technical Brief – Groundwater Supply Assessment.* (Project No. 07-1413-0077 (6300); Doc No. 0079) August 8, 2008.

Golder 2008d. Western Copper Corporation. Carmacks Copper Project. Draft Report re: *Open Pit Slope Design*. (Project No. 07-1413-0077; Doc No. 0091) October 22 2008.

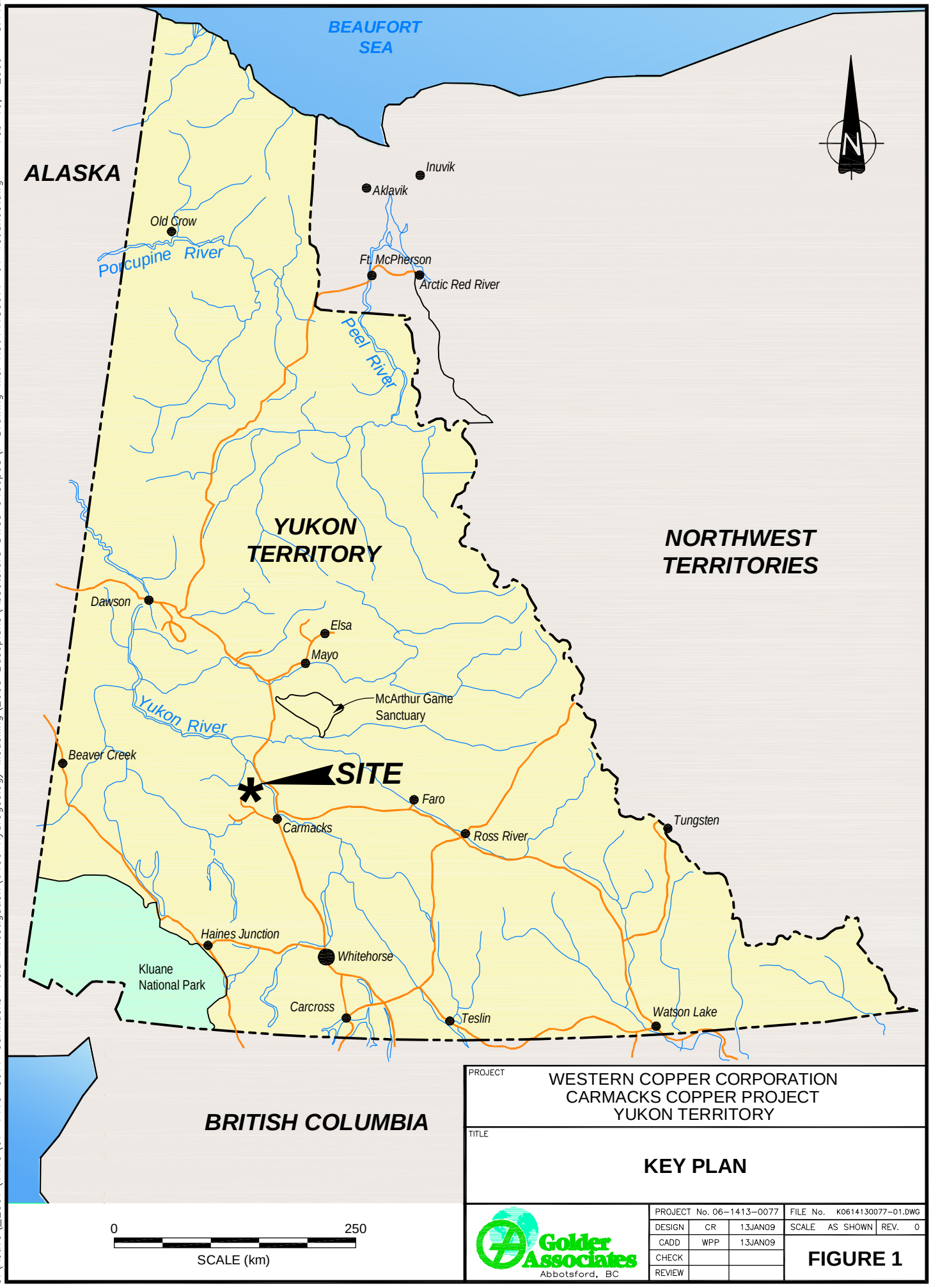
Golder 2008e. Western Copper Corporation. Carmacks Copper Project. Report re: 2007 Geotechnical Investigation. Vol I and II (Project No. 07-1413-0077; Doc No. 0042) April 9 2008.

Golder 2008f. Western Copper Corporation. Carmacks Copper Project. Report re: Preliminary Design Report. Heap Leach Facility. Vol I. (Project No. 06-1413-0077; Doc No. 038 Rev.1) January 28, 2008.

Golder 2008g. Western Copper Corporation. Carmacks Copper Project. Report re: Preliminary Design. Waste Rock Storage Area. Vol I. (Project No. 06-1413-0077; Doc No. 066 Rev.1) April 15, 2008.

Knight Piésold Ltd, 1995. Western Copper Holdings Limited. Carmacks Copper Project. *Report on Preliminary Design* (Ref. No. 1783/1). May 1, 1995.

Knight Piésold Ltd, 1996. Western Copper Holdings Limited. Carmacks Copper Project. *Report on 1996 Geotechnical and Hydrogeological Site Investigations* (Ref. No. 1784/1). June 7, 1996.



PROJECT

WESTERN COPPER CORPORATION
CARMACKS COPPER PROJECT
YUKON TERRITORY

TITLE

KEY PLAN

Golder Associates
Abbotsford, BC

PROJECT No. 06-1413-0077			FILE No.	K0614130077-01.DWG
DESIGN	CR	13JAN09	SCALE AS SHOWN	REV. 0
CADD	WPP	13JAN09		
CHECK				
REVIEW				

FIGURE 1

O:\Active_2007\1413\07-1413-0077 Carmacks-Field Investigation\6400 Hydrogeology Modelling\2008 Baseplans\Abbotsford DWGs 04Sep08\P Drawing file: K0614130077-01 13Jan09.dwg Feb 10, 2009 - 8:44am

Existing Main Access Road
NORTH WILLIAMS CREEK
Waste Rock Storage Area (WRSA)
Existing Access Road
Open Pit
Heap Leach Facility (HLF)
WILLIAMS CREEK
HYD-WELL-2
Existing Main Access Road
BH01-08
BH02-08
6914800 N
6914600 N
6914400 N
6914200 N
6914000 N
6913800 N
6913600 N
6913400 N
6913200 N
6913000 N
6912800 N
6912600 N
6912400 N
6912200 N
6912000 N
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411000 E
411200 E
411400 E
411600 E
411800 E
412000 E
412200 E
412400 E
412600 E
412800 E
413000 E
413200 E

LEGEND

- HYD-WELL-2 — Approximate 2008 Vibrating Wire Piezometer Location
- DW08-02 — Approximate 2008 Water Well Location
- GA08-08 — 2008 Angled Drill Hole Location
- BH-09-07 — Approximate 2007 Borehole Location
- BH-17-07 — Approximate 2007 Borehole Location with Thermistor Installation
- MW-01-07 — Approximate Monitoring Well Location
- WW-95-01 — Approximately 1995 Water Well Location
- DH95-F / RC-92-09 / TH2 — Approximate Drill Hole / Rock Core / Test Hole Location (Previous Investigation by Knight Piesold)
- MW96-E — Approximate Monitoring Well Location (Previous Investigation by Knight Piesold)
- WCR-072 — Approximate Exploratory Drill Hole Location (Previous Investigation by Western Copper Corporation)
- Existing Access Road

FAULT LEGEND

- Approximate Location of Faults Derived from Aurora Geosciences Ltd. General Plan Map Jan. 8th, 2007.
- Approximate Location of Probable Faults Derived from Aurora Geosciences Ltd. General Plan Map Jan. 8th, 2007.
- Location of Faults from NorthWestel Shape File Recieved August 28th, 2008.

NOTES

1.) Topographic Elevations Shown are in metres above Mean Sea Level.
2.) Grid Coordinates Shown in UTM NAD 83, Zone 8.

REFERENCES

1.) M3 Engineering Ltd., CAD Files: 100-CI-010P5.dwg, Dated March 13th, 2008.
2.) Eagle Mapping Ltd., CAD Files: SH1-UTM.dwg to SH9-UTM.dwg, Dated November 1st, 2007.
3.) Western Copper Corporation, CAD File: End_Of_Yr_06.dwg, Dated March 30th, 2007.
4.) IMC Tuscon, CAD Files: mph4tr06.dxf and plmph4tr06.dxf, Dated March 4th, 2008.
5.) Aurora Geosciences Ltd., Figure 12.1: General Plan Map, from Report Dated January 8th, 2007.
6.) NorthWestel, Shape File: Carmacks Property Faults_ln.shp, Received August 28th, 2008.

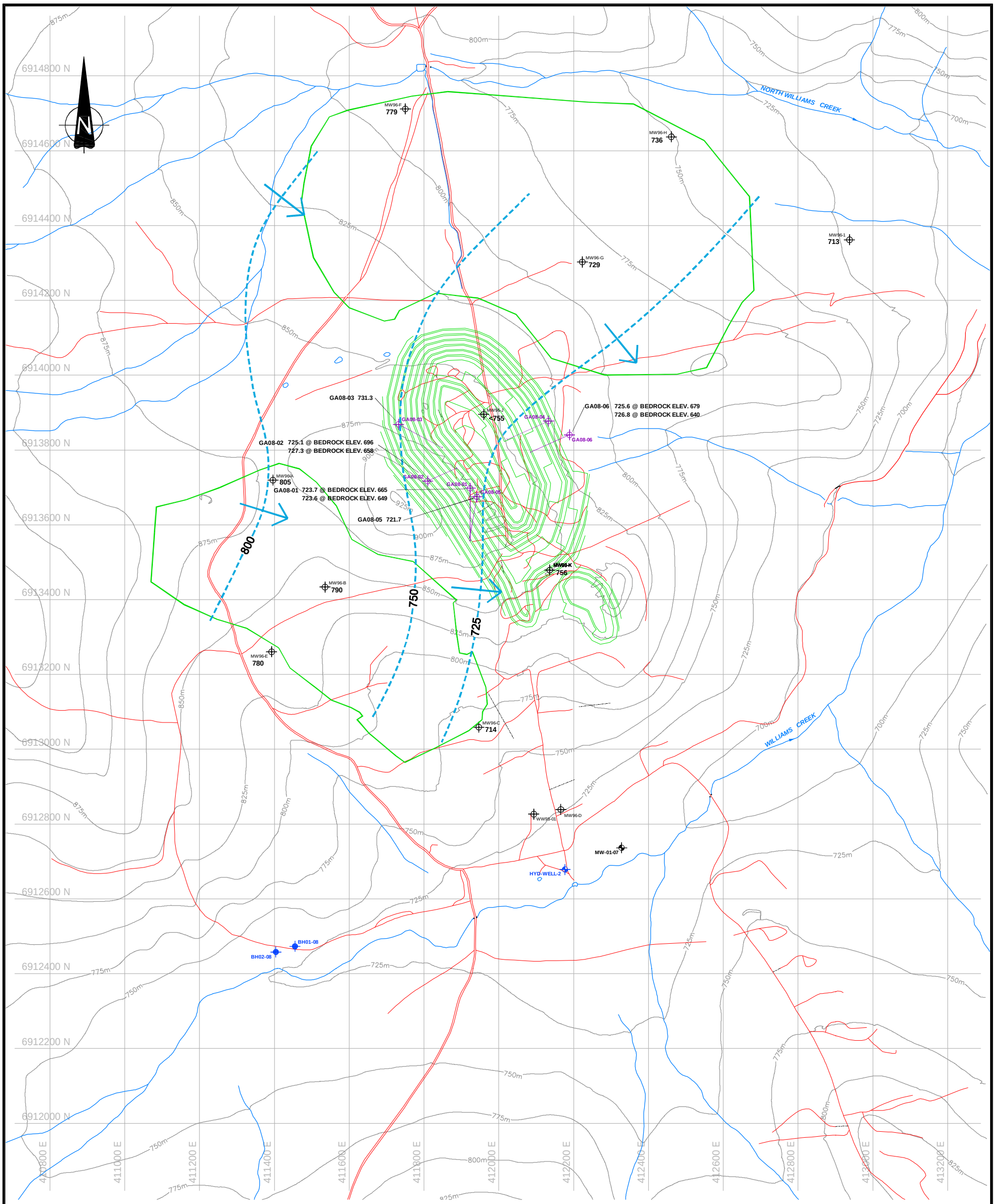
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PROJECT
WESTERN COPPER CORPORATION
CARMACKS COPPER PROJECT
YUKON TERRITORY

TITLE
SITE PLAN AND BOREHOLE/WELL LOCATIONS

Golder Associates
Abbotsford, BC

PROJECT No. 07-1413-0077			PHASE 6400	TASK 0000	
DESIGN	CR	13JAN09	FILE No. P6400-01		
CADD	WPP	13JAN09	SCALE AS SHOWN	REV. 0	
CHECK	CR	13JAN09	FIGURE 2		
REVIEW					



LEGEND

- HYD-WELL-2 — Approximate 2008 Vibrating Wire Piezometer Location
- DW08-02 — Approximate 2008 Water Well Location
- MW96-E — Approximate Monitoring Well Location (Previous Investigation by Knight Piesold)
- 725 — Measured water level elevation (masl)
- Inferred water table contours (masl)
- Inferred groundwater flow direction.

NOTES

1.) Topographic Elevations Shown are in metres above Mean Sea Level.
2.) Grid Coordinates Shown in UTM NAD 83, Zone 8.
3.) Hydraulic heads for the boreholes GA08-01 to 06 were recorded April 2008.
4.) Hydraulic heads for the monitoring wells were recorded in May-June 2007,except for two wells, MW96-D and MW96-G with data from March 1996 due to absence of data in subsequent years.

REFERENCES

1.) M3 Engineering Ltd., CAD Files: 100-CI-010P5.dwg, Dated March 13th, 2008.
2.) Eagle Mapping Ltd., CAD Files: SH1-UTM.dwg to SH9-UTM.dwg, Dated November 1st, 2007.
3.) Western Copper Corporation, CAD File: End_Of_Yr_06.dwg, Dated March 30th, 2007.
4.) IMC Tuscon, CAD Files: mph4tr06.dxf and plmph4tr06.dxf, Dated March 4th, 2008.
5.) Aurora Geosciences Ltd., Figure 12.1: General Plan Map, from Report Dated January 8th, 2007.
6.) NorthWestel, Shape File: Carmacks Property Faults_ln.shp, Received August 28th, 2008.

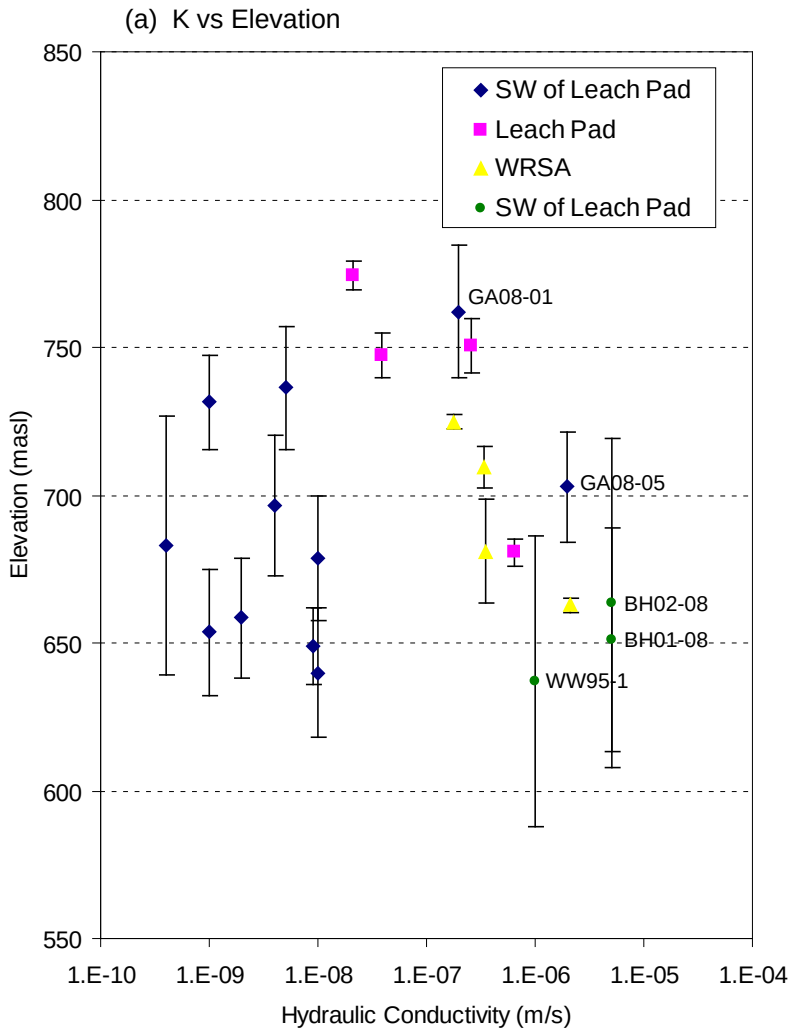
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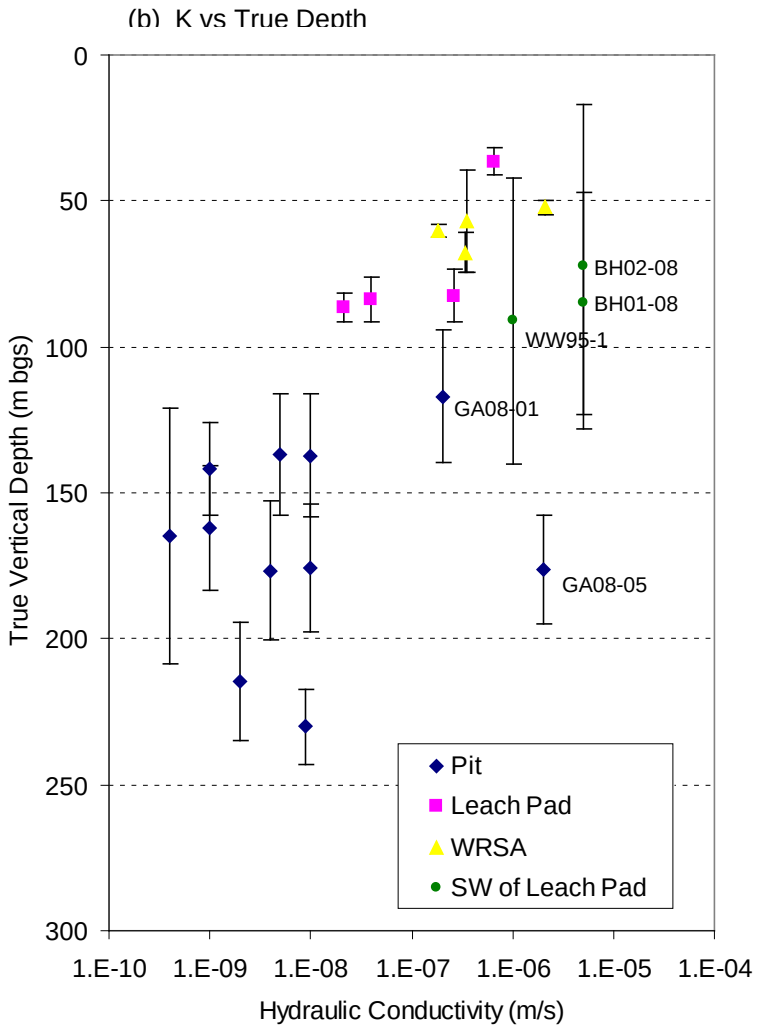
PROJECT
WESTERN COPPER CORPORATION
CARMACKS COPPER PROJECT
YUKON TERRITORY

TITLE
PRE-MINING HYDRAULIC HEADS

Golder Associates
Abbotsford, BC

PROJECT No. 07-1413-0077			PHASE 6400	TASK 0000	
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CHECK	CR	13JAN09	**FIGURE 3**		
REVIEW					





LEGEND

Open interval with mid-point

Notes:

1. Length and position of open interval along angled coreholes is corrected to true vertical depth.

PROJECT

WESTERN COPPER CORPORATION
CARMACKS COPPER PROJECT
YUKON TERRITORY

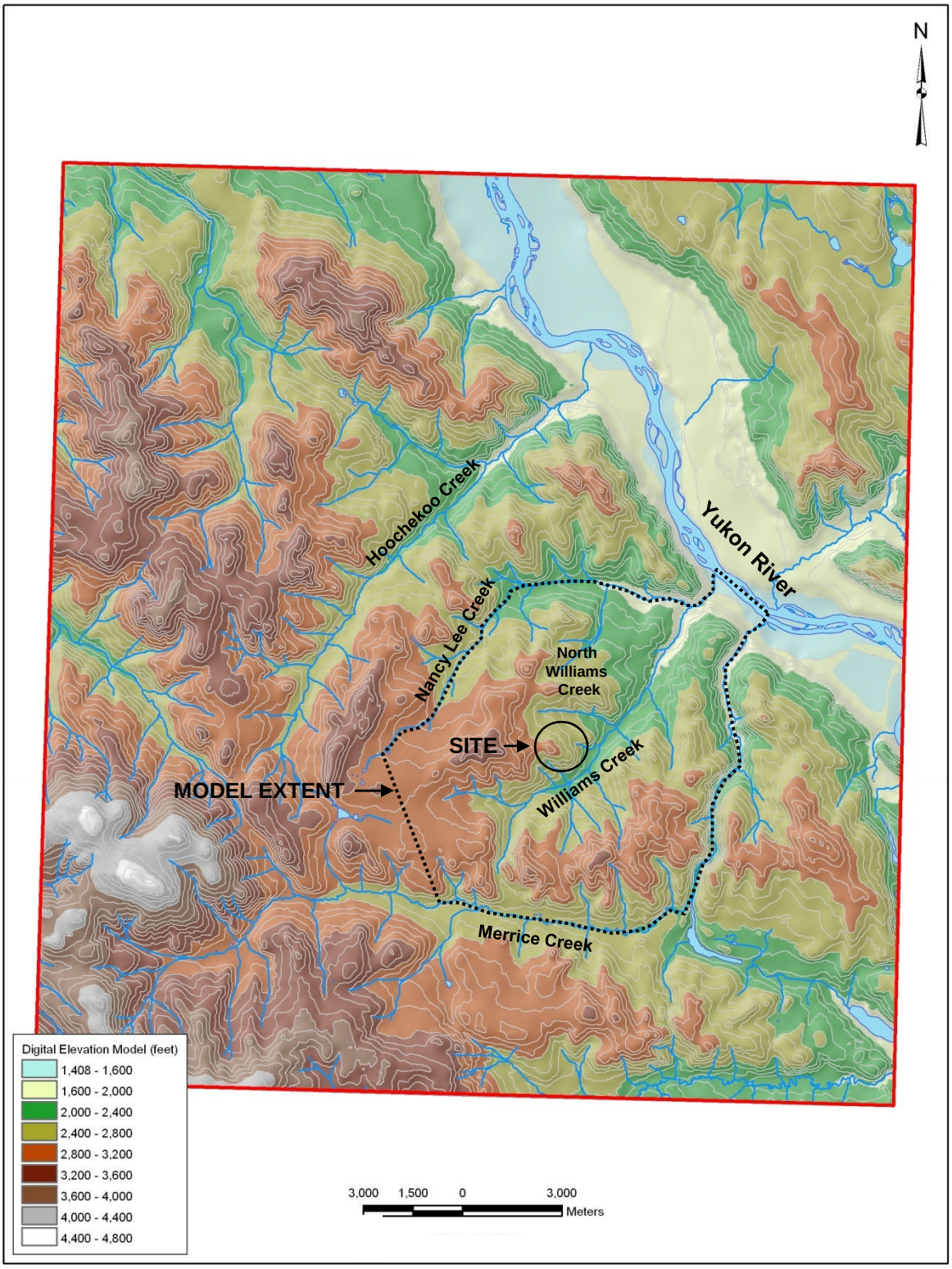
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HYDRAULIC CONDUCTIVITY DATA

Golder Associates

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CADD	CR	15DEC08			
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REVIEW					

FIGURE 4



PROJECT

WESTERN COPPER CORPORATION
CARMACKS COPPER PROJECT
YUKON TERRITORY

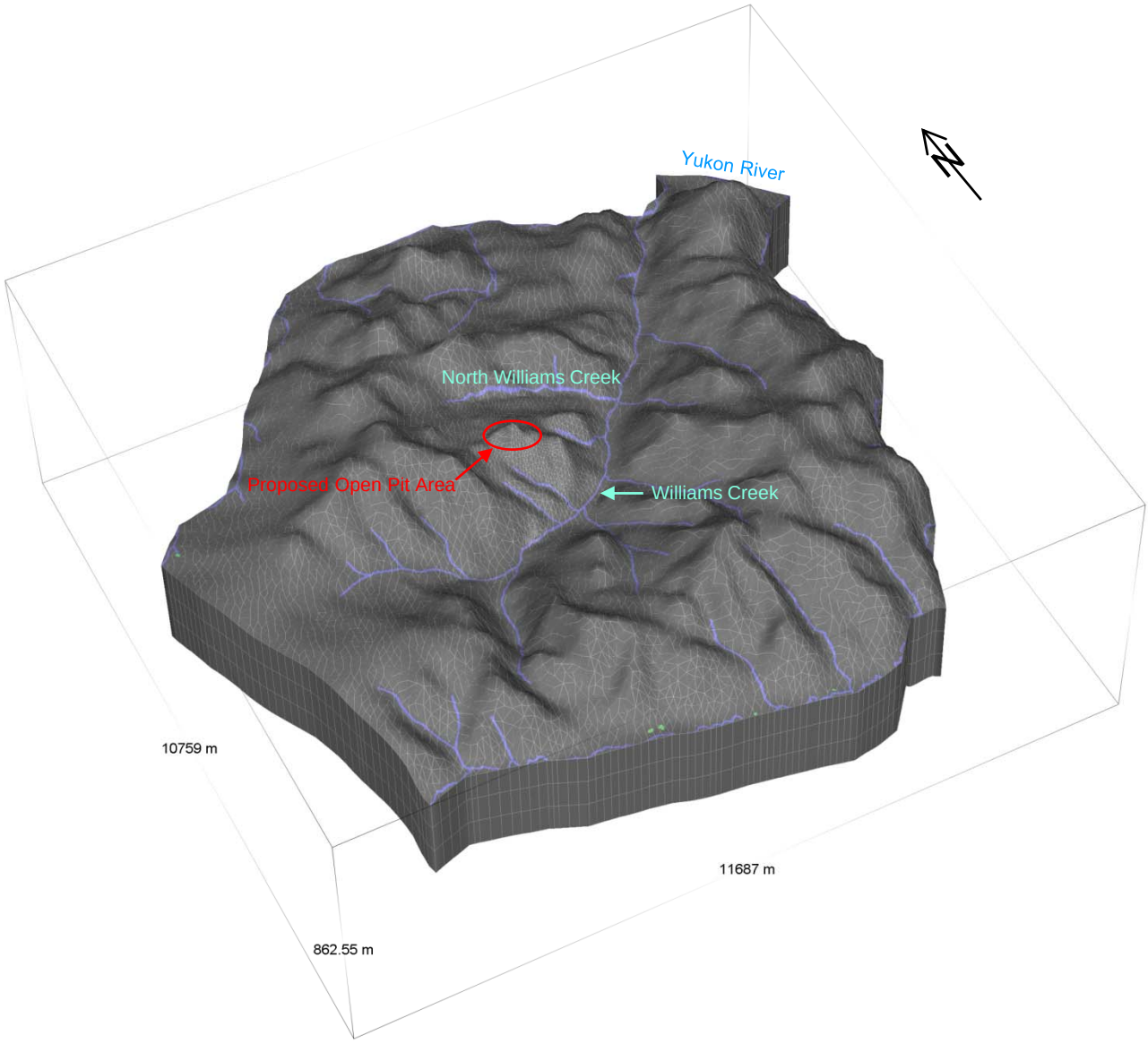
TITLE

EXTENT OF MODEL DOMAIN

Golder Associates

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CADD	CR	15DEC08	**FIGURE 5**		
CHECK	CR	15DEC08			
REVIEW					

REVISION DATE: BY: FILE: O:\Active_2007\1413\07-1413-0077 Carmacks-Field Investigation\6400 Hydrogeology Modelling\2008 Report



Notes:
1. Scale is approximate.
2. Vertical exaggeration of 5:1

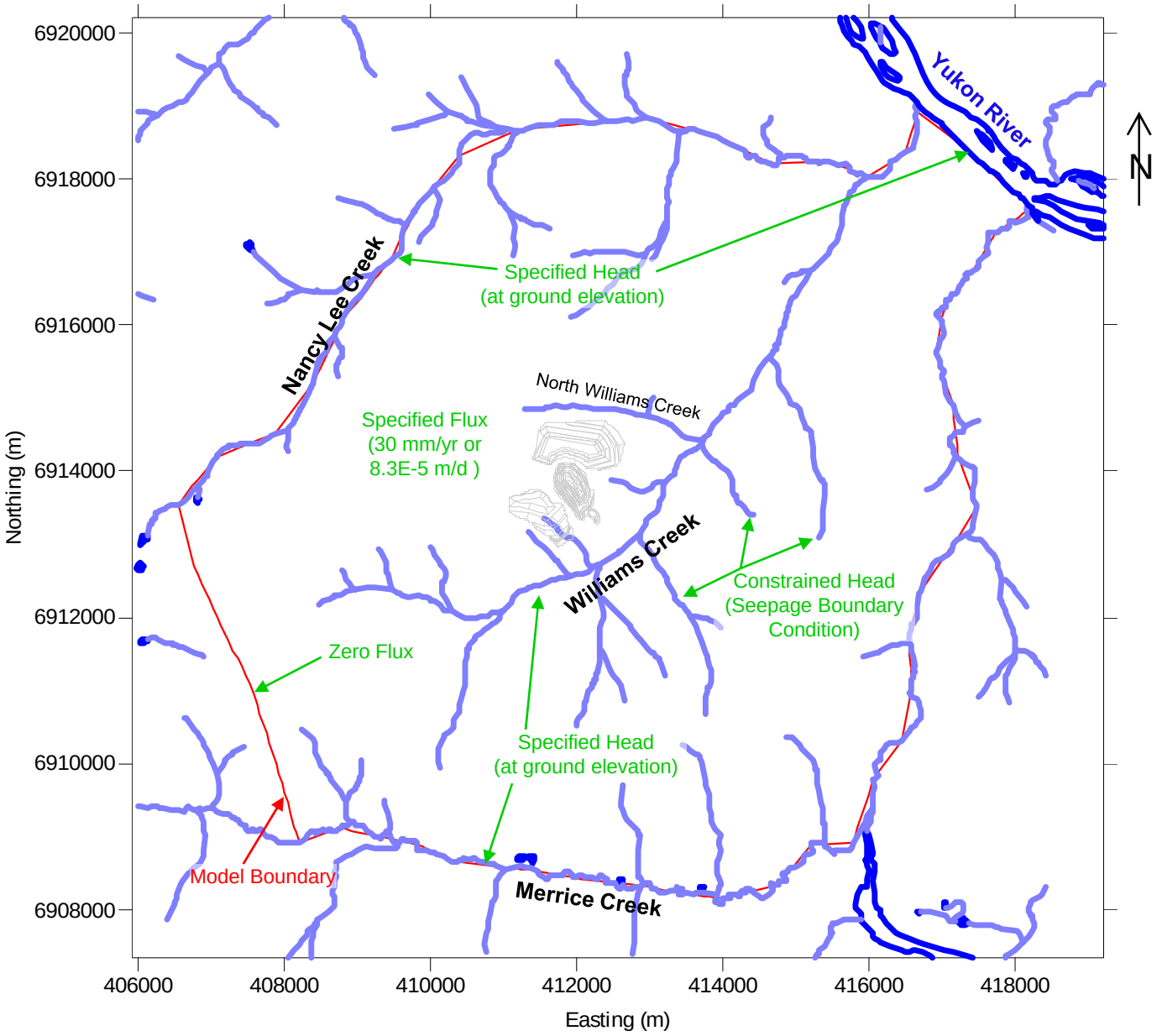
PROJECT
WESTERN COPPER CORPORATION
CARMACKS COPPER PROJECT
YUKON TERRITORY

TITLE
EXTENT OF FINITE ELEMENT MESH

Golder Associates

PROJECT No. 07-1413-0077			FILE No. ----	
DESIGN	CR	15DEC08	SCALE NTS	REV.
CADD	CR	15DEC08	**FIGURE 6**	
CHECK	CR	15DEC08		
REVIEW				

REVISION DATE: BY: FILE: O:\Active_2007\1413\07-1413-0077 Carmacks-Field Investigation\6400 Hydrogeology Modelling\2008 Report



Notes:
1. Scale in meters.

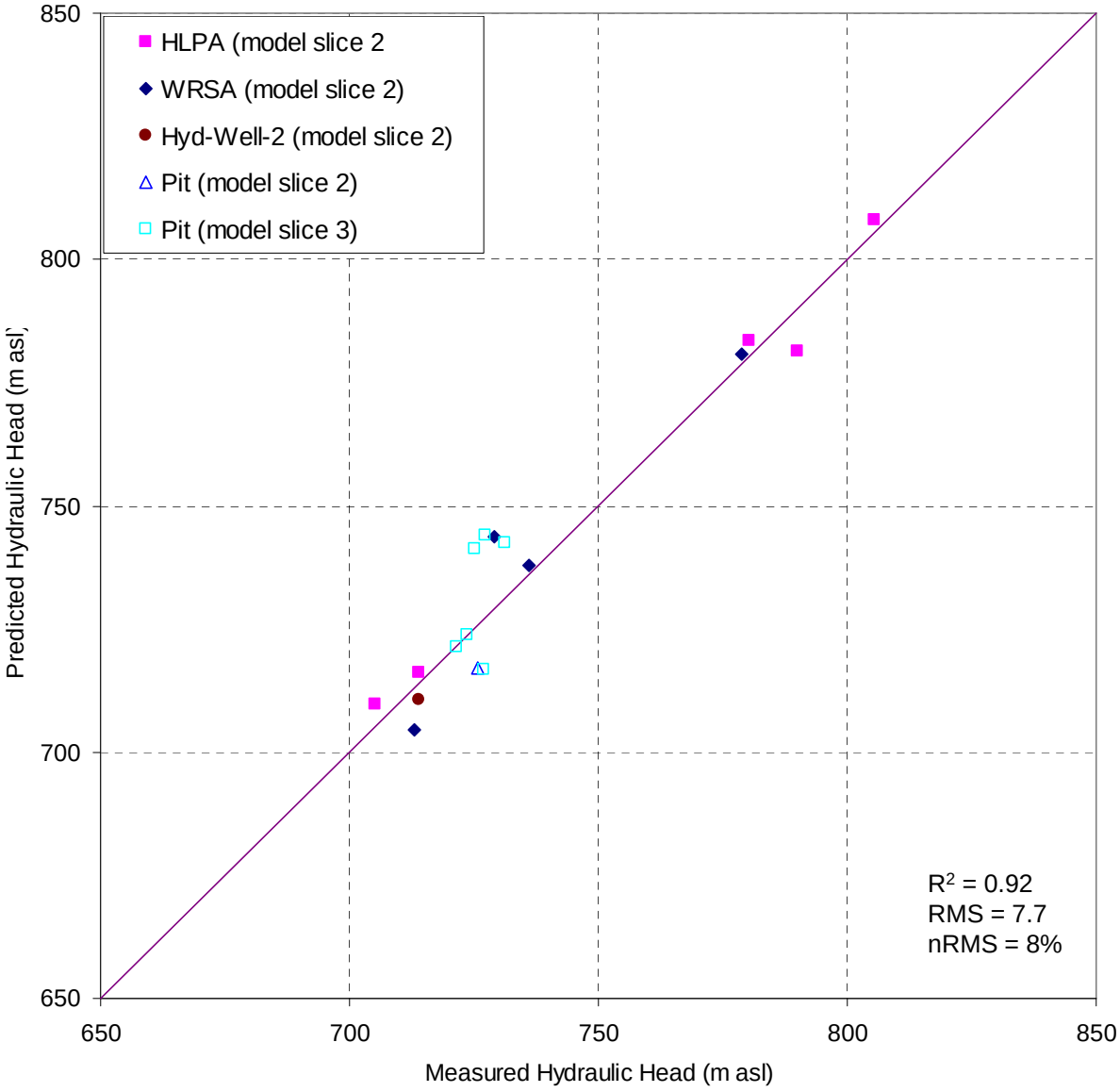
PROJECT
WESTERN COPPER CORPORATION
CARMACKS COPPER PROJECT
YUKON TERRITORY

TITLE
MODEL BOUNDARY CONDITIONS

Golder Associates

PROJECT No. 07-1413-0077			FILE No. ----		
DESIGN	CR	15DEC08	SCALE NTS		REV.
CADD	CR	15DEC08	**FIGURE 7**		
CHECK	CR	15DEC08			
REVIEW					

REVISION DATE: BY: FILE: O:\Active_2007\1413\07-1413-0077 Carmacks-Field Investigation\6400 Hydrogeology Modelling\2008 Report

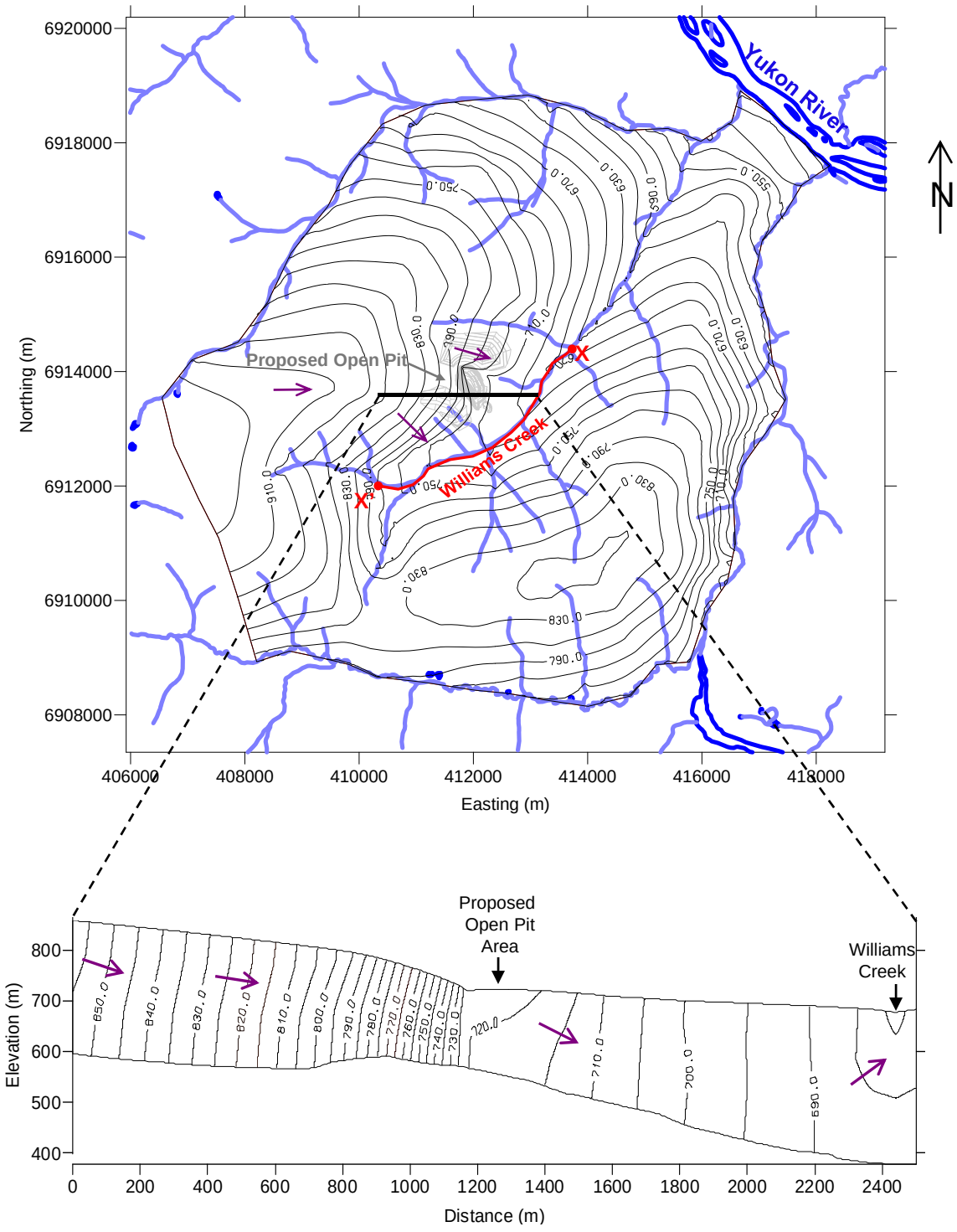


PROJECT	WESTERN COPPER CORPORATION CARMACKS COPPER PROJECT YUKON TERRITORY
TITLE	RESULTS OF MODEL CALIBRATION PREDICTED VS. MEASURED HYDRAULIC HEADS

Golder Associates

PROJECT No. 07-1413-0077			FILE No. ----		
DESIGN	CR	15DEC08	SCALE NTS		REV.
CADD	CR	15DEC08	FIGURE 8		
CHECK	CR	15DEC08			
REVIEW					

REVISION DATE: BY: FILE: O:\Active_2007\1413\07-1413-0077 Carmacks-Field Investigation\6400 Hydrogeology Modelling\2008 Report



LEGEND

- Predicted Hydraulic Head Contours (masl)
- Predicted Groundwater Flow Direction
- X — X' Reach of Williams Creek considered for Baseflow Evaluation

Notes:

1. Vertical exaggeration 2:1

PROJECT

WESTERN COPPER CORPORATION
CARMACKS COPPER PROJECT
YUKON TERRITORY

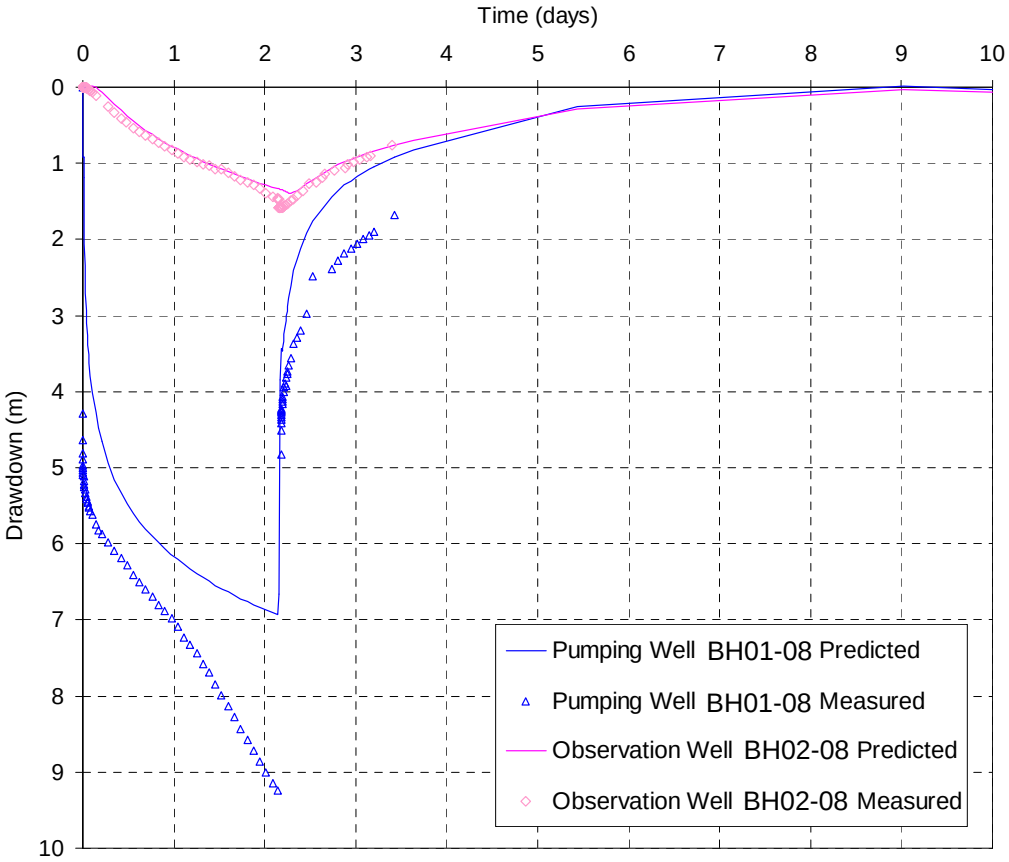
TITLE

RESULTS OF MODEL CALIBRATION PRE-MINING CONDITIONS

Golder Associates

PROJECT No. 07-1413-0077			FILE No. ----		
DESIGN	CR	15DEC08	SCALE NTS		REV.
CADD	CR	15DEC08	**FIGURE 9**		
CHECK	CR	15DEC08			
REVIEW					

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Notes:

1. Constant rate pumping test conducted in May 2008 Test by Golder. DW08-01 pumped for 52 hours (3093 min) at 382 m^3/d (265 L/min or 70 USgpm) and recovery monitored for 30 hrs.

PROJECT

WESTERN COPPER CORPORATION
CARMACKS COPPER PROJECT
YUKON TERRITORY

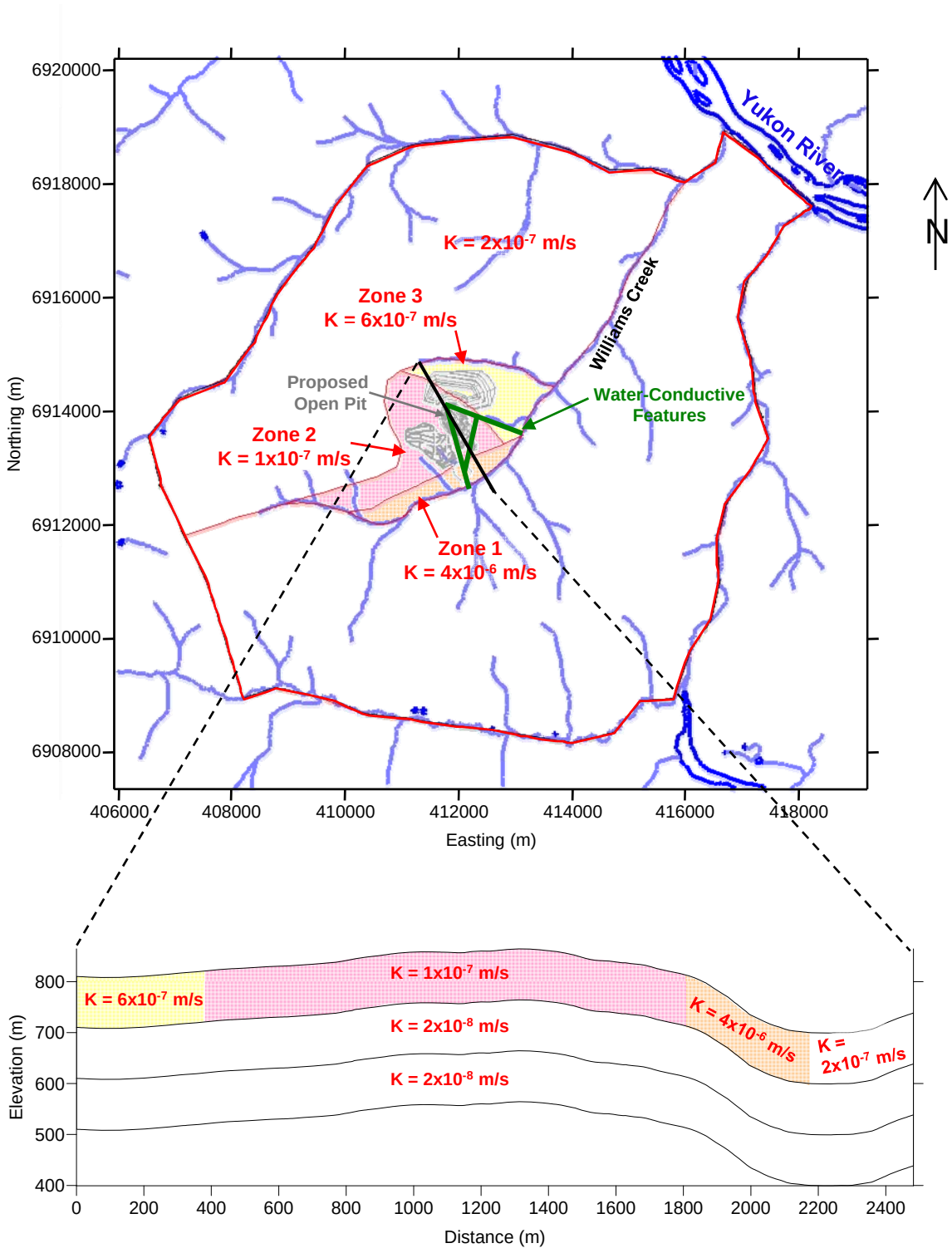
TITLE

RESULTS OF MODEL CALIBRATION PUMPING TEST

Golder Associates

PROJECT No. 07-1413-0077			FILE No. ----		
DESIGN	CR	15DEC08	SCALE NTS		REV.
CADD	CR	15DEC08	**FIGURE 10**		
CHECK	CR	15DEC08			
REVIEW					

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Notes:

1. Vertical exaggeration 2:1
2. Sy = 0.01 in all layers
3. Ss = 0.0001 m^{-1} in all layers
4. Water-conductive features K = $4x10^{-6}$ m/s; approximate effective width = 50 m

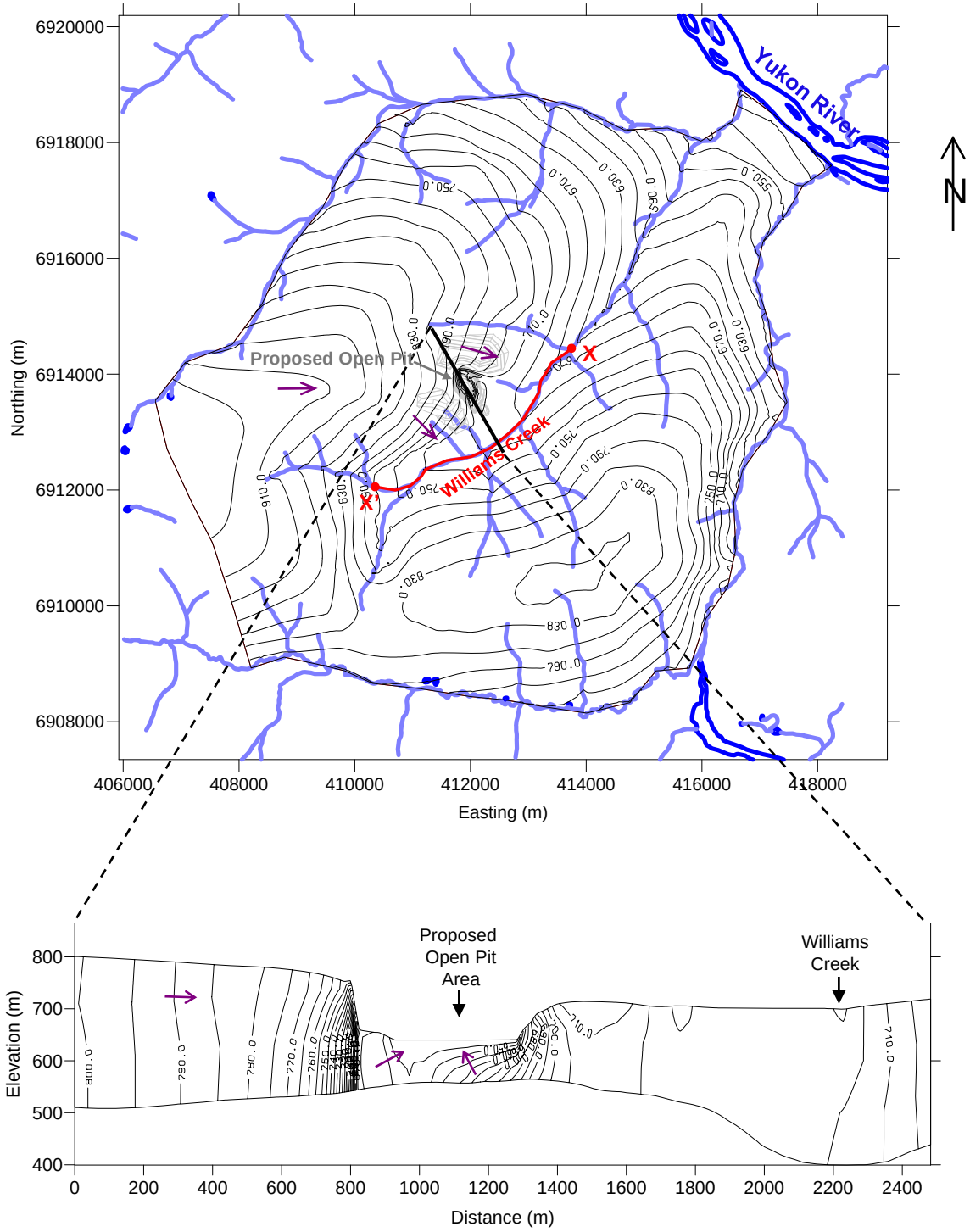
PROJECT
WESTERN COPPER CORPORATION
CARMACKS COPPER PROJECT
YUKON TERRITORY

TITLE
CALIBRATED MODEL PARAMETERS

Golder Associates

PROJECT No. 07-1413-0077			FILE No. ----	
DESIGN	CR	15DEC08	SCALE NTS	REV.
CADD	CR	15DEC08	**FIGURE 11**	
CHECK	CR	15DEC08		
REVIEW				

REVISION DATE: BY: FILE: O:\Active_2007\1413\07-1413-0077 Carmacks-Field Investigation\6400 Hydrogeology Modelling\2008 Report



LEGEND

- Predicted Hydraulic Head Contours (masl)
- Predicted Groundwater Flow Direction
- X — X' Reach of Williams Creek considered for Baseflow Evaluation

Notes:

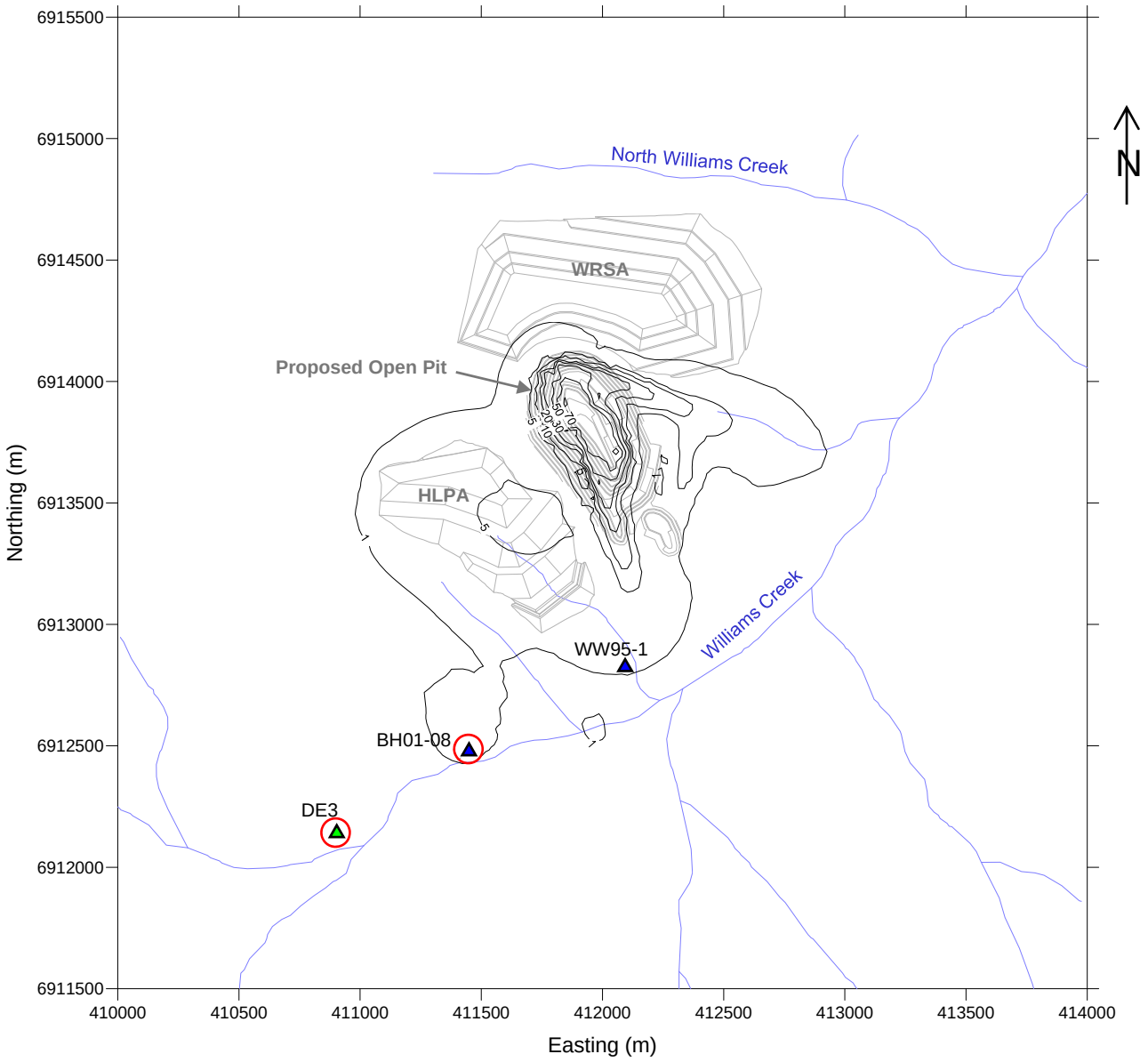
1. Vertical exaggeration 2:1

PROJECT	WESTERN COPPER CORPORATION CARMACKS COPPER PROJECT YUKON TERRITORY
TITLE	PREDICTED HYDROGEOLOGIC CONDITIONS AT THE FINAL PIT EXTENT IN YEAR 6

Golder Associates

PROJECT No. 07-1413-0077			FILE No. ----	
DESIGN	CR	15DEC08	SCALE NTS	REV.
CADD	CR	15DEC08	FIGURE 12	
CHECK	CR	15DEC08		
REVIEW				

REVISION DATE: BY: FILE: O:\Active_2007\1413\07-1413-0077 Carmacks-Field Investigation\6400 Hydrogeology Modelling\2008 Report



LEGEND

- Predicted Drawdown Contours (1, 5, 10, 20, 30, 50, 70, 90 m)
- Existing Water Well Locations
- Proposed Water Well Location
- Proposed Active Water Well

PROJECT

WESTERN COPPER CORPORATION
CARMACKS COPPER PROJECT
YUKON TERRITORY

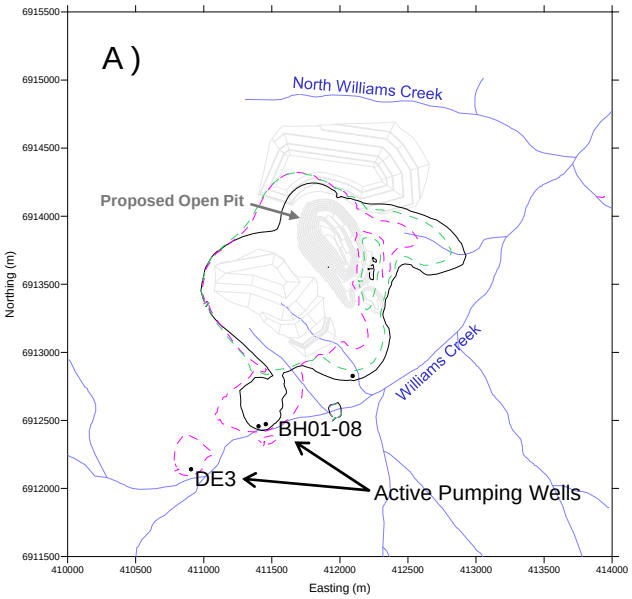
TITLE

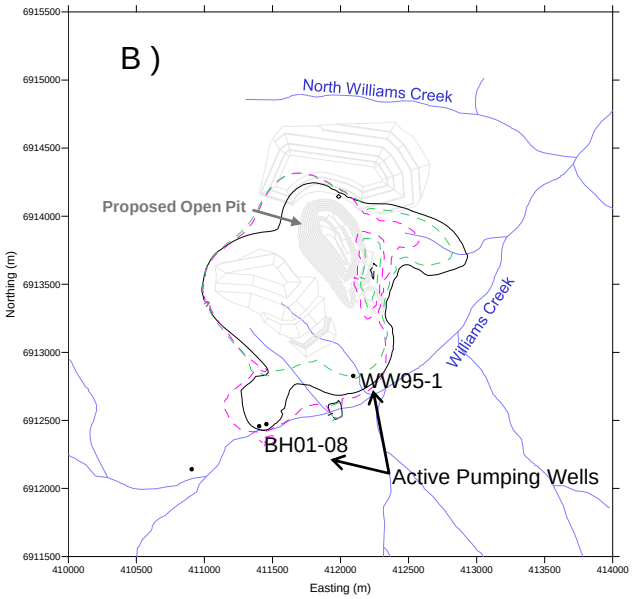
PREDICTED DRAWDOWN AT THE FINAL PIT EXTENT IN YEAR 6

Golder Associates

PROJECT No. 07-1413-0077			FILE No. ----		
DESIGN	CR	15DEC08	SCALE NTS		REV.
CADD	CR	15DEC08	**FIGURE 13**		
CHECK	CR	15DEC08			
REVIEW					

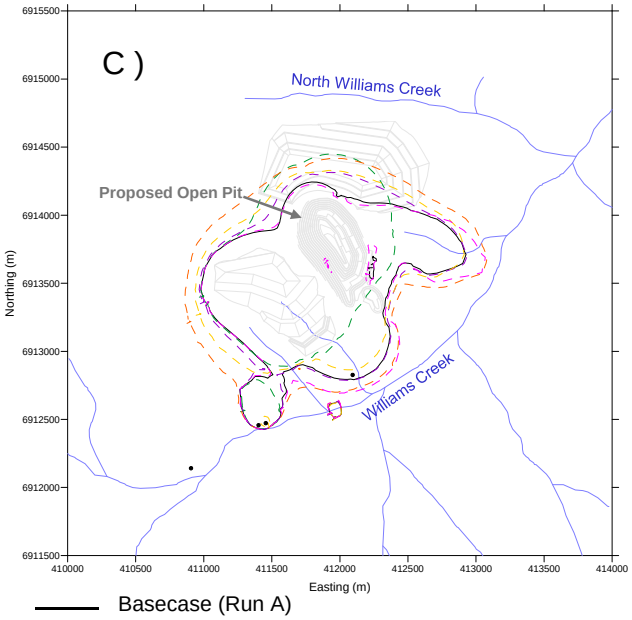
REVISION DATE: BY: FILE: O:\Active_2007\1413\07-1413-0077 Carmacks-Field Investigation\6400 Hydrogeology Modelling\2008 Report







Basecase – average annual pumping (Time = 2190 days)
Peak groundwater withdrawal period – monthly pumping schedule (Time = 1914 days; end of March)
Lowest groundwater withdrawal period - monthly pumping schedule (Time = 2097 days; end of September)



Basecase (Run A)
Sensitivity Run – water-conductive features removed (Run B)
Sensitivity Run – reduced specific storage (Run C)
Sensitivity Run – increased hydraulic conductivity (K) of deeper bedrock (Run D)
Sensitivity Run - increased K of all bedrock (Run I)
Sensitivity Run – increased K of water-conductive features (Run J)

Notes:
Only 1 m drawdown contour is shown.

A) Comparison of predicted drawdown extent when BH01-08 and DE3 water wells pumping at average rates vs. monthly varying rates

B) Comparison of predicted drawdown extent when BH01-08 and WW95-1 water wells pumping at average rates vs. monthly varying rates

C) Comparison of predicted drawdown extent for limited sensitivity analysis

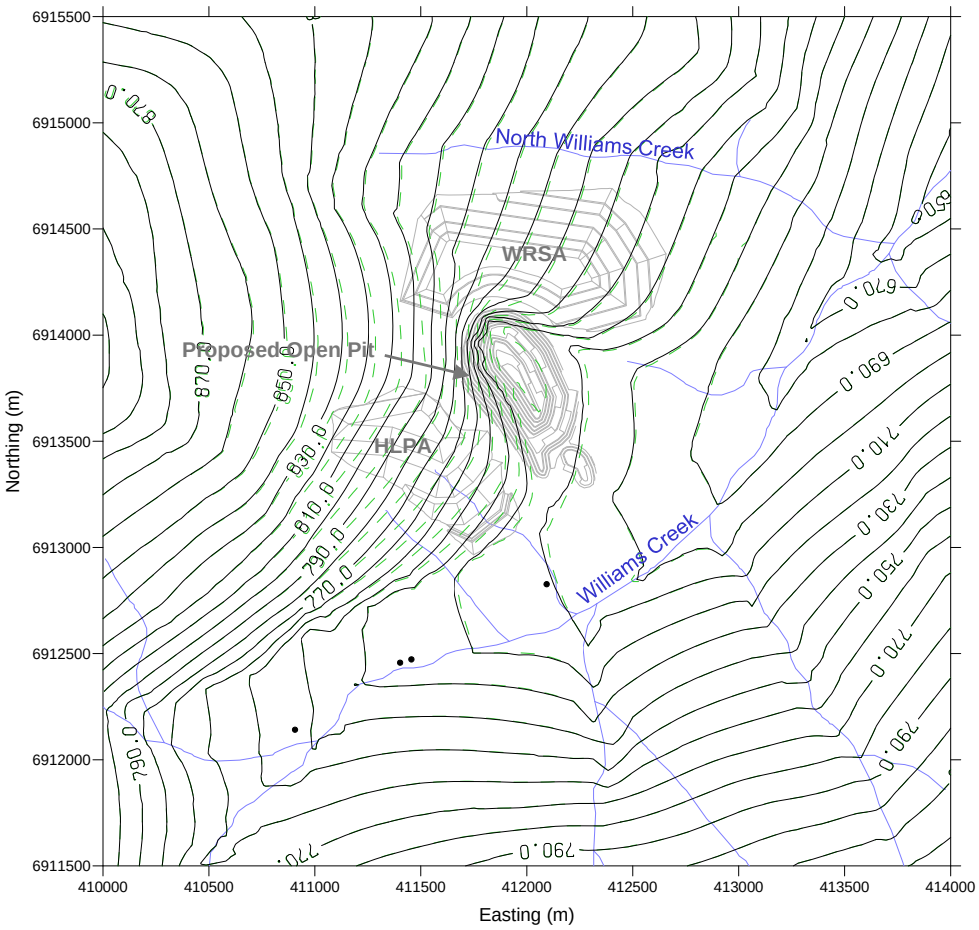
PROJECT
WESTERN COPPER CORPORATION
CARMACKS COPPER PROJECT
YUKON TERRITORY

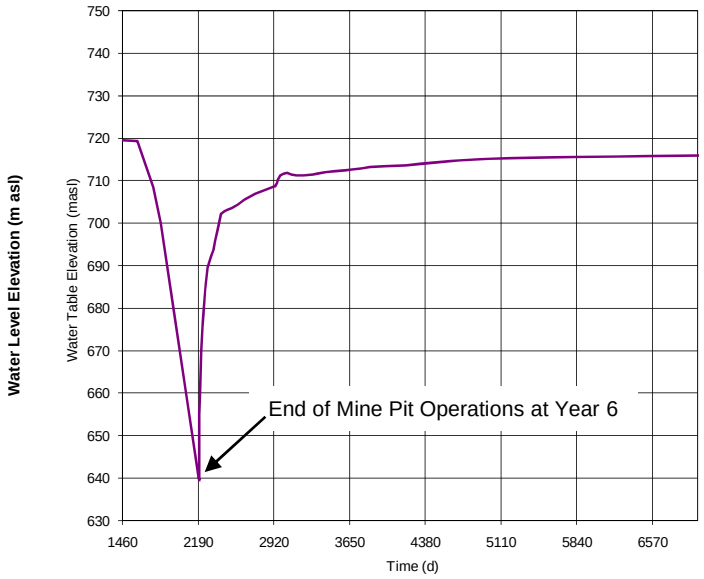
TITLE
COMPARISON OF PREDICTED DRAWDOWN EXTENT FINAL YEAR OF PIT MINING

Golder Associates

PROJECT No. 07-1413-0077			FILE No. ----	
DESIGN	CR	15DEC08	SCALE NTS	REV.
CADD	CR	15DEC08	**FIGURE 14**	
CHECK	CR	15DEC08		
REVIEW				

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LEGEND

- Predicted Pre-mining Hydraulic Head Contours (m asl)
- Predicted Post Mine Closure Hydraulic Head Contours (m asl) (T=7300 days)

PROJECT

WESTERN COPPER CORPORATION
CARMACKS COPPER PROJECT
YUKON TERRITORY

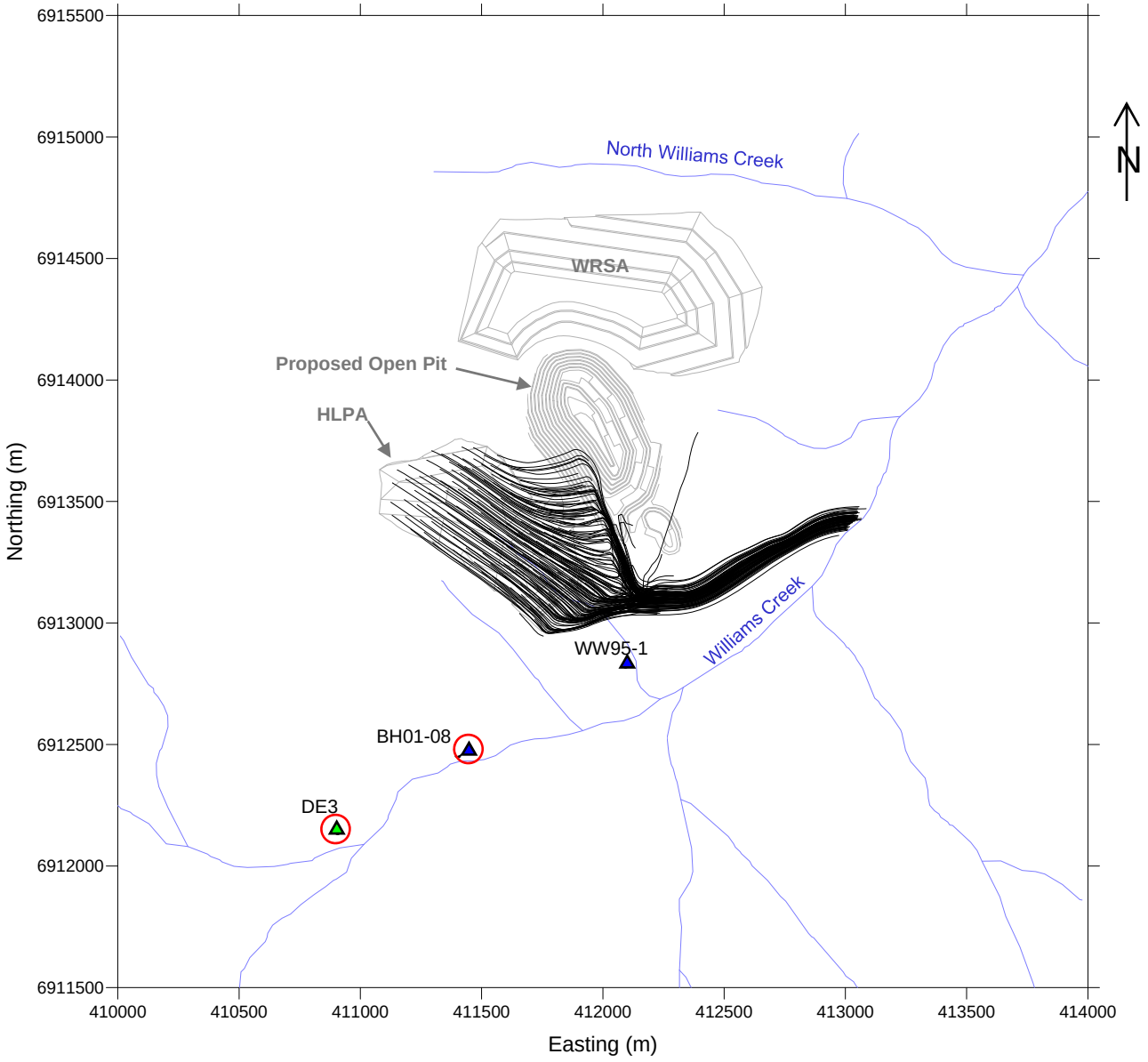
TITLE

PREDICTED PIT LAKE DEVELOPMENT FOLLOWING MINE PIT CLOSURE

Golder Associates

PROJECT No. 07-1413-0077			FILE No. ----		
DESIGN	CR	15DEC08	SCALE NTS	REV.	
CADD	CR	15DEC08	**FIGURE 15**		
CHECK	CR	15DEC08			
REVIEW					

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LEGEND

- Particle Track
- Existing Water Well Locations
- Proposed Water Well Location
- Proposed Active Water Well

PROJECT
WESTERN COPPER CORPORATION
CARMACKS COPPER PROJECT
YUKON TERRITORY

TITLE
PREDICTED GROUNDWATER PATHWAY FROM HLP FROM START OF MINE OPERATIONS

Golder Associates

PROJECT No. 07-1413-0077			FILE No. ----	
DESIGN	CR	15DEC08	SCALE NTS	REV.
CADD	CR	15DEC08	**FIGURE 16**	
CHECK	CR	15DEC08		
REVIEW				

REVISION DATE: BY: FILE: O:\Active_2007\1413\07-1413-0077 Carmacks-Field Investigation\6400 Hydrogeology Modelling\2008 Report

APPENDIX I

GROUNDWATER EXTRACTION ESTIMATES AND BOREHOLE LOGS FOR WATER WELLS

TABLE I-1:
Proposed Groundwater Extraction for Water Wells for Plant and Camp Operation
Carmacks Copper Project

Month	Duration	Start	End	Monthly Combined Groundwater Withdrawal Rates*				Inferred Individual Well Pumping Rates					
								DW08-01			DW-3 or WW95-1		
	d	d	d	m^3/hr	m^3/d	USgpm	m^3/mo.	m^3/d	USgpm	m^3/mo.	m^3/d	USgpm	m^3/mo.
Jan	31	0.0	31.0	25.4	609.6	115	18898	397.5	75.0	12323	212.1	40.0	6575
Feb	28	31.1	59.0	25.5	612.0	115	17136	397.5	75.0	11130	214.5	40.5	6006
Mar	31	59.1	90.0	25.3	607.2	115	18823	397.5	75.0	12323	209.7	39.6	6501
Apr	30	90.1	120.0	13.1	314.4	59	9432	308.4	58.2	9252	6	1.1	180
May	31	120.1	151.0	0.6	14.4	3	446	8.4	1.6	260	6	1.1	186
Jun	30	151.1	181.0	0.7	16.8	3	504	10.8	2.0	324	6	1.1	180
Jul	31	181.1	212.0	1.1	26.4	5	818	20.4	3.8	632	6	1.1	186
Aug	31	212.1	243.0	1.3	31.2	6	967	25.2	4.8	781	6	1.1	186
Sept	30	243.1	273.0	2.3	55.2	10	1656	49.2	9.3	1476	6	1.1	180
Oct	31	273.1	304.0	5.4	129.6	24	4018	123.6	23.3	3832	6	1.1	186
Nov	30	304.1	334.0	10.5	252.0	48	7560	246.0	46.4	7380	6	1.1	180
Dec	31	334.1	365.0	15.8	379.2	72	11755	373.2	70.4	11569	6	1.1	186
TOTALS							92014			71282			20732
Average Daily Pumping Rate (m^3/d) --->										**195**			**57**

* From Table 6-2 in "Site Water Balance - Carmacks Copper Project"; June 12, 2008; Golder Project No. 07-1413-0077/7300

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-01-08

SHEET 1 OF 17

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 17th-20th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
0		Ground Surface		0.00											0.7m Stick-up
	Schramm, T450 W Rotadrill	Loose, moist, brown, fine SAND, trace gravel.													Surface Seal - Bentonite Grout Diameter = 250mm nominal
3				3.05											
		Loose, moist, brown, fine to medium SAND, trace gravel.													Steel Casing- Diameter = 150mm nominal
4				4.57											
5		Wet, brown, fine to medium SAND, some silt and gravel.													28/05/2008 ▽
6				6.10											
7		Moist, blackish grey, sandy SILT and CLAY.													
8		*CONTINUED NEXT PAGE*													

DEPTH SCALE

1 : 40

Golder Associates

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CHECKED:

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-01-08

SHEET 2 OF 17

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 17th-20th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
8	Schramm, T450 W Rotadrill	Moist, blackish grey, sandy SILT and CLAY. *(continued)*													Steel Casing- Diameter = 150mm nominal
9															
10															
11		Moist, brownish grey, sandy SILT, some clay, trace gravel.		11.00											
12															
13															
14		Brownish grey, gravelly SILT, some sand.		13.40											
15															
16		*CONTINUED NEXT PAGE*													

DEPTH SCALE

1 : 40

LOGGED: G.P.

CHECKED:

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-01-08

SHEET 3 OF 17

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 17th-20th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
16		Brownish grey, gravelly SILT, some sand. *(continued)*													
		Coarse SAND and fine GRAVEL, trace fine sand. Q ± 30-40 USgpm		16.20											
		Moist, brown, medium SAND.		16.50											Steel Casing- Diameter = 150mm nominal
17				16.80											
18															
19															
20	Schramm, T450 W Rotadrill	Weathered Bedrock, GRANODIORITE.													Open hole
21		Q < 1 USgpm at 21.3m													
22															
23															
24		*CONTINUED NEXT PAGE*													

DEPTH SCALE

1 : 40

LOGGED: G.P.

CHECKED:

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-01-08

SHEET 4 OF 17

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 17th-20th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
24	Schramm, T450 W Rotadrill	Weathered Bedrock, GRANODIORITE. *(continued)*													Open hole
25															
26															
27															
28															
29															
30															
31															
31.40		GNEISS.													
32		*CONTINUED NEXT PAGE*													

DEPTH SCALE

1 : 40

LOGGED: G.P.

CHECKED:

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-01-08

SHEET 5 OF 17

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 17th-20th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
32															
33															
34		Fracture at 34.4m. GNEISS. *(continued)*													
35															
36	Schramm, T450 W Rotadrill														Open hole
37		Q ± 5 USgpm at 36.6m.													
38				37.50											
39		GRANODIORITE.													
40		*CONTINUED NEXT PAGE*													

DEPTH SCALE

1 : 40

LOGGED: G.P.

CHECKED:

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-01-08

SHEET 6 OF 17

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 17th-20th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
40															
41															
42		Q ± 5-10 USgpm at 42.7m.													
43															
44	Schramm, T450 W Rotadrill	GRANODIORITE. *(continued)*													Open hole
45															
46															
47															
48		*CONTINUED NEXT PAGE*													

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp — W — Wl; 10 20 30 40

RECOVERY %: SAMPLE / CORE; 20 40 60 80

DEPTH SCALE

1 : 40

LOGGED: G.P.

CHECKED:

Golder Associates

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-01-08

SHEET 7 OF 17

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 17th-20th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
48	Schramm, T450 W Rotadrill	Q ± 15 USgpm at 48.8m.													
49															
50															
51															
52		GRANODIORITE. *(continued)*													Open hole
53															
54															
55															
56		*CONTINUED NEXT PAGE*													

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp — W — Wl; 10 20 30 40

SAMPLE / CORE: RECOVERY % — SAMPLE, CORE; 20 40 60 80

DEPTH SCALE

1 : 40

LOGGED: G.P.

CHECKED:

Golder Associates

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-01-08

SHEET 8 OF 17

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 17th-20th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
56	Schramm, T450 W Rotadrill	GRANODIORITE. *(continued)*													Open hole
57															
58															
59															
60															
61		Q ± 20 USgpm at 61m.													
62															
63															
64		*CONTINUED NEXT PAGE*													

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp — W — Wl; 10 20 30 40

RECOVERY %: SAMPLE / CORE; 20 40 60 80

DEPTH SCALE

1 : 40

LOGGED: G.P.

CHECKED:

Golder Associates

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-01-08

SHEET 9 OF 17

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 17th-20th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
64															
65															
66															
67															
68	Schramm, T450 W Rotadrill	GRANODIORITE. *(continued)*													Open hole
69															
70															
71															
72		*CONTINUED NEXT PAGE*													

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp — W — Wl; 10 20 30 40

SAMPLE / CORE: RECOVERY % — SAMPLE, CORE; 20 40 60 80

DEPTH SCALE

1 : 40

LOGGED: G.P.

CHECKED:

Golder Associates

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-01-08

SHEET 10 OF 17

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 17th-20th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
72															
73		Q ± 20-25 USgpm at 73m.													
74															
75															
76	Schramm, T450 W Rotadrill	GRANODIORITE. *(continued)*													Open hole
77															
78															
79															
80		*CONTINUED NEXT PAGE*													

DEPTH SCALE

1 : 40

LOGGED: G.P.

CHECKED:

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-01-08

SHEET 11 OF 17

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 17th-20th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
80															
81															
82															
83															
84	Schramm, T450 W Rotadrill	GRANODIORITE. *(continued)*													Open hole
85															
86															
87															
88		*CONTINUED NEXT PAGE*													

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp — W — Wl; 10 20 30 40

SAMPLE / CORE: RECOVERY % — SAMPLE, CORE; 20 40 60 80

DEPTH SCALE

1 : 40

LOGGED: G.P.

CHECKED:

Golder Associates

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-01-08

SHEET 12 OF 17

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 17th-20th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
88	Schramm, T450 W Rotadrill	GRANODIORITE. *(continued)*													Open hole
89															
90															
91															
92															
93															
94															
95															
96		*CONTINUED NEXT PAGE*													

RECOVERY % — SAMPLE / CORE: 20, 40, 60, 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}

WATER CONTENT PERCENT: Wp — W — Wl; 10, 20, 30, 40

DEPTH SCALE

1 : 40

Golder Associates

LOGGED: G.P.

CHECKED:

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-01-08

SHEET 13 OF 17

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 17th-20th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
96	Schramm, T450 W Rotadrill														
97		Q ± 40 USgpm at 97.5m.													
98															
99															
100		GRANODIORITE. *(continued)*													Open hole
101															
102															
103															
104		Q ± 40-45 USgpm at 103.6m													
		CONTINUED NEXT PAGE													

DEPTH SCALE

1 : 40

Golder Associates

LOGGED: G.P.

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PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-01-08

SHEET 14 OF 17

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 17th-20th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
104	Schramm, T450 W Rotadrill	GRANODIORITE. *(continued)*													Open hole
105															
106															
107															
108															
109		Q ± 50 USgpm at 109.7m													
110															
111															
112		*CONTINUED NEXT PAGE*													

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp — W — Wl; 10 20 30 40

RECOVERY %: SAMPLE / CORE; 20 40 60 80

DEPTH SCALE

1 : 40

Golder Associates

LOGGED: G.P.

CHECKED:

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-01-08

SHEET 15 OF 17

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 17th-20th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
112	Schramm, T450 W Rotadrill	GRANODIORITE. *(continued)*													Open hole
113															
114															
115															
116															
117															
118															
119		Q ± 50 USgpm at 118.9m.													
120		*CONTINUED NEXT PAGE*													

DEPTH SCALE

1 : 40

Golder Associates

LOGGED: G.P.

CHECKED:

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-01-08

SHEET 16 OF 17

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 17th-20th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
120	Schramm, T450 W Rotadrill	GRANODIORITE. *(continued)*													Open hole
121															
122															
123															
124															
125															
126															
127															
128		*CONTINUED NEXT PAGE*													

DEPTH SCALE

1 : 40

LOGGED: G.P.

CHECKED:

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-01-08

SHEET 17 OF 17

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 17th-20th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
128		GRANODIORITE. *(continued)* Q ± 60 USgpm at 128.6m.													Open hole
		End of Borehole.		128.60											
129															
130															
131															
132															
133															
134															
135															
136															

DEPTH SCALE

1 : 40

Golder Associates

LOGGED: G.P.

CHECKED:

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-02-08

SHEET 1 OF 16

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 21st-25th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
0		Ground Surface		0.00											0.51m Stick-up
0	Schramm, T450 W Rotadrill	Loose, moist, light brown, fine to medium, SAND.													Surface Seal - Bentonite Chips Diameter = 250mm nominal
2.74		Moist to wet, brownish-grey, fine to medium, SAND, some gravel.													
3.96		Moist, brownish-grey, SAND, some silty gravel and clay.													Steel Casing- Diameter = nominal 150mm
5.18		Moist, brownish-grey, gravelly SAND, trace silt.													
6.70		Moist, brownish-grey, coarse SAND and GRAVEL, trace silt.													28/05/2008 ▽
8		*CONTINUED NEXT PAGE*													

DEPTH SCALE

1 : 40

LOGGED: G.P.

CHECKED:

Golder Associates

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-02-08

SHEET 2 OF 16

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 21st-25th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
8	Schramm, T450 W Rotadrill	Moist, brownish-grey, coarse SAND and GRAVEL, trace silt. *(continued)*													Steel Casing- Diameter = nominal 150mm
				8.80											
9		Moist, brownish-grey, gravelly SILT and CLAY, some sand.													
				9.75											
10		Moist, brown, fine to medium SAND, some silt.													
				10.66											
11		Moist, brown, silty SAND.													
12															
				12.50											
13		Wet, brownish-grey, SILT and CLAY, trace sand.													
14															
				14.93											
15		Moist, brownish-grey, sandy SILT, some gravel.													
16		*CONTINUED NEXT PAGE*													

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp — W — Wl; 10 20 30 40

SAMPLE / CORE: RECOVERY % — SAMPLE, CORE; 20 40 60 80

DEPTH SCALE

1 : 40

Golder Associates

LOGGED: G.P.

CHECKED:

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-02-08

SHEET 3 OF 16

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 21st-25th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
16	Schramm, T450 W Rotadrill	Moist, brownish-grey, sandy SILT, some gravel. *(continued)*													Steel Casing- Diameter = nominal 150mm
17															
				17.40											
18		Moist, brownish-grey, SAND and GRAVEL, some silt.													
				18.60											
19		GRANODIORITE BOULDER.													
				19.20											
20															
21		Very dense, moist, brownish-grey, gravelly SILT.													
22															
23															
				23.50											
24		Moist, brownish-grey, gravelly SILT.													
		CONTINUED NEXT PAGE													

DEPTH SCALE

1 : 40

Golder Associates

LOGGED: G.P.

CHECKED:

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-02-08

SHEET 4 OF 16

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 21st-25th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
24															
		Moist, brownish-grey, gravelly SILT. *(continued)*													
25				25.00											
		Wet, brownish-grey, SAND and GRAVEL, some silt.													
				25.60											
26															
27		Moist, pinkish-grey, sandy SILT, some gravel, trace clay.													
28	Schramm, T450 W Rotadrill														Steel Casing- Diameter = nominal 150mm
29															
				29.60											
30															
		Wet to moist, pinkish-grey, SILT, some sand and gravel.													
31															
32		*CONTINUED NEXT PAGE*													

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp — W — Wl; 10 20 30 40

SAMPLE / CORE: RECOVERY % 20 40 60 80

DEPTH SCALE

1 : 40

LOGGED: G.P.

CHECKED:

Golder Associates

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-02-08

SHEET 5 OF 16

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 21st-25th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
32	Schramm, T450 W Rotadrill	Wet to moist, pinkish-grey, SILT, some sand and gravel. *(continued)*													Steel Casing- Diameter = nominal 150mm
33															
34				33.80											
35		Dry to moist, pinkish-grey, SAND, some silt and gravel.													
36															
37				36.60											
38		Very dense, wet, pinkish-grey, gravelly SILT, some sand.													
39															
40		*CONTINUED NEXT PAGE*													

DEPTH SCALE

1 : 40

LOGGED: G.P.

CHECKED:

Golder Associates

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-02-08

SHEET 6 OF 16

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 21st-25th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
40	Schramm, T450 W Rotadrill	Very dense, wet, pinkish-grey, gravelly SILT, some sand. *(continued)*													Steel Casing- Diameter = nominal 150mm
41															
42															
43															
44															
45															
46															
47															
				47.40											
48		Pink, altered BEDROCK, (no water).													Open hole
		CONTINUED NEXT PAGE													

DEPTH SCALE

1 : 40

LOGGED: G.P.

CHECKED:

Golder Associates

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-02-08

SHEET 7 OF 16

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 21st-25th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
48	Schramm, T450 W Rotadrill	Pink, altered BEDROCK, (no water). *(continued)*													Open hole
49															
50															
51															
52															
53															
54															
55															
56		*CONTINUED NEXT PAGE*													

DEPTH SCALE

1 : 40

Golder Associates

LOGGED: G.P.

CHECKED:

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-02-08

SHEET 8 OF 16

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 21st-25th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
56	Schramm, T450 W Rotadrill	Pink, altered BEDROCK, (no water). *(continued)*													Open hole
57															
58															
59															
60															
61															
62															
63															
64		*CONTINUED NEXT PAGE*													

DEPTH SCALE

1 : 40

LOGGED: G.P.

CHECKED:

Golder Associates

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-02-08

SHEET 9 OF 16

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 21st-25th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
64															
65		Pink, altered BEDROCK, (no water). *(continued)*													
66															
67															
	Schramm, T450 W Rotadrill			67.50											
68															Open hole
69		GRANODIORITE.													
70															
71															
72		*CONTINUED NEXT PAGE*													

RECOVERY % scale: 20, 40, 60, 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}

WATER CONTENT PERCENT: Wp — W — Wl; 10, 20, 30, 40

DEPTH SCALE

1 : 40

LOGGED: G.P.

CHECKED:

Golder Associates

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-02-08

SHEET 10 OF 16

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 21st-25th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
72	Schramm, T450 W Rotadrill	GRANODIORITE. *(continued)*													Open hole
73															
74															
75															
76															
77															
78															
79															
80		*CONTINUED NEXT PAGE*													

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp — W — Wl; 10 20 30 40

RECOVERY %: SAMPLE / CORE; 20 40 60 80

DEPTH SCALE

1 : 40

LOGGED: G.P.

CHECKED:

Golder Associates

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-02-08

SHEET 11 OF 16

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 21st-25th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
80	Schramm, T450 W Rotadrill	GRANODIORITE. *(continued)*													Open hole
81															
82															
83															
84															
85															
86		Q ± 1 USgpm at 85.9m.													
87															
88		*CONTINUED NEXT PAGE*													

DEPTH SCALE

1 : 40

LOGGED: G.P.

CHECKED:

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-02-08

SHEET 12 OF 16

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 21st-25th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
88	Schramm, T450 W Rotadrill	GRANODIORITE. *(continued)*													Open hole
89															
90															
91															
92															
93															
94															
95															
96		*CONTINUED NEXT PAGE*													

RECOVERY % — SAMPLE / CORE: 20, 40, 60, 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}

WATER CONTENT PERCENT: Wp — W — Wl; 10, 20, 30, 40

DEPTH SCALE

1 : 40

LOGGED: G.P.

CHECKED:

Golder Associates

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-02-08

SHEET 13 OF 16

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 21st-25th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
96	Schramm, T450 W Rotadrill														
97		Q ±1 USgpm at 97m.													
98															
99															
100		GRANODIORITE. *(continued)*													Open hole
101															
102															
103															
104		*CONTINUED NEXT PAGE*													

DEPTH SCALE

1 : 40

Golder Associates

LOGGED: G.P.

CHECKED:

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-02-08

SHEET 14 OF 16

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 21st-25th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
104	Schramm, T450 W Rotadrill	GRANODIORITE. *(continued)*													Open hole
105															
106															
107															
108															
109															
110															
111															
112		*CONTINUED NEXT PAGE*													

RECOVERY % scale: 20, 40, 60, 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}

WATER CONTENT PERCENT: Wp — W — Wl; 10, 20, 30, 40

DEPTH SCALE

1 : 40

LOGGED: G.P.

CHECKED:

Golder Associates

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-02-08

SHEET 15 OF 16

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 21st-25th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
112															
113															
114															
115															
116	Schramm, T450 W Rotadrill	GRANODIORITE. *(continued)*													Open hole
117															
118															
119															
120		*CONTINUED NEXT PAGE*													

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp — W — Wl; 10 20 30 40

SAMPLE / CORE: RECOVERY % — SAMPLE, CORE; 20 40 60 80

DEPTH SCALE

1 : 40

Golder Associates

LOGGED: G.P.

CHECKED:

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

PROJECT No.: 07-1413-0077

RECORD OF BOREHOLE: BH-02-08

SHEET 16 OF 16

LOCATION: Western Copper Corporation Mining Camp

DRILLING DATE: May 21st-25th, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	SAMPLE / CORE: RUN No.	SAMPLE / CORE: RECOVERY % (SAMPLE / CORE)	GRADATION %: GRAVEL	GRADATION %: SAND	GRADATION %: FINES	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
120															
121	Schramm, T450 W Rotadrill	GRANODIORITE. *(continued)*													Open hole
122															
123		Q ± 1 USgpm at 123.4m.													
		End of Borehole.		123.40											
124															
125															
126															
127															
128															

DEPTH SCALE

1 : 40

LOGGED: G.P.

CHECKED:

File:ALL 2007 HOLES.GPJ Output Form:BOREHOLE (CARMACKS) Template:GLDR_CAN_ABB - 02MAY08.GDT Library:ABBOTSFORD LIBRARY 11JUN08.GLB KJustice 10/2/09

APPENDIX II

SUMMARY OF MODEL SIMULATIONS

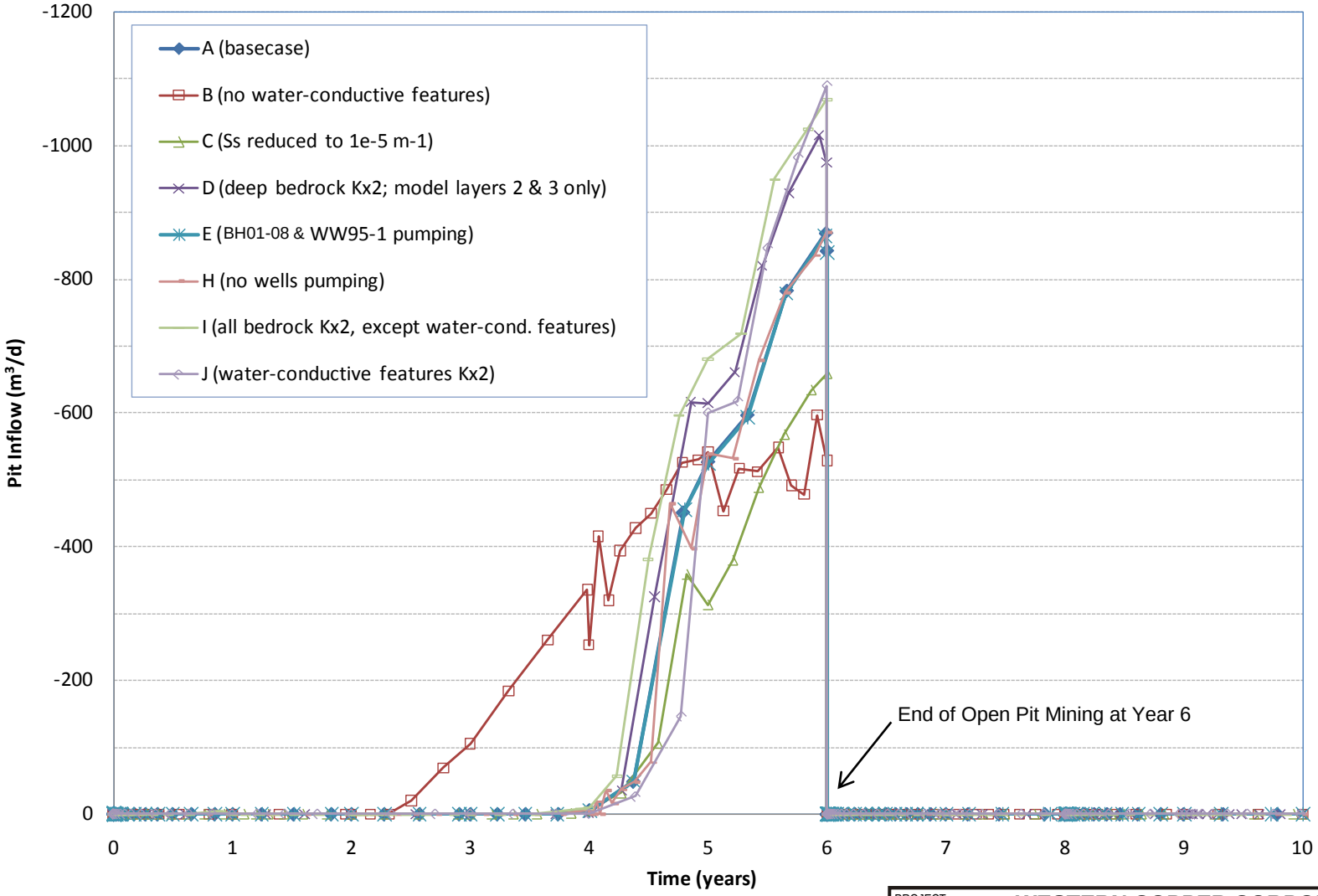
TABLE II-1:
Model Simulations for Pre-Mining, Mining, and Closure Conditions

	Simulation ID	Purpose	Description	File Name	Initial Heads File
1	A	basecase	Based on planned site operations and closure conditions (Section 7.0) and calibrated model parameters (Section 8.2.3)	3Run_A.fem	calibration-with-high-K-zone-replacing-fractures-21-SS.fem
2	B *	sensitivity analysis	No water-conductive features in the vicinity of the pit	3Run_B.fem	carmacks-22-SS.fem
3	C	sensitivity analysis	Specific storage reduced from 1E-4 m^{-1} (basecase) to 1E-5 m^{-1}	3Run_C.fem	calibration-with-high-K-zone-replacing-fractures-21-SS.fem
4	D *	sensitivity analysis	Hydraulic conductivity in model layer 2 and 3 increased by a factor of 2 (K=4E-8 m/s); ambient recharge increased to 10% of precipitation.	3Run_D.fem	calibration-with-high-K-zone-replacing-fractures-24-SS.fem
5	E	alternative well scenario	Additional water well DW3 replaced by WW95-1	3Run_E.fem	calibration-with-high-K-zone-replacing-fractures-21-SS.fem
6	F	assessment of monthly pumping schedule	Annual average pumping rates applied to water wells DW08-01 and DW3 replaced by a monthly pumping schedule (see Table I-1 in Appendix I)	3Run_F.fem	calibration-with-high-K-zone-replacing-fractures-21-SS.fem
7	G	assessment of monthly pumping schedule - alternative well scenario	Annual average pumping rates applied to water wells DW08-01 and WW95-1 replaced by a monthly pumping schedule (see Table I-1 in Appendix I)	3Run_G.fem	calibration-with-high-K-zone-replacing-fractures-21-SS.fem
8	H	assessment of pit dewatering alone	Water wells inactived to evaluate the influence of only pit dewatering works	3Run_H.fem	calibration-with-high-K-zone-replacing-fractures-21-SS.fem
9	I	sensitivity analysis	Hydraulic conductivity in all model layers increased by a factor of 2; ambient recharge increased to 15% of precipitation.	3Run_I.fem	calibration-with-high-K-zone-replacing-fractures-26-SS.fem
10	J	sensitivity analysis	K of water-conductive features the vicinity of the pit increased by factor of 2	3Run_J.fem	calibration-with-high-K-zone-replacing-fractures-27-SS.fem

Note calibration-with-high-K-zone-replacing-fractures-21-SS.fem

*Initial (hydraulic head) conditions were obtained from steady-state recalibration of the model for pre-mining conditions after accounting for changes to model input paramters as part of the sensitivity analysis.

REVISION DATE: BY: FILE: O:\Active\ 2007\1413\07-1413-0077 Carmacks-Field Investigation\6400 Hydrogeology Modelling\2008 Report



PROJECT

WESTERN COPPER CORPORATION
CARMACKS COPPER PROJECT
YUKON TERRITORY

TITLE

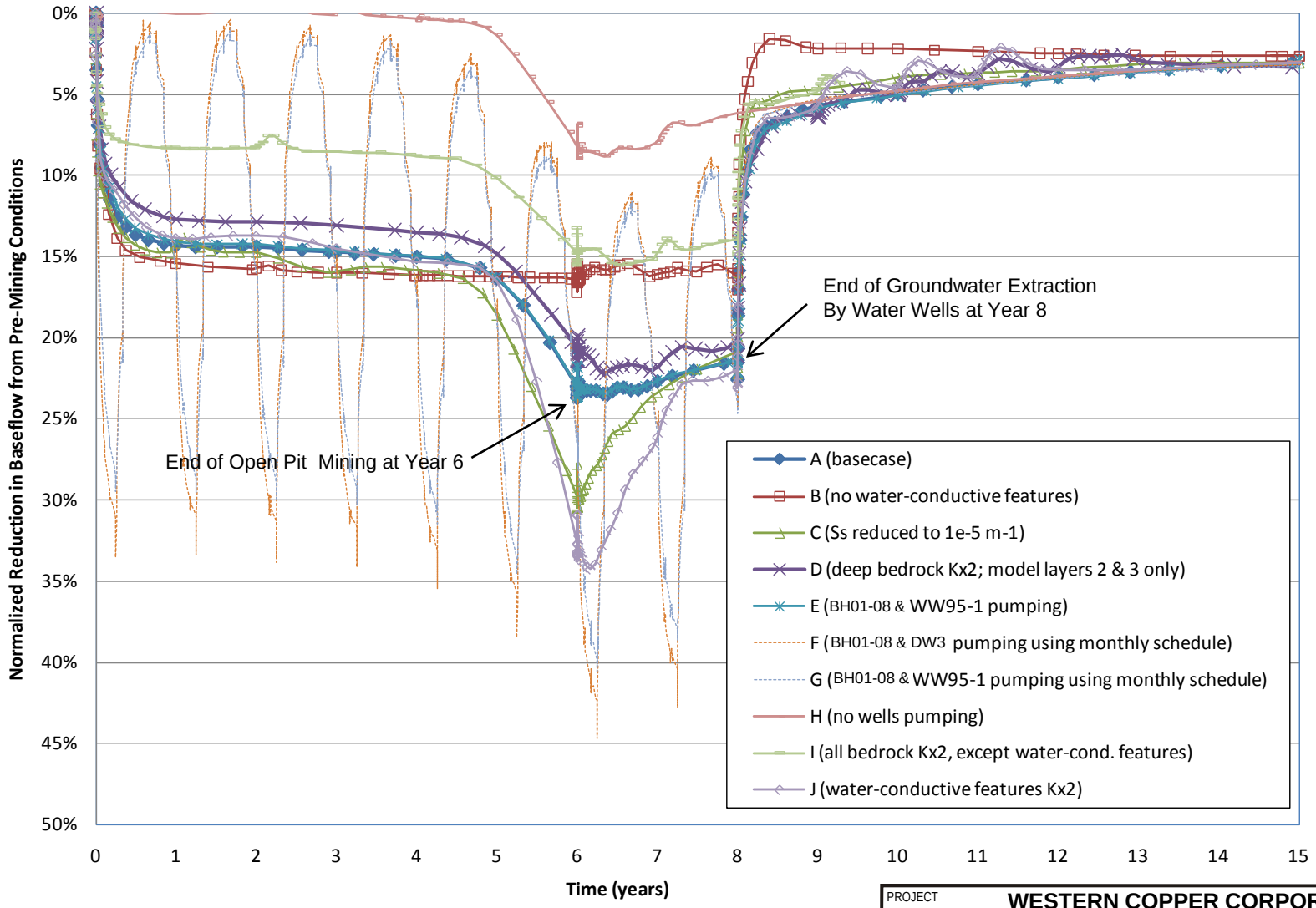
PIT INFLOW
RESULTS OF SENSITIVITY ANALYSIS

Golder Associates

PROJECT No. 07-1413-0077			FILE No. ----		
DESIGN	CR	15DEC08	SCALE NTS	REV.	
CADD	CR	15DEC08			
CHECK	CR	15DEC08			
REVIEW					

FIGURE II-1

REVISION DATE: BY: FILE: O:\Active\ 2007\1413\07-1413-0077 Carmacks-Field Investigation\6400 Hydrogeology Modelling\2008 Report



PROJECT

WESTERN COPPER CORPORATION
CARMACKS COPPER PROJECT
YUKON TERRITORY

TITLE

PIT INFLOW
RESULTS OF SENSITIVITY ANALYSIS

Golder Associates

PROJECT No. 07-1413-0077			FILE No. ----	
DESIGN	CR	15DEC08	SCALE NTS	REV.
CADD	CR	15DEC08		
CHECK	CR	15DEC08		
REVIEW				

FIGURE II-2

Western Copper Corporation

2009 ANNUAL QUARTZ MINING LICENCE REPORT

SUBMITTED TO YUKON GOVERNMENT, ENERGY MINES AND RESOURCES

YUKON QUARTZ MINING LICENCE QML-0007

Appendix D

Site Water Balance Update (October 2009)

TECHNICAL MEMORANDUM

DATE	October 8, 2009	**PROJECT No.**	07-1413-0077/1100
TO	Jonathan Clegg Western Copper Corporation	**DOC No.**	115 Rev. 1
CC	John Hull		
FROM	Yapo Allé-Ando	**EMAIL**	yalleando@golder.com

SITE WATER BALANCE UPDATE – CARMACKS COPPER PROJECT

The purpose of this technical memorandum is to address the Yukon Water Board (YWB) request to update the water balance for the proposed Carmacks Copper Heap Leach Facility and provide the following information, based on Questions 9 to 11 of the YWB letter (YWB, 2009) dated July 17, 2009:

- Update the precipitation analysis performed by Clearwater (2006) to account for available recent climate data from Pelly Ranch and Williams Creek and include results in the updated water balance (Question 9);
- Comment on whether the storm event of August 25, 2008 at the Williams Creek site fits the precipitation frequency distribution or is an outlier (Question 10);
- Update the site water balance with the re-examined climate frequency distribution, as necessary; and
- Update the site water balance to include pit water inflows (Question 11).

It is noted that a comparison between the updated site water balance (this memorandum) and the previous site water balance (Golder, 2008) is provided when possible; however, there are instances where the pumping strategy affects modelling results significantly and prevents direct comparison between the two water balances. For example, the timing of triggering a pump at any of the ponds or sumps will affect volume, inflows and outflows calculations throughout the model. Additionally, as this update includes revised pit water inflow values which impact water volumes that are managed, the model treats water storage and pumps differently for the operation (as noted above).

1.0 CLIMATE UPDATE

This climate update builds on the Clearwater (2006) regional hydrology analysis and Golder (2008) site water balance. The site precipitation information is updated with available Pelly Ranch and Williams Creek 2005 to 2008 data. The synthetic rainfall series developed in the previous water balance (Golder, 2008) is unchanged. The following sections present the updated climate results as presented in the site wide report from Golder (2008).

Golder Associates Ltd.
500 - 4260 Still Creek Drive, Burnaby, British Columbia, Canada V5C 6C6
Tel: +1 (604) 296 4200 Fax: +1 (604) 298 5253 www.golder.com

Golder Associates: Operations in Africa, Asia, Australasia, Europe, North America and South America

2.0 SYNTHETIC DAILY RAINFALL

The daily rainfall input to the water balance model is the synthetic 7-years daily rainfall series developed for the site water balance (Golder, 2008). The synthetic rainfall series was developed from the incomplete 1996 to 2007 climate record of the Williams Creek climate station. Details on the method used to generate the synthetic rainfall can be found in the Golder report (Golder, 2008).

3.0 SITE PRECIPITATION

The average annual precipitation in the Carmacks area is about 343 mm with roughly 58% (200 mm) falling as rain and 42% (143 mm) falling as snow. The following information is presented in the tables below:

- Table 1 presents the annual precipitation characteristics for various return periods. The table includes the previous water balance (Golder, 2008) annual precipitation for comparison. Results indicate that the updated annual precipitation is, on average, 4% greater than the in the previous water balance.
- Table 2 presents a summary of the average monthly precipitation at Carmacks.
- Table 3 presents the one-day storm precipitation for various return periods. The table includes the previous water balance (Golder, 2008) storm events for comparison. Results indicate that the updated daily storm events are typically wetter for dry years and dryer for wet years.

Table 1: Annual Precipitation Characteristics

Return Period (years)	Annual Precipitation (mm) from Previous Water Balance Report[a]	Updated Annual Precipitation (mm)	Updated Rainfall (mm)	Updated Snowfall (mm)
20 (dry)	248	257	150	107
5 (dry)	288	292	170	122
2 (wet)	338	338	197	141
10 (wet)	416	428	249	178
20 (wet)	443	459	268	191
50 (wet)	473	498	290	208
100 (wet)	496	526	307	219
200 (wet)	516	553	323	231

(a) From Golder (2008)

Table 2: Estimated Mean Monthly Site Precipitation (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall	0.0	0.0	0.2	3.6	23.2	37.9	57.6	40.8	28.5	7.8	0.4	0.1	200.2
Snowfall	25.4	17.8	14.1	8.2	0.6	0.0	0.0	0.0	2.9	19.0	29.6	25.5	143.0
Total Precipitation	25.4	17.8	14.3	11.8	23.8	38.0	57.6	40.8	31.4	26.7	30.0	25.6	343.2

Table 3: Daily Storm Events

Return Period (years)	Daily Precipitation (mm) from Previous Water Balance Report[a]	Updated Daily Precipitation (mm)
20 (dry)	11.7	12.1
5 (dry)	16.5	17.6
2 (wet)	22.9	24.3
10 (wet)	36.8	36.9
20 (wet)	41.9	41.1
50 (wet)	48.4	46.2
100 (wet)	53.2	49.8
200 (wet)	58	53.2

(a) From Golder (2008).

3.1 Site Sublimation and Snowmelt

Sublimation rates over the winter period were estimated in the Golder (2008) report using snowfall and snow survey data at Pelly Ranch (1986-2007). As a result, they were not updated in this analysis. Sublimation rates of 0%, 20%, and 29% are used as estimates of the snowpack moisture loss over the winter period.

Snowmelt rates used for the design of water management infrastructure are based on the following durations:

- A 14-day snowmelt occurring in May (Clearwater, 2006); and
- A 30-day snowmelt occurring from mid-April to mid-May (for average conditions).

Table 4 presents daily snowmelt rates for various return period, melt durations, and sublimation rates.

Table 4: Snowmelt Rates for 14-Day and 30-Day Events

Return Period (years)	Snowfall (mm)	Snowmelt (mm/d) 0% Sublimation		Snowmelt (mm/d) 20% Sublimation		Snowmelt (mm/d) 29% Sublimation	
		14-day Duration	30-day Duration	14-day Duration	30-day Duration	14-day Duration	30-day Duration
20 (dry)	107	7.6	3.6	6.1	2.9	5.4	2.5
5 (dry)	122	8.7	4.1	7.0	3.3	6.2	2.9
Average	141	10.1	4.7	8.1	3.8	7.2	3.3
10 (wet)	178	12.7	5.9	10.2	4.7	9.0	4.2
20 (wet)	191	13.6	6.4	10.9	5.1	9.7	4.5
50 (wet)	208	14.9	6.9	11.9	5.5	10.5	4.9
100 (wet)	219	15.6	7.3	12.5	5.8	11.1	5.2
200 (wet)	231	16.5	7.7	13.2	6.2	11.7	5.5

3.2 Site Evaporation

No updates to site evaporation were made. Thus, a constant evaporation rate of 2.61 mm/d is applied over the open water season from May to September (Golder, 2008).

3.3 Site Runoff

No updates to site runoff were made. Thus, the following catchment types were used:

- Heap area where the ore is placed, including the area prepared for placement;
- Waste Rock Storage where waste rock is placed;
- Mine Pit area where ore and waste rock is extracted;
- Events Pond wet area associated with the surface area of water (Heap Leach Facility Sedimentation Pond and Waste Rock Area Sedimentation Pond); and
- Events Pond dry area associated with the exposed areas of the ponds (Heap Leach Facility Sedimentation Pond and Waste Rock Area Sedimentation Pond), calculated as the difference between the entire footprint and the water surface area.

3.4 Comments on August 25, 2008 Storm Event

The 24-hour rainfall event recorded at the Williams Creek site on August 25, 2008, (62.4 mm) was not observed at Pelly Ranch with such a magnitude. A storm was observed on that date at Pelly Ranch, however, its magnitude was comparable to a 2-year wet storm event. Storm events typically contain cells with various rainfall intensity. Given the distance and elevation difference between Pelly Ranch and Williams Creek, it is not uncommon to witness such a difference in the storm intensity between the two stations. As a result, the storm that occurred at Williams Creek on August 25, 2008, will not affect the frequency distribution calculated based on the Clearwater (2006) methodology and Pelly Ranch climate data. The updated climate analysis indicates that the Williams Creek storm event was greater than the predicted 1 in 500 year rainfall event.

4.0 WATER BALANCE MODEL UPDATE

The water balance model components, assumptions, input parameters, and scenarios are presented in the Golder (2008) report. However, the water balance model was updated to include the following:

- Updated precipitation input parameters to reflect the results of the climate analysis presented above.
- Updated pit water inflows to reflect the three dimensional groundwater modelling performed for the Carmacks project (Golder, 2009). In the previous water balance, the mine pit water inflows were assumed to occur between April and October at a rate of approximately 410 m^3/d. The updated water balance model is, however, using conservative mine pit water inflows based on the estimated rate of 1,200 m^3/d occurring year-round (Golder, 2009).

- Increased pit pump capacity (from 150 m^3/hr to 185 m^3/hr) to accommodate the increased seepage inflow.
- Reduced HLF Sedimentation Pond catchment area to reflect end of life conditions at full pit development. The updated catchment area is approximately 20.09 ha and does not include the HLF footprint, the Events Pond footprint and its catchment area.

These updates supersede the Golder (2008) report, where applicable.

4.1 Water Balance Scenarios

The water balance scenarios are presented in the Golder (2008) report. In summary, Scenarios 1 to 4 are modeled to assess the water levels and pump rates associated with various snowmelt conditions. Scenarios 5 and 6 represent upset conditions where the process plant and/or treatment plant are assumed to be shut down for a two-month period starting at the onset of the freshet. These scenarios represent worst-case operational scenarios. Further details on the six scenarios are presented in the Golder report.

5.0 UPDATED WATER BALANCE MODEL RESULTS

The following sections present the results of the updated water balance.

5.1 Scenario 1 – Average Conditions, 14-day Melt

Scenario 1 represents average conditions at the site based on a 1 in 2 year snow pack, 20% sublimation loss, and melt occurring over 14 days. Results are shown in Figures 1a and 1b and summarized as follows:

- Water levels in the HLF vary daily due to precipitation that raises water levels on one day, and pumping to the process plant or Events Pond in the next time period that draws the levels down again. The maximum simulated water levels are estimated at 793.20 m. They typically occur in the summer and are associated with heavy rainfall events. The minimum simulated freeboard is estimated at 13.30 m. See Table 5 for a summary of the maximum water level and minimum free board results.
- Water levels in the Events Pond increase quickly at the beginning of the freshet from a minimum operating level of 748 m to about 755 m. The runoff is contained in the Events Pond, and water levels are slowly drawn down as the water is used as process makeup and for agglomeration through the open water period and early winter. The minimum simulated freeboard in the Events Pond is estimated at approximately 4.90 m.

Table 5: Scenario 1 – Maximum Daily HLF Water Levels and Minimum Events Pond Daily Freeboard

	Heap Leach Facility		Events Pond	
Year	**Water Level (m)**	**Freeboard (m)**	**Water Level (m)**	**Freeboard (m)**
1996	793.20	13.30	753.47	6.53
1997	790.41	16.09	755.10	4.90
1998	789.76	16.74	752.35	7.65
1999	790.21	16.29	752.61	7.39
2000	790.51	15.99	753.94	6.06
2001	790.39	16.11	752.23	7.77
2002	789.48	17.02	752.58	7.42
Average	790.57	15.93	753.18	6.82
Max/Min	793.20	13.30	755.10	4.90

Notes: Scenario 1- 1:2 year 14-day snowmelt 20% sublimation.
Refer to Golder (2008) for details on the 7-year period covered in the water balance model.

- Groundwater is used as a source of makeup water, with a minimum mean monthly requirement of 0.5 m^3/hr and maximum mean monthly requirement occurring over the winter period as the primary makeup source for the process plant. The maximum mean monthly groundwater requirement is estimated at 25.5 m^3/hr. It is used as the sole supply for the Process Plant for 93 days per year, at an annual daily average of 7.1m^3/hr. When the groundwater is used as the sole supply for the process plant the pump rate is equal to 25.5 m^3/hr, corresponding to the Process Plant freshwater demand. See Table 6 for a summary of groundwater use.

- The HLFSP and WRASP are designed to attenuate flow and promote the settling of suspended particles prior to discharge to the environment. Discharge to Williams Creek only occurs after the water is tested and meets discharge standards. Discharge occurs via a pumped system (continuous basis throughout the summer). Results indicate that no discharge occurred via the spillway as overflow (during freshet or following large rainfall events). The total discharge to Williams Creek range from no discharge over the winter period to approximately 150 m^3/hr in May with no discharge over or by way of the spillway (always a pumped discharge). See Table 7 for a summary of the mean monthly discharge to Williams Creek.

The Scenario 1 results from this water balance update are similar to the previous water balance results (Golder, 2008) in that no spillway discharges occur from the Events pond or HLF. However, the mine pit seepage increase resulted in the following changes:

- The Mean Annual Discharges to Williams Creek from the HLFSP increase significantly from 17.2 m^3/hr (Golder , 2008) to 32.8 m^3/hr; and

- Groundwater use as the as the sole supply for the Process Plant is reduced by 42 days, from 135 days (Golder, 2008) to 93 days.

Table 6: Scenario 1 – Mean Monthly Groundwater Requirements

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual Mean/ Total	Mean May-Oct	Mean Nov-Apr
Groundwater Supply to Camp[a] (m^3/hr)	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
Groundwater Supply to Process Plant[a] (m^3/hr)	18.47	25.50	25.50	0.86	0.50	0.50	0.50	0.50	0.50	0.50	1.68	9.74	7.06	0.50	13.62
Total Groundwater Requirements (m^3/hr)	19.25	26.28	26.28	1.64	1.28	1.28	1.28	1.28	1.28	1.28	2.46	10.52	7.84	1.28	12.53
Days as Primary Source for Process Plant[b]	22	28	31	0	0	0	0	0	0	0	1	10	93	0	15

Notes: Based on daily simulation of 1996-2002 modelling period; (a) including continuous base withdrawal of 0.5 m^3/hr; (b) number of days that groundwater serves as primary source for plant makeup water and for agglomeration (does not count days when only supplying base withdrawal or the 2.6 m^3/hr for dust control).

Table 7: Scenario 1 – Mean Monthly Discharge to Williams Creek (m^3/hr)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Mean Annual	Mean May-Oct	Mean Nov-Apr
HLFSP	0.0	0.0	0.0	4.9	114.9	54.6	63.6	56.1	46.0	54.1	0.0	0.0	32.8	64.9	0.8
WRASP	0.0	0.0	0.0	0.0	35.0	27.1	29.4	32.8	32.9	20.4	0.0	0.0	14.8	29.6	0.0
Total	0.0	0.0	0.0	4.9	149.9	81.7	92.9	88.9	78.9	74.5	0.0	0.0	47.6	94.5	0.8

Notes: Based on daily simulation of 1996-2002 modeling period.

5.2 Scenario 2 – Average Conditions, 30-day Melt

Scenario 2 represents average conditions at the site based on a 1:2 year snow pack, 20% sublimation, and snow melt occurring over 30 days. It differs from the base case with a longer snowmelt duration, which effectively reduces the daily runoff rate and applies it over a longer period. Results are shown in Figures 2a and 2b and summarized below:

- Average daily water levels within the HLF and Events Ponds do not vary significantly from Scenario 1. The maximum simulated water levels are estimated at approximately 792.3 m and 755.1 m for the HLF and Events Ponds, respectively. Minimum simulated freeboards are estimated at 14.2 m and 4.95 m for the HLF and Events Ponds, respectively. See Table 8 for a summary of the maximum water level and minimum free board results.

Table 8: Scenario 2 – Maximum Daily Water Levels and Minimum Freeboard

	Heap Leach Facility		Events Pond	
Year	**Water Level (m)**	**Freeboard (m)**	**Water Level (m)**	**Freeboard (m)**
1996	792.30	14.20	752.78	7.22
1997	791.19	15.31	755.05	4.95
1998	789.69	16.81	751.71	8.29
1999	790.52	15.98	752.35	7.65
2000	789.59	16.91	753.74	6.26
2001	789.95	16.55	751.93	8.07
2002	789.08	17.42	752.17	7.83
Average	790.33	16.17	752.82	7.18
Max/Min	792.30	14.20	755.05	4.95

Notes: Scenario 2 – 1:2 year 30-day snowmelt 20% sublimation.

- The mean monthly groundwater requirements at the Process Plant increase from 7.06 m^3/hr in Scenario 1 to 7.34 m^3/hr in Scenario 2. The total annual groundwater requirements for Scenario 2 are estimated at 8.12 m^3/hr, similar to that of Scenario 1. See Table 9 for a summary of groundwater use.
- Scenario 2 total mean annual discharge to Williams Creek is similar to that of Scenario 1. However, the monthly maximum discharge is reduced from 107.9 m^3/hr (Scenario 1) to 106.4 m^3/hr (Scenario 2). Table 10 presents the mean monthly discharge to Williams Creek.

Scenario 2 results from the water balance update are similar to the previous water balance results (Golder, 2008) in that no spillway discharges occur from the Events pond or HLF. However, the mine pit seepage increase resulted in the following changes:

- The Mean Annual Discharges to Williams Creek from the HLFSP increase significantly from 17.5 m^3/hr (Golder , 2008) to 31.2 m^3/hr; and
- Groundwater use as the as the sole supply for the Process Plant is reduced by 47 days, from 143 days (Golder, 2008) to 96 days.

Table 9: Scenario 2 – Mean Monthly Groundwater Requirements

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual Mean/ Total	Mean May-Oct	Mean Nov-Apr
Groundwater Supply to Camp[a] (m^3/hr)	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
Groundwater Supply to Process Plant[a] (m^3/hr)	19.48	25.50	25.50	0.92	0.50	0.50	0.50	0.50	0.50	0.50	1.99	11.66	7.34	0.50	14.17
Total Groundwater Requirements (m^3/hr)	20.26	26.28	26.28	1.70	1.28	1.28	1.28	1.28	1.28	1.28	2.77	12.44	8.12	1.28	14.95
Days as Primary Source for Process Plant[b]	23	28	31	1	0	0	0	0	0	0	2	12	96	0	16

Notes: Based on daily simulation of 1996-2002 modelling period; (a) including continuous base withdrawal of 0.5 m^3/hr; (b) number of days that groundwater serves as primary source for plant makeup water and for agglomeration (does not count days when only supplying base withdrawal or the 2.6 m^3/hr for dust control).

Table 10: Scenario 2 – Mean Monthly Discharge to Williams Creek (m^3/hr)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Mean Annual	Mean May-Oct	Mean Nov-Apr
HLFSP	0.0	0.0	0.0	52.1	52.6	51.8	62.9	55.7	45.8	54.0	0.0	0.0	31.2	53.8	8.7
WRASP	0.0	0.0	0.0	5.9	40.8	34.4	32.9	33.4	33.0	21.8	0.0	0.0	16.8	32.7	1.0
Total	0.0	0.0	0.0	58.0	93.4	86.2	95.8	89.1	78.8	75.8	0.0	0.0	48.1	86.5	9.7

Notes: Based on daily simulation of 1996-2002 modeling period.

5.3 Scenario 3 – 1:100-year Wet Conditions

Scenario 3 represents wet conditions at the site based on a 1:100 year snow pack, sublimation of 20%, and snow melt occurring over 14 days. The increased runoff associated with the large snowpack results in higher water levels, more surface water availability, decreased groundwater requirements, and higher discharge to Williams Creek. Results are shown in Figures 3a and 3b and are summarized below:

- HLF water levels in Scenario 3 are similar to the levels simulated in the base case scenario. The Average water levels are estimated at 790.55 m compared to 790.57 m for the base case scenario. The minimum simulated daily freeboard is estimated at 14.78 m. See table 11 for a summary of the HLF maximum water levels and minimum freeboard results.

- The Events Pond minimum simulated freeboard is 3.49 m (compared to 4.90 m in the base case and 4.95 m in Scenario 2). This is 0.5 m below the operating level of 757 m for the Events Pond. See Table 11 for a summary of the Events Pond maximum water levels and minimum freeboard results.

Table 11: Scenario 3 – Maximum Daily Water Levels and Minimum Freeboard

	Heap Leach Facility		Events Pond	
Year	**Water Level (m)**	**Freeboard (m)**	**Water Level (m)**	**Freeboard (m)**
1996	791.72	14.78	755.15	4.85
1997	790.40	16.10	756.51	3.49
1998	789.91	16.59	754.19	5.81
1999	790.61	15.89	754.48	5.52
2000	790.93	15.57	755.53	4.47
2001	790.33	16.17	754.13	5.87
2002	789.93	16.57	754.49	5.51
Average	790.55	15.95	754.93	5.07
Max/Min	791.72	14.78	756.51	3.49

Notes: Scenario 3 – 1:100 year 14-day snowmelt 20% sublimation.

- The mean annual groundwater requirement is estimated at 5.78 m^3/hr and results indicated that during the winter period (November to April) the groundwater requirements increase to an average of 10.28 m^3/hr. Groundwater is the sole supply of freshwater to the process plant for 64 days. See Table 12 for a summary of groundwater use.

- The total mean monthly discharge to Williams Creek over the open water season (May to October) is estimated at 72.2 m^3/hr from the HLFSP and 33.1 m^3/hr from the WRASP. The total annual discharge for Scenario 3 represents an increase of approximately 11% from the base case. See Table 13 for a summary of the mean monthly discharge to William Creek.

Scenario 3 results from the water balance update are similar to the previous water balance results (Golder, 2008) in that no spillway discharges occur from the Events pond or HLF. However, the mine pit seepage increase resulted in the following updated changes:

- The Mean Annual Discharges to Williams Creek from the HLFSP increase significantly from 18.9 m^3/hr (Golder , 2008) to 36.5 m^3/hr; and
- Groundwater use as the as the sole supply for the Process Plant is reduced by 40days, from 104 days (Golder, 2008) to 64 days.

Table 12: Scenario 3 – Mean Monthly Groundwater Requirements

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual Mean/ Total	Mean May-Oct	Mean Nov-Apr
Groundwater Supply to Camp[a] (m^3/hr)	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
Groundwater Supply to Process Plant[a] (m^3/hr)	9.51	16.69	25.44	0.86	0.50	0.50	0.50	0.50	0.50	0.50	0.50	3.96	5.00	0.50	9.49
Total Groundwater Requirements (m^3/hr)	10.29	17.47	26.22	1.64	1.28	1.28	1.28	1.28	1.28	1.28	1.28	4.74	5.78	1.28	10.28
Days as Primary Source for Process Plant[b]	11	18	31	0	0	0	0	0	0	0	0	4	64	0	11

Notes: Based on daily simulation of 1996-2002 modelling period; (a) including continuous base withdrawal of 0.5 m^3/hr; (b) number of days that groundwater serves as primary source for plant makeup water and for agglomeration (does not count days when only supplying base withdrawal or the 2.6 m^3/hr for dust control).

Table 13: Scenario 3 – Mean Monthly Discharge to Williams Creek (m^3/hr)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Mean Annual	Mean May-Oct	Mean Nov-Apr
HLFSP	0.0	0.0	0.0	4.9	154.1	54.2	65.3	57.3	46.3	56.0	0.0	0.0	36.5	72.2	0.8
WRASP	0.0	0.0	0.0	0.0	43.7	34.4	32.7	33.4	33.0	21.7	0.0	0.0	16.6	33.1	0.0
Total	0.0	0.0	0.0	4.9	197.8	88.6	98.0	90.7	79.3	77.7	0.0	0.0	53.1	105.3	0.8

Notes: Based on daily simulation of 1996-2002 modeling period.

5.4 Scenario 4 – 1:20-year Dry Conditions

Scenario 4 represents dry conditions at the site based on a 1:20 year dry snow pack, 29% sublimation, and snow melt occurring over 14 days. Scenario 4 was run to assess groundwater requirements when surface water availability is limited. Results are shown in Figures 4a and 4b and are summarized below:

- The minimum freeboard within the Heap Facility (14.42 m) is greater than for the base case (13.30 m). Lower water levels in the Events Pond also result in additional freeboard: 4.90 m for the base case compared to 5.96 m for Scenario 4. Scenario 4 maximum daily water levels and minimum freeboard results are shown in Table 14.

- Groundwater use increases under the Scenario 4 drought conditions compared to the base case. As shown in Table 15, the number of days when groundwater is the sole source for the plant increases from 93 days to 105 days. This results in a mean annual withdrawal of 8.75 m^3/hr compared to 7.84 m^3/hr in the base case.

- The mean monthly discharge to Williams Creek between May and October is 26.28 m^3/hr from the HLFSP and 13.51 m^3/hr from the WRASP. This represents a decrease of the total discharge to Williams Creek of about 20% compared to the base case. A summary of the flows is provided in Table 16.

Scenario 4 results from the water balance update are similar to the previous water balance results (Golder, 2008) in that no spillway discharges occur from the Events pond or HLF. However, the mine pit seepage increase resulted in the following updated changes:

- The Mean Annual Discharges to Williams Creek from the HLFSP increase significantly from 15.4 m^3/hr (Golder , 2008) to 26.3 m^3/hr; and

- Groundwater use as the as the sole supply for the Process Plant is reduced by 51 days, from 156 days (Golder, 2008) to 105 days.

Table 14: Scenario 4 – Maximum Daily Water Levels and Minimum Freeboard

	Heap Leach Facility		Events Pond	
Year	**Water Level (m)**	**Freeboard (m)**	**Water Level (m)**	**Freeboard (m)**
1996	792.08	14.42	752.39	7.61
1997	789.68	16.82	754.04	5.96
1998	790.43	16.07	751.03	8.97
1999	790.39	16.11	751.30	8.70
2000	790.42	16.08	752.71	7.29
2001	790.34	16.16	750.93	9.07
2002	789.37	17.13	751.39	8.61
Average	790.39	16.11	751.97	8.03
Max/Min	792.08	14.42	754.04	5.96

Notes: Scenario 4 – 1:20 dry year 14-day snowmelt 29% sublimation.

Table 15: Scenario 4 – Mean Monthly Groundwater Requirements

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual Mean/ Total	Mean May-Oct	Mean Nov-Apr
Groundwater Supply to Camp[a] (m^3/hr)	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
Groundwater Supply to Process Plant[a] (m^3/hr)	24.66	25.50	25.50	0.86	0.50	0.50	0.50	0.50	0.50	0.50	1.99	14.14	7.97	0.50	15.44
Total Groundwater Requirements (m^3/hr)	25.44	26.28	26.28	1.64	1.28	1.28	1.28	1.28	1.28	1.28	2.77	14.92	8.75	1.28	16.22
Days as Primary Source for Process Plant[b]	30	28	31	0	0	0	0	0	0	0	2	15	105	0	18

Notes: Based on daily simulation of 1996-2002 modelling period; (a) including continuous base withdrawal of 0.5 m^3/hr; (b) number of days that groundwater serves as primary source for plant makeup water and for agglomeration (does not count days when only supplying base withdrawal or the 2.6 m^3/hr for dust control).

Table 16: Scenario 4 – Mean Monthly Discharge to Williams Creek (m^3/hr)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Mean Annual	Mean May-Oct	Mean Nov-Apr
HLFSP	0.0	0.0	0.0	5.2	47.2	44.8	64.3	55.8	46.4	51.8	0.0	0.0	26.3	51.7	0.9
WRASP	0.0	0.0	0.0	0.0	32.2	16.7	27.2	32.8	33.0	20.3	0.0	0.0	13.5	27.0	0.0
Total	0.0	0.0	0.0	5.2	79.4	61.5	91.4	88.6	79.3	72.2	0.0	0.0	39.8	78.7	0.9

Notes: Based on daily simulation of 1996-2002 modeling period.

5.5 Scenario 5 – Upset Conditions: Process Plant and Water Treatment Shut Down

Scenario 5 represents upset conditions at the site where the process plant and water treatment plant are shut down for a 2-month period starting at the beginning of the freshet. Year 1997 was chosen for simulation based on its wetter than average characteristics. In the scenario, all pumps to the process plant and heap facility, including heap irrigation, are turned off from May 1 to June 30. The exception is the pump from the Heap to the Events Pond which remains on to simulate draindown of the HLF.

In terms of hydrologic inputs, Scenario 5 is based on a 1:100-year snow pack melting over 14 days (0% sublimation), plus an extreme 1:100-year rainfall event (set on May 14, 1997). This scenario was run to evaluate the capacity of the Events Pond to contain the resulting runoff without release to the environment. Results are shown in Figure 5 and are summarized below:

- Water levels in the Events Pond rise dramatically throughout the freshet to a maximum water level of 758.62 m, which corresponds to a freeboard of 1.38 m.
- Even though the pumps to the process plant and water treatment plant are offline for two months, water levels in the Events Pond do not reach the spillway elevation and therefore there is no spillway discharge.

These results are similar to the previous water balance results (Golder, 2008) in that no spillway discharges occur from the Events pond or HLF.

5.6 Scenario 6 – Upset Conditions: Plant Shut Down

Scenario 6 is similar to Scenario 5; however, the water treatment plant remains operational when the process plant is shut down.

Water levels in the Events Pond are sensitive to the overall pump outflow rate. When available, water from the Events Pond can be used as irrigation make-up water (14.5 m^3/hr), and as water for ore agglomeration (8.4 m^3/hr). To reduce water levels within the pond, water may also be pumped to the HLFSP via the Water Treatment Plant which would treat the water prior to release. The rate of water treatment affects water levels as well as the time it takes for the pond to return to its minimum operating level each season.

Scenario 6 assumes a 25 m^3/hr treatment rate, which results in a maximum water level in the Events Pond at 2.20 m below the spillway elevation. However, when the treatment plant rate is set to 0 m^3/hr the events pond will still not overflow (as discussed in Scenario 5). A summary of pump sizes and treatment rates are listed in Table 17 based on the time required to drain the Events Pond. Results are shown in Figures 6 and are summarized below:

- Assuming a water treatment rate of 25 m^3/hr, water levels in the Events Pond rise throughout the freshet to a maximum water elevation of 757.80 m, which corresponds to a freeboard of 2.20 m.

Table 17: Treatment Plant Sizes to Drain the Events Pond

Time to Drain Events Pond	Pump Size (m^3/hr)
1 Week	17
2 Weeks	8
1 Month	4
2 Months	2

5.7 Comparison of Scenarios

A summary of HLF and Events Ponds water levels, groundwater requirements and discharge rate to Williams Creek is provided in the following bullets and tables:

- Water levels within the HLF reach a maximum peak of 791.72 m under wet conditions and 794.82 m under upset conditions, which corresponds to a water depth of approximately 8.8 m.
- Within the Events Pond the maximum water levels reach 756.51 m under wet conditions (Scenario 3) and 758.62 m under upset conditions (Scenario 5). A summary of the Events Pond water levels is provided in Table 18.
- During upset conditions, the maximum water level and minimum freeboard in the Events Pond are 758.62 m and 1.38 m, respectively (Table 18). This reflects a 2-month shut-down of the process plant and water treatment facilities starting at the onset of the spring freshet.
- Under normal operating conditions, mean annual groundwater requirements vary from 5.36 m^3/hr for the wet scenario (Scenario 3) to 8.79 m^3/hr for drought scenario (Scenario 4). Refer to Table 19.
- The mean monthly discharge from the HLFSP to Williams Creek in the open water season (May to October) ranges from 51.70 m^3/hr for the dry scenario (Scenario 4) to 72.20 m^3/hr for the wet scenario (Scenario 3). Discharge during the open water season from the WRASP ranges from 27.03 m^3/hr for the dry scenario (Scenario 4) to 33.14 m^3/hr for the wet scenario (Scenario 3). A summary of the average daily discharge to Williams Creek is provided in Table 20.

Table 18: Comparison of Scenarios – Maximum and Water Levels and Minimum Freeboard

Scenario	Scenario Description	-	Heap Leach Facility		Events Pond	
			Water Level (m)	Freeboard (m)	Water Level (m)	Freeboard (m)
1	Average Conditions Base Case	Average	790.57	15.93	753.18	6.82
		Max/Min	793.20	13.30	755.10	4.90
2	Average Conditions	Average	790.33	16.17	752.82	7.18
		Max/Min	792.30	14.20	755.05	4.95
3	Wet	Average	790.55	15.95	754.93	5.07
		Max/Min	791.72	14.78	756.51	3.49
4	Dry	Average	790.39	16.11	751.97	8.03
		Max/Min	792.08	14.42	754.04	5.96
5	Upset conditions: process plant & water treatment plant are shut down [a]	Average	793.20	13.30	756.18	3.82
		Max/Min	794.82	11.68	758.62	1.38
6	Upset Conditions: process plant is shut down [b]	Average	794.01	12.49	756.99	3.01
		Max/Min	794.82	11.68	757.80	2.20

Notes: (a) Process plant and water treatment plant are shut down for two months between May 1 and June 30. Solution in the HLF is drained to the Events Pond.

(b) Process plant is shut down for two months between May 1 and June 30. Water treatment plant operates at 25 m^3/hr. Solution in the HLF is drained to the Events Pond.

Table 19: Comparison of Scenarios – Average Daily Groundwater Requirements

Scenario	Scenario Description	Withdrawal Rate[a] (m^3/hr)			Days as Primary Source for Plant[b] (#)		
		Mean Annual	Mean May-Oct	Mean Nov-Apr	Mean Annual	Mean May-Oct	Mean Nov-Apr
1	Average Conditions Base Case	7.84	1.28	12.53	93	0	15
2	Average Conditions	8.12	1.28	14.95	96	0	16
3	Wet	5.78	1.28	10.28	64	0	11
4	Dry	8.75	1.28	16.22	105	0	18

Notes: Based on daily simulation of 1996-2002 modelling period; (a) including continuous base withdrawal of 0.5 m^3/hr; (b) number of days that groundwater serves as primary source for plant makeup water and for agglomeration (does not count days when only supplying base withdrawal or the 2.6 m^3/hr for dust control).

Table 20: Comparison of Scenarios – Average Daily Discharge to Williams Creek (m^3/hr)

Scenario	HLFSP			WRASP			Total		
	Mean Annual	Mean May-Oct	Mean Nov-Apr	Mean Annual	Mean May-Oct	Mean Nov-Apr	Mean Annual	Mean May-Oct	Mean Nov-Apr
1	32.85	64.87	0.82	14.80	29.60	0.00	47.65	94.47	0.82
2	31.25	53.81	8.68	16.84	32.68	0.99	48.08	86.50	9.67
3	36.51	72.20	0.81	16.57	33.14	0.00	53.08	105.34	0.81
4	26.28	51.70	0.87	13.51	27.03	0.00	39.80	78.73	0.87

6.0 SUMMARY

The updated water balance results indicated, as was the case in the previous water balance, that water levels within the HLF and Events Pond are not very sensitive to snowmelt duration or to storms during the freshet. Water levels in the Events Pond, however, are sensitive to the amount of runoff generated by snowmelt and the overall pump outflow rate.

Six scenarios were modeled to evaluate system performance given different climate conditions and operational considerations. For all scenarios, water from the Events Pond is re-used as makeup water for irrigation as well as for agglomeration. The following bullets summarize the model results:

- On an annual basis, the Events Pond is expected to have sufficient capacity to store the full spring runoff volume without treating and discharging any water to the environment. The rate of water re-use for irrigation make-up and agglomeration is sufficient to draw water levels down to the minimum operating level by the end of each year or early the following year (*i.e.,* in six to seven months).

- There is sufficient capacity in the Events Pond to hold the 1:100-yr snowmelt plus heap drain down, even if the process plant is shut down for two months. The runoff can be contained in the Events Pond without having to treat water to draw down water levels and prevent discharge to the environment via the emergency spillway.

- Groundwater requirements increase considerably in drought conditions where the snowpack is limited. For the 1:20-year drought (Scenario 4), the average pump rate is 8.79 m^3/hr and is the sole supply for the process plant for 105 days. This represents 12 more days of pumping and 14% more groundwater withdrawal compared to the base case.

- The mean annual discharge from the HLFSP and WRASP to Williams Creek ranges from 39.80 to 53.08 m^3/hr for Scenarios 1 to 4. The average discharge during the open water season (May to October) ranges from 78.73 to 105.34 m^3/hr, while winter discharges range from 0.82 to 9.67 m^3/hr.

7.0 CLOSURE

We trust that the information provided to you in this technical memorandum is sufficient to address the YWB water balance update request. Should you have any questions regarding this report please do not hesitate to contact the undersigned.

GOLDER ASSOCIATES LTD.

ORIGINAL SIGNED

Yapo Allé-Ando, M.A.Sc., EIT
Water Resources Engineer

ORIGINAL SIGNED

John A. Hull, P.Eng.
Principal

YAA/JAH/rs

Attachments: Figures 1a, 1b, 2a, 2b, 3a, 3b, 4a, 4b, 5 and 6

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REFERENCES

Clearwater Consultants Ltd., 2006. Carmacks Copper Project – Williams Creek Site Hydrology Update. Prepared for Access Consulting Group. January 13, 2006.

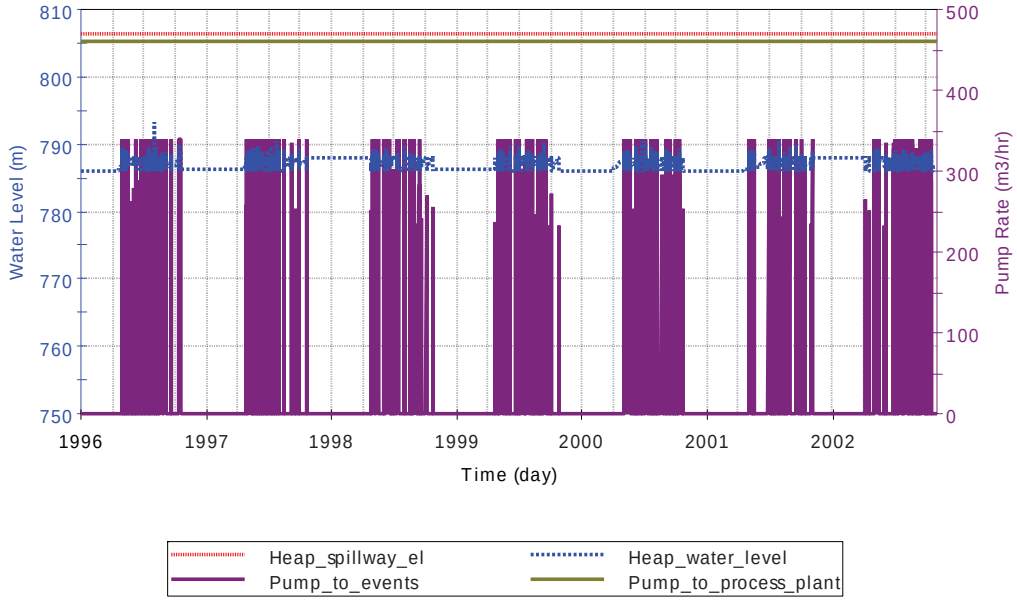
Golder Associates Ltd., 2008. Site Water Balance, Carmacks Copper Project. June 12, 2008.

Golder Associates Ltd., 2009. Assessment of Hydrogeological Conditions During Operation and Closure, Carmacks Copper Project, Yukon. February 12, 2009.

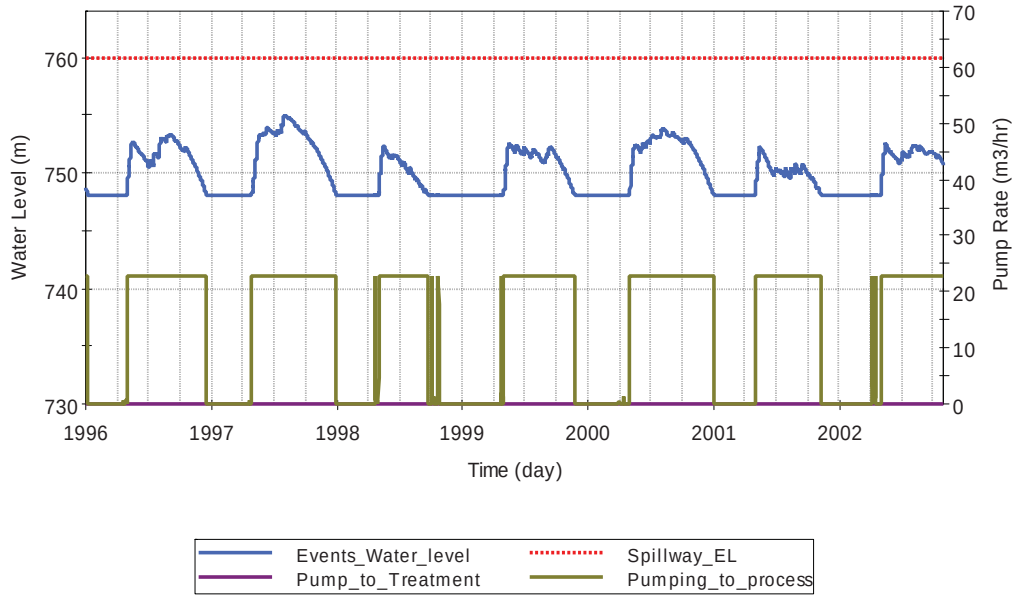
Yukon Water Board (YWB), 2009. Letter on "*Water Use Application QZ08-084 – Carmacks Copper*" dated July 17, 2009.

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Heap Leach Facility Water Levels and Pumped Outflows



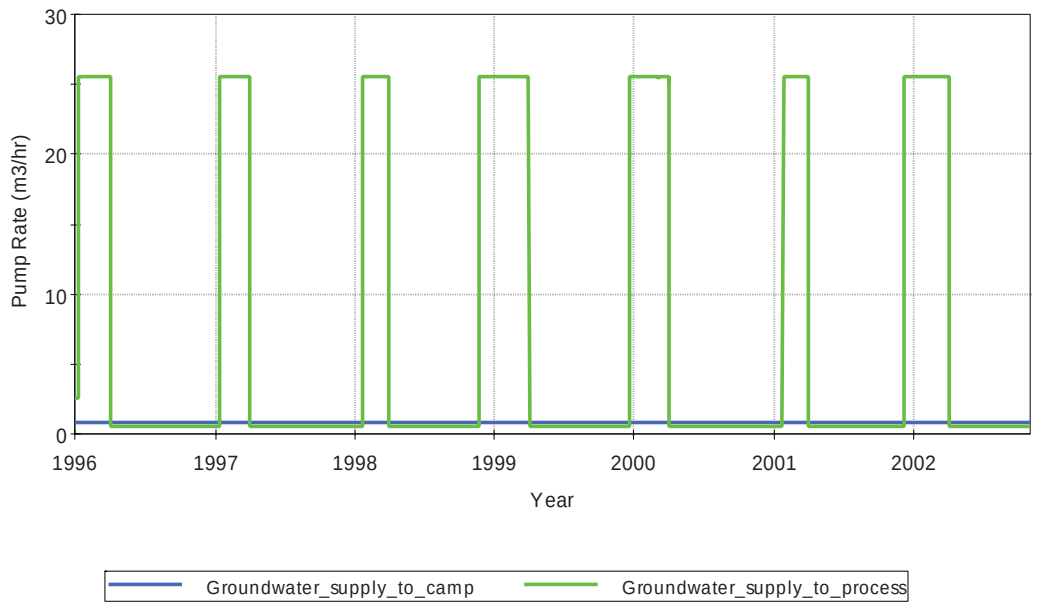
Events Pond Water Levels and Pumped Outflows



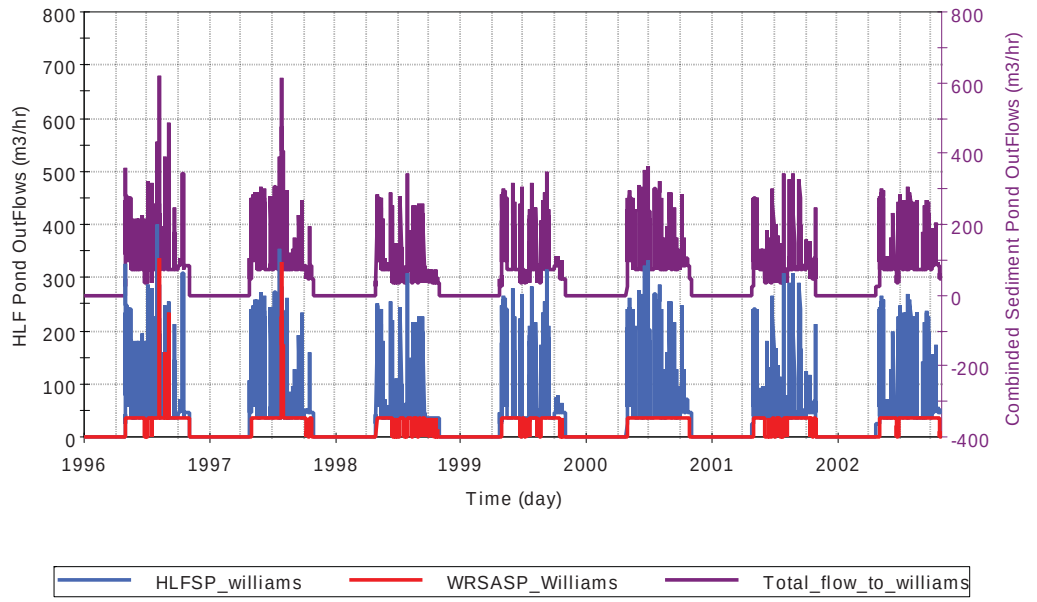
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	CHECKED	DATE: OCTOBER 09	
	SCALE		PROJECT No: 07-1413-0077 / FIGURE No: 1a / REV No

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Groundwater Use for Camp and Process



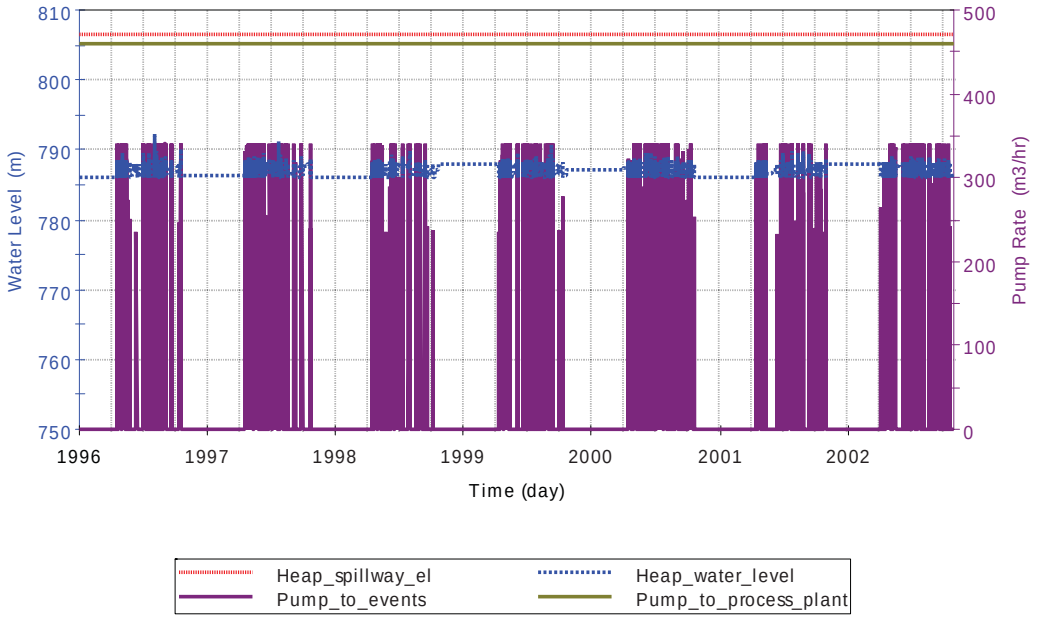
Flows to Williams Creek From the Sediment Ponds



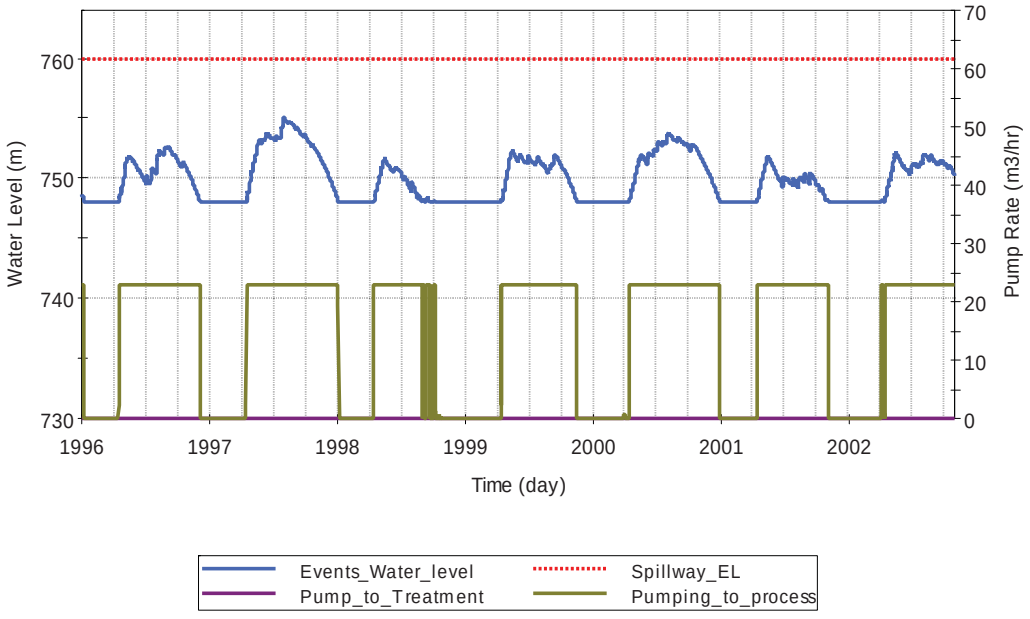
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Heap Leach Facility Water Levels and Pumped Outflows



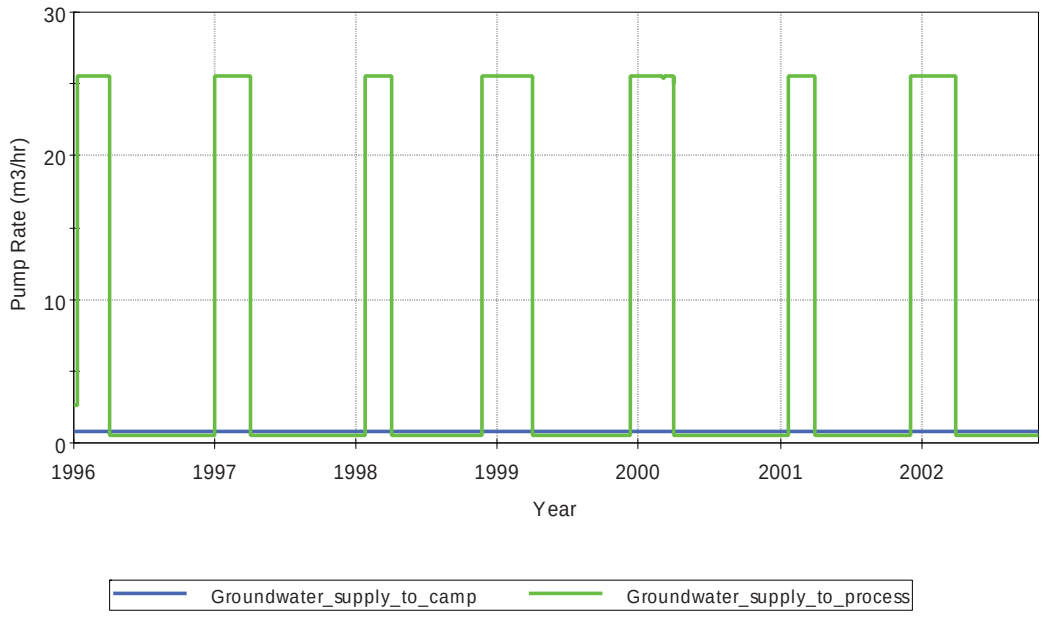
Events Pond Water Levels and Pumped Outflows



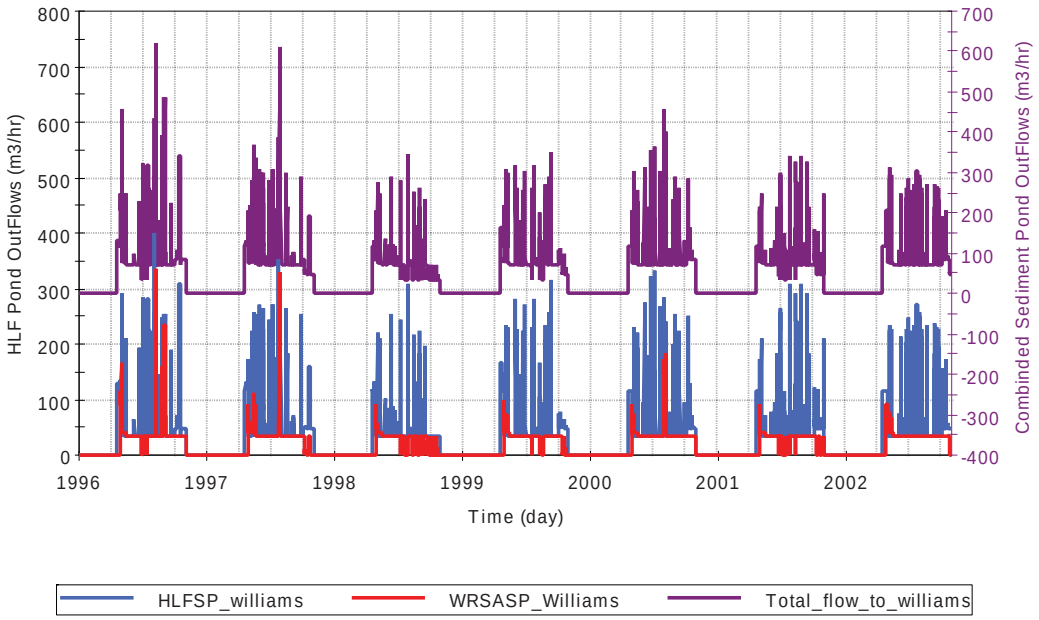
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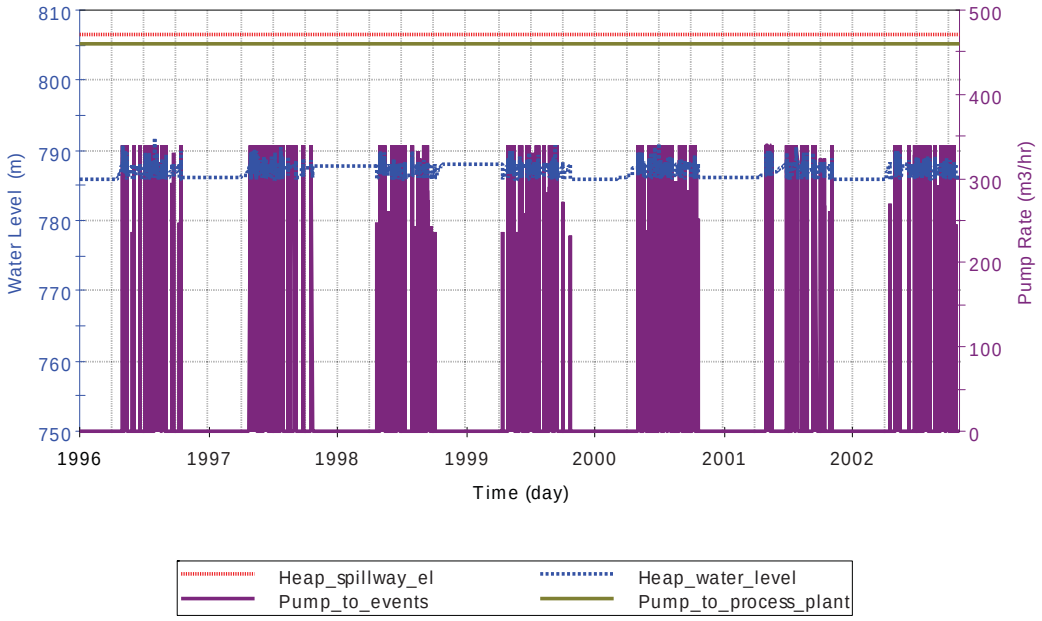
Flows to Williams Creek From the Sediment Ponds



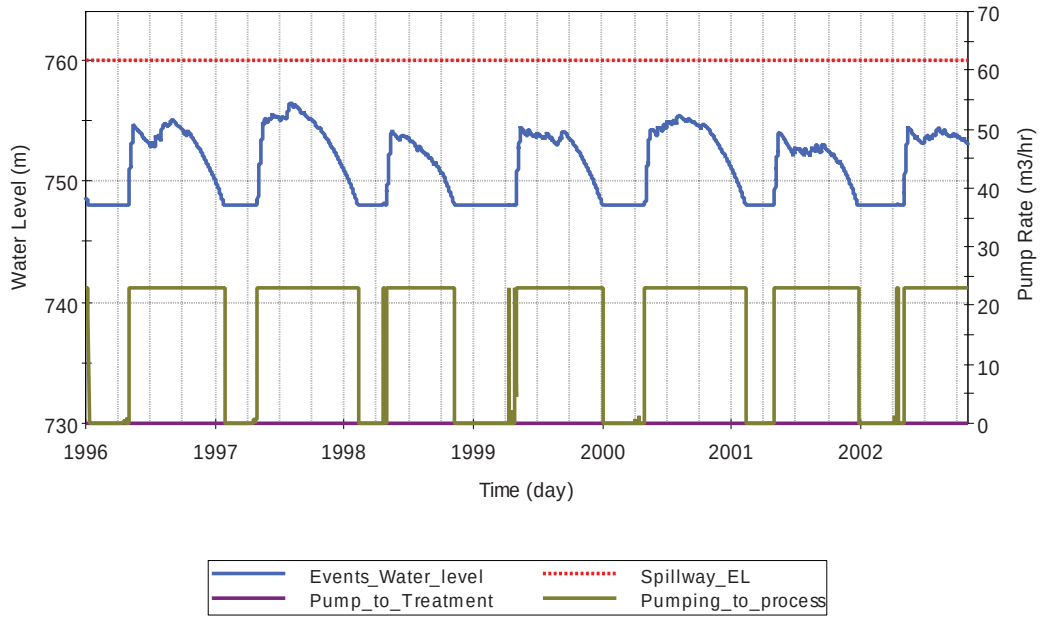
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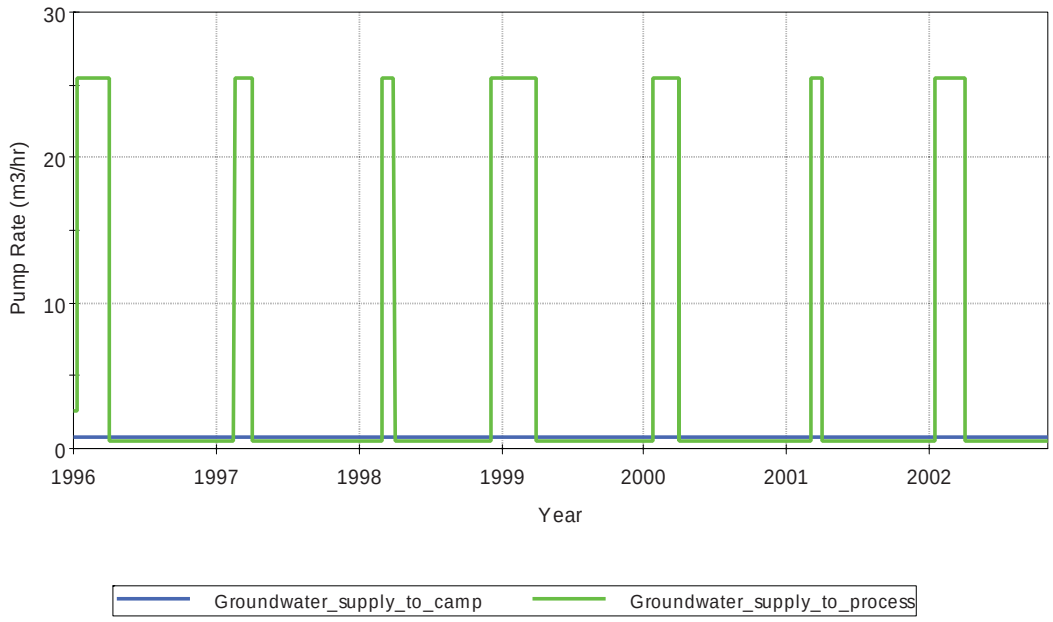
Events Pond Water Levels and Pumped Outflows



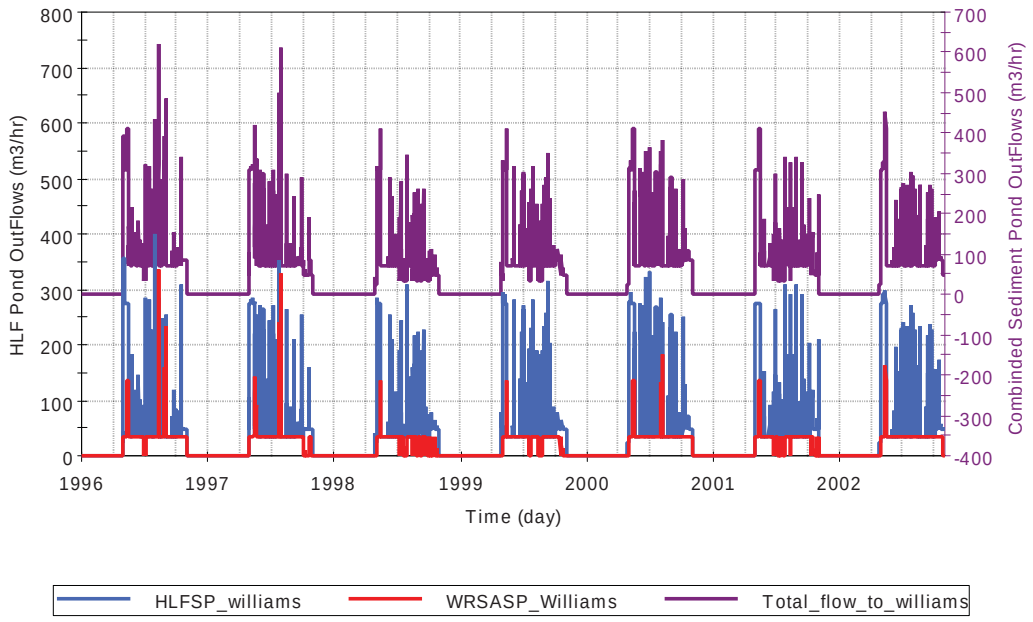
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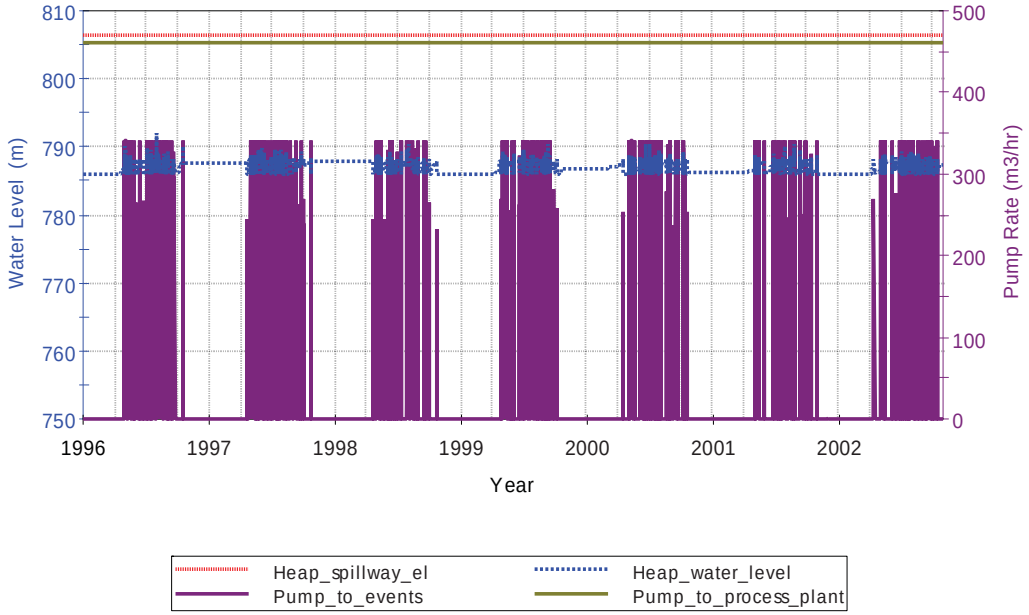
Flows to Williams Creek From the Sediment Ponds



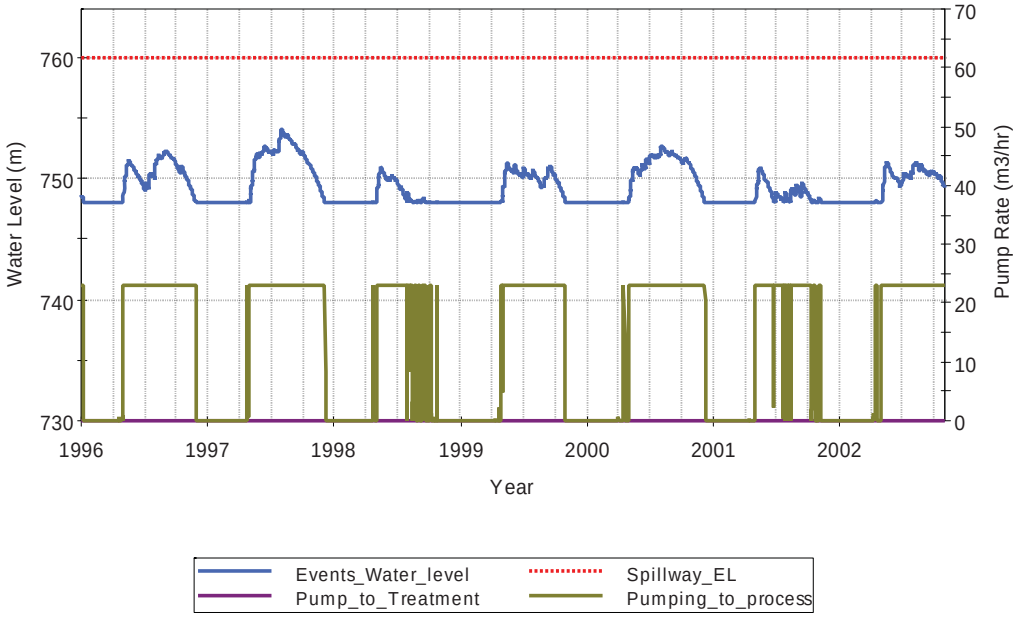
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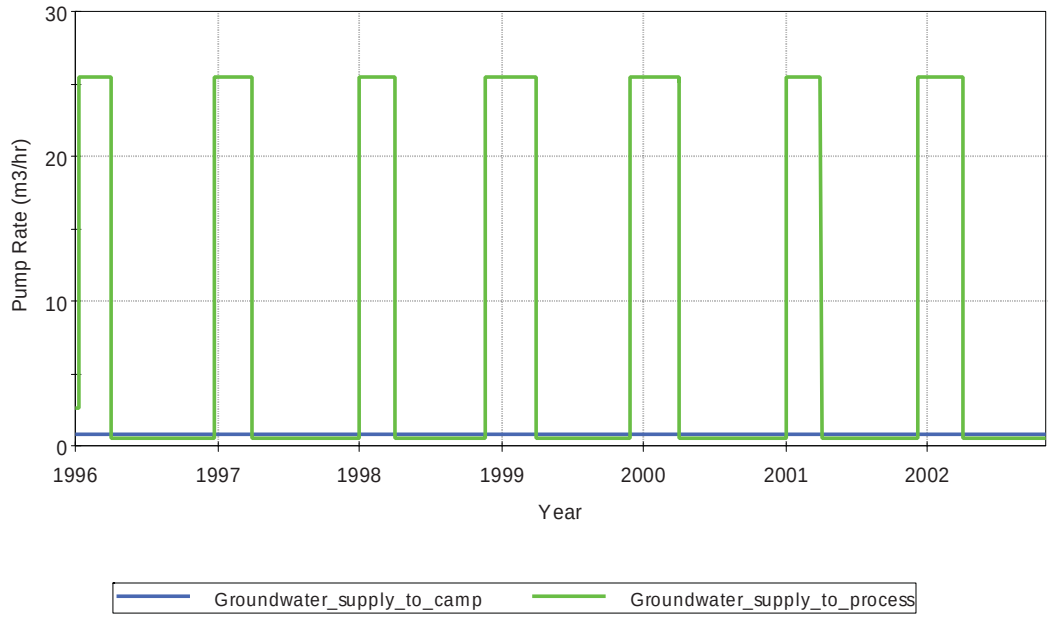
Events Pond Water Levels and Pumped Outflows



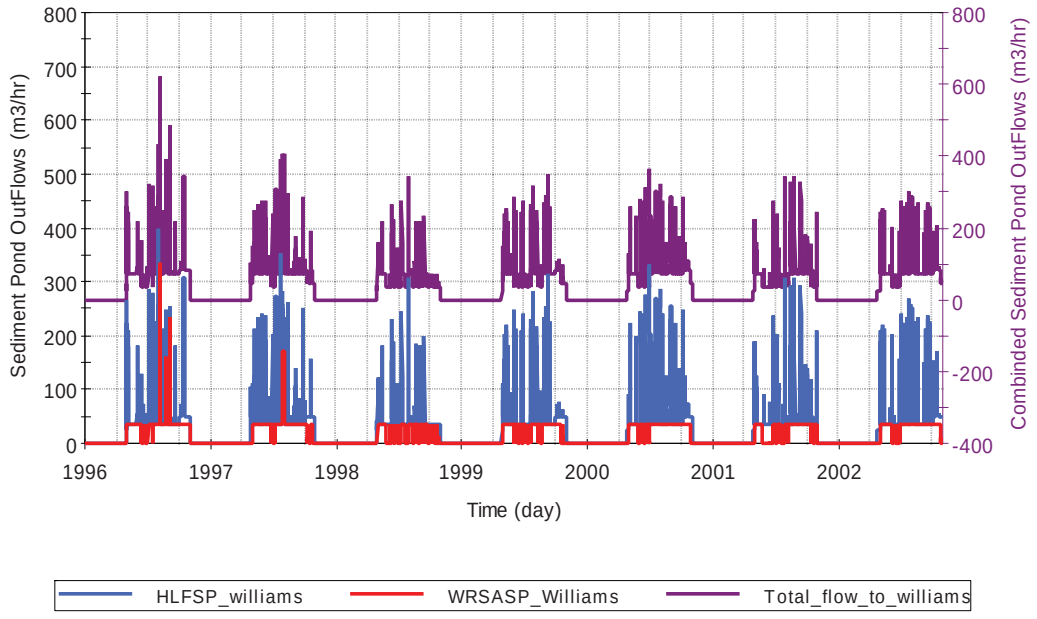
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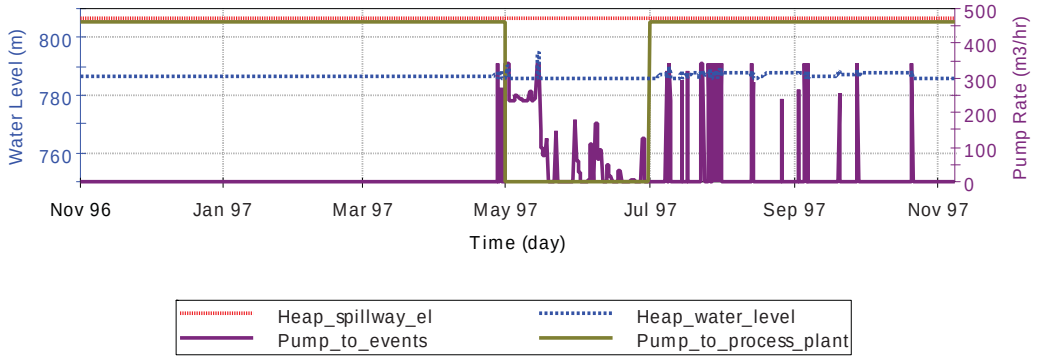
Flows to Williams Creek From the Sediment Ponds



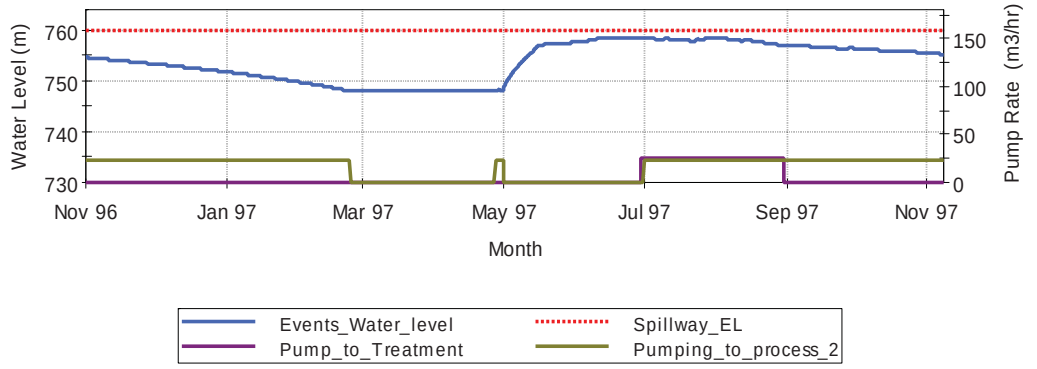
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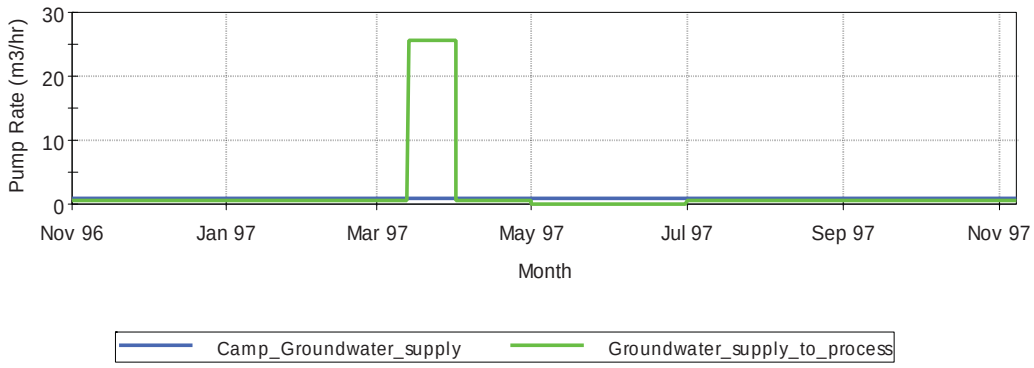
Heap Leach Facility Water Levels and Pumped Outflows



Events Pond Water Levels and Pumped Outflows



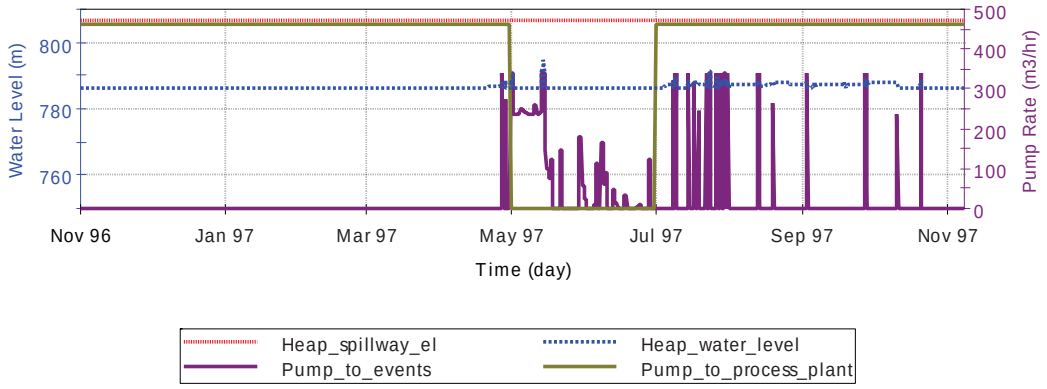
Groundwater Use for Camp and Process



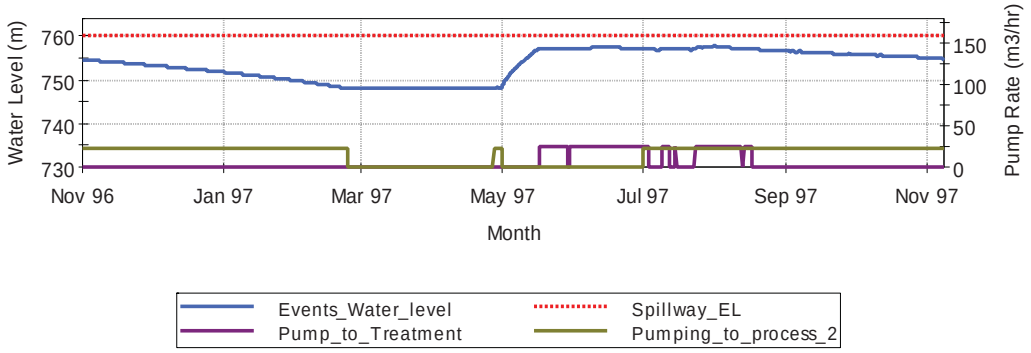
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	CHECKED	DATI: OCTOBER 09	
	SCALE		PROJECT No: 07-1413-0077
			FIGURE No: 5
			REV No:

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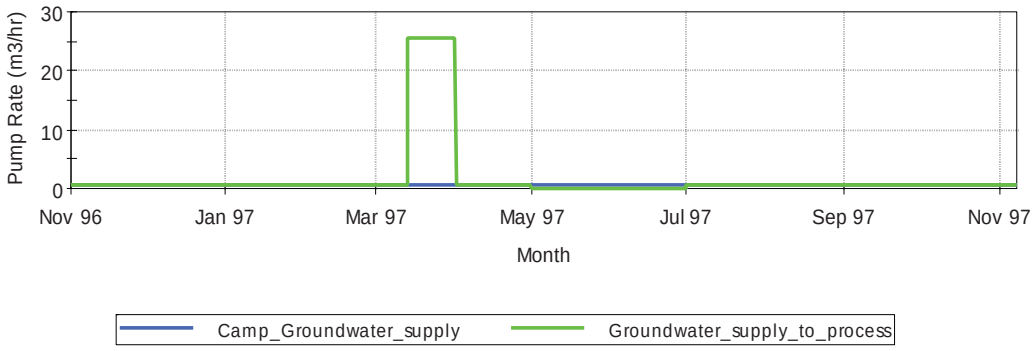
Heap Leach Facility Water Levels and Pumped Outflows



Events Pond Water Levels and Pumped Outflows



Groundwater Use for Camp and Process



Golder Associates	CLIENT: Western Copper Corporation		PROJECT: Carmacks Copper Project
	DRAWN	DATE: OCTOBER 09	TITLE: Scenario 6 1:100 Year Wet Snowmelt Over 14-days 1:100 yr rain on May 14 0% sublimation, All Pumps Stop Wit Treatment May 1-June 1
	CHECKED	DATE: OCTOBER 09	
	SCALE		PROJECT No: 07-1413-0077 / FIGURE No: 6 / REV No:

Western Copper Corporation

2009 ANNUAL QUARTZ MINING LICENCE REPORT

SUBMITTED TO YUKON GOVERNMENT, ENERGY MINES AND RESOURCES

YUKON QUARTZ MINING LICENCE QML-0007

Appendix E

Site Hydrology Update (November 2009)

TECHNICAL MEMORANDUM

DATE November 5, 2009

PROJECT No. 07-1413-0077/1100
Doc. No. 128

TO Jonathan Clegg
Western Copper Corporation

CC John Hull

FROM Mike Paget

EMAIL mpaget@golder.com

WILLIAMS CREEK SITE HYDROLOGY UPDATE – CARMACKS COPPER PROJECT, YUKON

1.0 INTRODUCTION

The purpose of this technical memorandum is to provide the updated hydrological data which extends the data base to include the 2008 information. This data base was then utilized to complete the site water balance update (Golder, 2009a).

2.0 CLIMATE UPDATE

Pelly Ranch was identified as the most relevant climate station near or close to Carmacks Copper Project site. Pelly Ranch is approximately 70 km away from the site and accumulates a substantial record of precipitation over a long period of time (1951 to 2009). Even though Williams Creek and Carmacks climate stations are closer to the site they provide discontinuous data over a shorter period of time. In addition, there is no precipitation data from Carmacks climate station after 1999. See Table 1 below for a list of Yukon climate stations within 200 km of the Carmacks site.

The data from Pelly Range station was correlated with the available data from Williams Creek station using orthographic factors to produce a derived Williams Creek station data set. The updated factors are presented in Appendix A Table 8.

Table 1: Yukon Climate Stations

Station Name	Station Number	Latitude	Longitude	Distance from Site (km)	Elevation (m)	Period of Record		Comments
Williams Creek	115	62.346	-136.711	1.0	850	1995	2009	Incomplete
Carmacks[a]	2100300	62.100	-136.300	35	525	1963	2009	No Precipitation data after 1999
Pelly Ranch[a]	2100880	62.817	-137.367	70	454	1951	2009	Fairly complete
Whitehorse A	2101300	60.710	-135.068	157	703	1942	2009	Fairly complete
Dawson A	2100402	64.043	-139.128	224	370	1976	2009	Fairly complete

(a) Distance from site and elevations from Clearwater 1998.

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The regional data presented in the Clearwater Site Hydrology Update CCL-CC6 (Clearwater, 2006) was updated with available Pelly Ranch and Williams Creek data (2006 to 2008). Appendix A presents the climate analysis update using the same format as the tables from CCL-CC6. Tables 2, 3 and 4 presents relevant design precipitation parameters and the percentage change from the previous data (Clearwater, 2006).

Table 2: Williams Creek Annual Precipitation Characteristics

Condition	Return Period (Years)	Annual Percent Probability	Total Precipitation (mm)	Rainfall (mm)	Snowfall (mm)	Percentage Change Total Precipitation[a]	Percentage Change Rainfall[a]	Percentage Change Snowfall[a]
Dry	20	95.0%	257	150	107	3.6%	4.2%	2.9%
	5	80.0%	292	170	122	1.4%	1.8%	0.8%
Median	2	50.0%	338	197	141	0.0%	0.5%	-0.7%
Wet	5	20.0%	394	229	164	2.1%	2.2%	1.2%
	10	10.0%	428	249	178	2.9%	2.9%	1.7%
	20	5.0%	459	268	191	3.6%	4.3%	2.7%
	50	2.0%	498	290	208	5.3%	5.5%	4.5%
	100	1.0%	526	307	219	6.0%	6.6%	5.3%
	200	0.5%	553	323	231	7.2%	8.0%	6.5%
	500	0.2%	589	343	245	8.5%	8.9%	7.5%

(a) Percentage change from Clearwater 2006 reported values.

Table 3: Williams Creek Estimated Monthly Site Precipitation (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Updated Climate Analysis													
Average Rainfall	0.0	0.0	0.2	3.6	23.2	37.9	57.6	40.8	28.5	7.8	0.4	0.1	200.2
Average Snowfall	25.4	17.8	14.1	8.2	0.6	0.0	0.0	0.0	2.9	19.0	29.6	25.5	143.0
Average Precipitation	25.4	17.8	14.3	11.8	23.8	38.0	57.6	40.8	31.4	26.7	30.0	25.6	343.2
Change from Clearwater 2006 Results													
Average Rainfall (mm)	0.0	0.0	0.2	-0.5	-0.8	-1.7	0.4	-0.5	-2.0	7.8	0.4	0.1	3.7
Average Snowfall (mm)	3.7	1.6	0.6	-4.0	0.6	0.0	0.0	0.0	2.9	-9.1	2.9	2.2	1.1
Average Precipitation (As Percent)	17.1%	9.9%	5.9%	-27.2%	-0.8%	-4.0%	0.7%	-1.2%	3.0%	-5.0%	12.4%	9.9%	1.4%

Table 4: One Day Precipitation Amounts (mm)

Condition	Return Period (Years)	Annual Percent Probability	One-Day Precipitation (mm)	Percentage Change from Clearwater [a]
Dry	20	95.0%	12.1	3.4%
	5	80.0%	17.6	6.7%
Median	2	50.0%	24.3	6.1%
Wet	5	20.0%	32.2	2.9%
	10	10.0%	36.9	0.3%
	20	5.0%	41.1	-1.9%
	50	2.0%	46.2	-4.5%
	100	1.0%	49.8	-6.4%
	200	0.5%	53.2	-8.3%
	500	0.2%	57.6	-10.6%

(a) Clearwater 2006

The updated parameters show increased annual precipitation while the ratio of rain to snow remains unchanged at 42% rain and 58% snow. The estimated monthly site precipitation shows the same general trend as the Clearwater 2006 report and the overall monthly precipitation has increased by 1.4%. Additionally, one-day precipitation events show a general increase in precipitation for dry events, a small increase for 5 and 10 year wet events, and a decrease in precipitation in wetter longer term events.

3.0 COMMENT THE STORM EVENT OF AUGUST 25, 2008, EFFECTS ON MAJOR INFRASTRUCTURE

The storm event measured on August 25, 2008 of 62.3 mm, falls within the operational capacity of the project, as demonstrated in Scenarios 5 and 6 of the Water Balance report (Golder, 2009a). This is based on the fact that the scenarios modeled assumed the extreme rainfall event (1 in 100 year storm) in addition to the spring freshet (49.8 mm rain + 15.6 mm snowmelt = 65.4 mm). Consequently, these scenarios use inflows greater than those created by the 62.3 mm rain event of August 25 2008.

In Scenario 5 all pumps to the process plant and heap facility, including heap irrigation are turned off from May 1 to June 30. The exception is the pump from the Heap to the Events Pond which is pumping at its maximum rate (340 m^3/s) during the storm. The total volume reporting to the events pond from catchment runoff, incident precipitation, and pumped volumes during the storm is 9240 m^3. If this volume is applied to the maximum Events Pond water level of scenario 3 (756.51 m) the water level would rise to 757.07 m with a corresponding freeboard of 2.93 m. For detailed results see Site Water Balance Update scenarios 5 and 6 (Golder, 2009a).

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Attachments: Appendix A: Williams Creek Site Hydrology Update

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REFERENCES

Clearwater Consultants Ltd. (2006). Carmacks Copper Project- Williams Creeks Site Hydrology Update. Prepared for Access Consulting Group. January 13, 2006.

Clearwater Consultants Ltd. (2006). Carmacks Copper Project- Site Hydrology Revisions. Prepared for Access Consulting Group. March 12, 1998.

Golder. (2009a). Carmacks Copper Project - Site Water Balance Update Doc 115 Rev. 1. Prepared for Western Copper Corporation. October 2009.

Golder. (2009b). Carmacks Copper Project – Preliminary Closure Operations Water Balance for the Heap Leach Rinsing and Neutralizing Operations Doc 116 Rev 2. Prepared for Western Copper Corporation. October 2009.

Golder. (2009c). Carmacks Copper Project – HLF and Events Pond Spillways Preliminary Design Doc 113. Prepared for Western Copper Corporation. September 2009.

Golder. (2009d). Carmacks Copper Project – Site Water Balance Design Doc 0068. Prepared for Western Copper Corporation. June 2008.

Yukon Water Board (YWB), 2009. Letter on Water Use Application QZ08-084-Carmacks Copper. Dated October 15, 2009.

APPENDIX A

WILLIAMS CREEK SITE HYDROLOGY UPDATE

Table 1a: Monthly Rainfall (Mm) - Concurrent Data at Williams Creek and Pelly River Ranch

Williams Creek Rainfall (Elevation 850 m)													
Year	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1996				2.9		11.3	63.6	99.1	19.9	19.1			
1997			1.9	7.3	59.7	46.5	102.4	14.6	23	6.3			
1998			8	1.9	5.4	39.1	28.3	19.2	16	4.7			
1999			6.5	5.2	15.1	54.3	38.6	35.2					
2000													
2001													
2002			3.3										
2003					14.6	64.6	67.7						
2004			7.9										
2005			0.7	1.6	14.7	63.9	83.5	42.6	19.8	27.2			
2006			0.1	0.5	0.5	24.3	35.7	34.2	23.8	6.3			
2007			0.4	4.3	13.4	36.7	63	45.6	36.9	20.1			
2008			3.4	7.6	15.1	44.2	49	111					
Average - Common with Pelly			3.6	3.9	17.3	42.8	59.1	50.2	23.2	14.0			214.0
Pelly River Ranch (Elevation 454.2 m)													
Year	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1996				7.6		27.9	67.2	58.2	33.6	0			
1997			0	5.8	81.6	50.6	80.6	36	29.4	0			
1998			0	0	6.4	40.6	19.4	21.4	25.8	3			
1999			0	5.4	19.8	62.8	28.2	57.2					
2000													
2001													
2002			0										
2003					10.2	35	52.6						
2004			0										
2005			0	1.4	33.6	51	83.7	21.6	28.2	22.2			
2006			0	2.9	19.9	31.4	42.6	38.8	11.6	7.4			
2007			0	2.4	3	36.8	50.7	24.5	51	4			
2008			0	1	9.2	22.6	73.8	105.4					
Average - Common with Williams			0.0	3.3	23.0	39.9	55.4	45.4	29.9	6.1			203.0

Note: Precipitation measured by tipping bucket rain gauge.

0.0138	/100 m	0.0094	/100 m
5.45	%	3.73	%

Total Calculation of Rainfall Orographic Factor Based on the above common months data.
Total Rainfall at Williams Creek = 214 mm
Total Rainfall at Pelly River Ranch = 203 mm
Orographic Factor per 100 m elevation = WC Rainfall 0.0138

Table 1b: Comparison of Maximum Daily and Maximum One Month Rainfalls

	Maximum One Day (mm)			Maximum One Month (mm)		
Year	**PRR**	**WC**	**Ratio = WC/PRR**	**PRR**	**WC**	**Ratio = WC/PRR**
1996	19.8	28.8	1.45	67.2	99.1	1.475
1997	26.4	22.7	0.86	81.6	102.4	1.255
1998	7.1	16.8	2.37	40.6	39.1	0.963
1999	23.4	17.6	0.75	62.8	54.3	0.865
2000						
2001						
2002						
2003	11.6	28.9	2.49	52.6	67.7	1.287
2004	10.0	10.6	1.06	0.0		
2005	15.2	19.7	1.30	83.7	83.5	0.998
2006	25.2	16.5	0.65	42.6	35.7	0.838
2007	18.6	11.6	0.62	51.0	63.0	1.235
2008	26.6	41.7	1.57	105.4	111.0	1.053
Averages	18.4	21.5	**1.3**	58.8	72.9	**1.11**

Note: Averages based on common days / months of data.

Table 2: Pelly River Ranch Total Precipitation (mm)

Year\Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1951												48.3	
1952	48.4	5.1	6.4	2.6	6.5	6.2	40.7	17.9	23.4	2.6	18.9	32.7	211
1953													
1954													
1955	22.4	5.4	8.2		7.1	43.3	14	86	10.7	4.9	26.4	23.9	252
1956	12.8	11.8		6.8	40.1	45	48.5	41	2.8	37.2	33.2	17.9	
1957	14.7	24	13.7	8	15.4	12.8	34.9	19.6	19.8	2.4	33.4	21.1	220
1958	20.9	16.4	1.3	3.1	14.3	33.5	62	67.1	17.2	45.5	35.1	12.5	329
1959	10.2	21.2	24.6	10.7	19.2	46.8	29	37.7	25.4	6.4	20.2	14.6	266
1960	11.3	15.3	12.8	5.1	18.7	26.7	117.9	36.6	28.5	8.6	24.4	17.8	324
1961	13.5	10.9	11.3	6.7	23.5	45.1	44.5	26	18.3	42.1	24.4	29.2	296
1962	25.4	17.3	4.1	24.9	16.3	56	35.7	39.5	13	6.4	15	38	292
1963	47.7	7.4	10.7	11.1		47.4	58.7	18.6	35.1	27.5	14.7	47.7	
1964	24.2	19.1	16.6	15.9	26.2	53.8	88.2	31	21.2	19.9	19	20.3	355
1965	12.4	10	5.1	3.6	14	30.1	42.1	17.7	40.7	42.5	17.8	24.9	261
1966	7.6	26.1	6.6		5.9	28.3	7.2	20.5	16.1	35.5	61.1	10.4	
1967	37.8	26.7	31.6	14.2	16.6	46.2	65.1	56.3	28.6	13	16.3	18.7	371
1968	31	12.3	19.9	15.8	25.2	21.6	29.9	25.8	59.8	14.4	27.4	10.8	294
1969	11.8	3.7	14.6	12	30.7	3.3	81.7	12.3	22.8	8	25.5	14.5	241
1970	8.4	15.9	2.1	7.6	48.9	24.4	5.4	42.7	50.2	35.4	25.7	35.3	302
1971	4.8	6.6	7.8	4.8	7.4	11.7	24.2	45	22.2	28.5	28.7	40.8	233
1972	23.3	13.7	7.9	12.7	14.8	71	47.4	23.2	23.6	54.1	20.3	12.3	324
1973	25.4	12.4	17.8	30.3	5.2	51.0	47.6	54.1	8.7	17.3	22.7	34.3	327
1974	4.8	37.5	9.6	19.1	7.3	14.8	66	31.7	8.7	28	14.1	30.6	272
1975	20.3	4.6	0.3	18.3	13.8	16.5	71.8	29	32.3	21	15.9	12.3	256
1976	30.7	14.2	27	10.7	43	37.5	46.7	19.3	14.6	15.3	24.1	13.8	297
1977	31.1	4.1	16.8	25.0	24.2	44.8	30.3	18.3	14.9	18.1	21.7	11.7	261
1978	10.8	3.3	3.4	12.9	17.8	33.4	100	46.7	23.8	24.7	23.7	26.9	327
1979	23.8	19.5	20.9	4.6	29.5	47.7	54.1	10.2	33.5	4	18.9	17.6	284
1980	24.3	11.5	2.8	3.2	9.2	24.8	44.4	33	53.4	17.6	21.5	1.8	248
1981	5.4	27	4.3	11	13.2	33.3	87.9	43.6	52.9	43	41.5	6	369
1982	11.3	13.1	6.4	13.9	33.7	13.3	62.7	22.4	31.7	25.4	22	13.2	269
1983	30.1	27.2	3.3	5.8	29	50.3	53.8	82.2	26	20.6	6.6	11.3	346
1984	24.1	23.6	8.2	8.5	33.5	27	44.6	48.7	25	14.4	14.7	28.9	301
1985	27.6	17	5.6	8.9	20.5	69.8	88.4	48.8	28.5	23.1	17.2	10.9	366
1986	27.7	4.7	16.9	5.8	30	47.4	73	44.5	8	9	20.9	14.5	302
1987	11.7	25.7	8.3	9.2	22.3	26.6	53.4	34.6	43.1	42.9	32.4	25.2	335

Table 2: Pelly River Ranch Total Precipitation (mm) (....continued)

Year\Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1988	12.4	14.8	13.9	4.1	23.8	26.2	68.8	28.6	9.8	26.6	22	21.3	272
1989	14	6	5.6	0.2	32.6	49.1	13.1	20.4	23.8	18.6	35.9	12	231
1990	11.6	21.9	6.8	1.6	48.4	57	13	41	45	34	23.2	40	344
1991	16.6	23.8	9.9	4	25.1	30	47.8	34.7	43	23.4	40.1	30	328
1992	32	11.2	16	46.6	28.2	32.2	44.3	47.4	56.4	39.2	31	19.4	404
1993	24.9	6.8	34.4	8.8	18.4	16.8	61.9	40	20.8	28.1	34.8	7	303
1994	24.6	4.8	15.9	7.7	37.8	53.6	36.2	8.6	21.6	27.4	27.4	3.6	269
1995	5.8	12.4	4.6	0.2	16.8	31.8	84.4	78.2	10.6	22.9	15.8	22.4	306
1996	12.8	16.6	9.9	16.6		27.9	67.2	58.2	33.6	32.8	6.2	23.4	
1997	7.6	17	18.4	12.6	81.6	50.6	80.6	36	29.4	30	24.7	18.2	407
1998	12.6	1.8	2.8	2.4	6.4	40.6	19.4	21.4	30.6	12.1	14	22.8	187
1999	21.2	21	8.2	12.4	19.8	63	28.2	57.2	35.2	38.4	33.9	31.8	370
2000	33.2	7.4	9.6	12.4	32.6	45.7	81.2	78.6	84.4	15.6	26.4	13.8	441
2001	16	7	5.6	12.6	12.3	47.8	99.4	36.4	23	22	23.2	12.4	318
2002	22.2	14.8	3.8	12.2	26.9	23.4	74.8	74.6	9	13.6	18	27.8	321
2003	8.7	13.4	15.2	3	13.6	35	52.6	26.8	20.4	9.8	50.6	34	283
2004	48.7	36.5	26.9	3.9	19.2	20.6	44.4	3.8	70.7	25.8	33.8	23	357
2005	25.8	15.9	3	1.4	33.6	51	83.7	21.6	28.2	37.2	42.5	5.5	349
2006	24.4	3.6	12.5	4.7	19.9	31.4	42.6	38.8	11.6	14.4	12.5	25.4	242
2007	19.3	7.4	29.8	3.8	3	36.8	50.7	24.5	51	23.9	18.8	26	295
2008	22	8.9	1.9	17.3	9.2	22.6	73.8	105.4	42.4	25.8		20.8	350
Max	48.7	37.5	34.4	46.6	81.6	71.0	117.9	105.4	84.4	54.1	61.1	48.3	441
Mean	20.3	14.3	11.3	10.0	22.5	36.1	54.0	38.4	28.8	23.3	24.4	21.3	304.1
Min	4.8	1.8	0.3	0.2	3.0	3.3	5.4	3.8	2.8	2.4	6.2	1.8	187
Count	55	55	54	54	53	55	55	55	55	55	55	56	51
Standard Deviation	10.8	8.4	8.3	8.3	13.9	15.7	25.2	21.3	16.7	12.4	10.2	10.7	53.0
Sum of Average Months													304.7
Average of Completed Years													**304.1**

Table 3: Pelly River Ranch Total Rainfall (mm)

Year\Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1951												0	
1952	0	0	0	0	6.5	6.2	40.7	17.9	19.3	2.6	0	5.1	98
1953													
1954													
1955	0	0	0	0	7.1	43.3	14	86	10.4	1.6	0	0	162
1956	0	0		0	40.1	45	48.5	41	2.6	16	0	0	
1957	0	0	0	7.7	15.4	12.8	34.9	19.6	13.4	0	2.5	0	106
1958	0	0	0	0	14.3	33.5	62	67.1	12.9	4.6	0	0	194
1959	0	0	0	0	18.7	46.8	29	37.7	25.4	0	0	0	158
1960	0	0	0	2.3	18.7	26.7	117.9	36.6	28.5	7.5	0.3	0	239
1961	0	0	0	0	23.5	45.1	44.5	26	18.3	12.5	0	0	170
1962	0	0	0	20.8	16.3	56	35.7	39.5	13	5.1	0	0	186
1963	0	0	0	5.1		47.4	58.7	18.6	35.1	14.6	0	0	
1964	0	0	0	0	19.9	53.8	88.2	31	21.2	4.6	0	0	219
1965	0	0	0	0.3	14	30.1	42.1	17.7	40.7	10.5	0	0	155
1966	0	0	0		5.9	28.3	7.2	20.5	16.1	8.8	0	0	
1967	0	0	0	1.3	16.6	46.2	65.1	56.3	28.6	8.6	1.3	0	224
1968	0	0	2.5	5.1	25.2	21.6	29.9	25.8	50.9	0	0	0	161
1969	0	0	0	0.8	30.7	3.3	81.7	12.3	22.8	1.6	0	0	153
1970	0	0	0	1	47.6	24.4	5.4	42.7	41.6	12	2.5	0	177
1971	0	0	0	1	7.4	11.7	24.2	45	22.2	4.1	0	0	116
1972	0	0	0	0	13	71	47.4	23.2	17.5	2.8	0	0	175
1973	0.0	0.0	0.0	22.3	5.2	51.0	47.6	54.1	8.7	1.5	0.0	0.0	190
1974	0	0	0	0.8	6.3	14.8	66	31.7	8.7	12.7	0	0	141
1975	0	0	0	7.4	13.8	16.5	71.8	29	32.3	3.3	0	0	174
1976	0	0	0	0	43	37.5	46.7	19.3	14.6	2.3	2	0	165
1977	0.0	0.3	0.0	1.8	24.2	44.8	30.3	18.3	14.9	16.8	0.0	0.0	151
1978	0	0	0	4	17.8	33.4	100	46.7	23.8	0.5	0	0	226
1979	0	0	2.5	0	29.5	47.7	54.1	10.2	33.5	2.2	10	0	190
1980	0	0	0	3.2	9.2	24.8	44.4	33	49.9	11.2	0	0	176
1981	0	0	0.8	7.6	13.2	33.3	87.9	43.6	50.9	31.4	0	0	269
1982	0	0	0	0	33.7	13.3	62.7	22.4	31.7	2.3	0	0	166
1983	0	0	0	4.8	29	50.3	53.8	82.2	23.7	9.8	0	0	254
1984	0	0	0	3.4	33.5	27	44.6	47.7	25	8.7	0	0	190
1985	0	0	0	0	20.5	69.8	88.4	48.8	28.5	2.4	0	0	258
1986	0	0	0	0	30	47.4	73	44.5	8	9	0	0	212
1987	0	0	2	2	17.9	26.6	53.4	34.6	43.1	33.4	0	0	213
1988	0	0	0	2.9	23.8	26.2	68.8	28.6	9.6	0	0	0	160

Table 3: Pelly River Ranch Total Rainfall (mm) (....continued)

Year\Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1989	0	0	0	0.2	32.6	49.1	13.1	20.4	21	2.8	0	0	139
1990	0	0	0	0.6	48.4	57	13	41	45	12.4	0	0	217
1991	0	0	0	0	25.1	30	47.8	34.7	43	14.6	0	0	195
1992	0	0	0.8	18	24.4	32.2	44.3	47.4	34.2	2.6	0	0	204
1993	0	0	0	7.8	18.4	16.8	61.9	40	18.8	14.2	0	0	178
1994	0	0	0	1.4	37.8	53.6	36.2	8.6	21.6	7.4	0	0	167
1995	0	0	0.4	0.2	16.8	31.8	84.4	78.2	10.6	14.6	0	0	237
1996	0	0	0	7.6		27.9	67.2	58.2	33.6	0	0	0	
1997	0	0	0	5.8	81.6	50.6	80.6	36	29.4	0	0	0	284
1998	0	0	0	0	6.4	40.6	19.4	21.4	25.8	3	0	0	117
1999	0	0	0	5.4	19.8	62.8	28.2	57.2	25.2	6.6	0	0	205
2000	0	0	0	7	32.6	45.7	81.2	78.6	77.6	0.4	0	0	323
2001	0	0	0	9.4	12.3	47.8	99.4	36.4	23	5.4	0	0	234
2002	0	0	0	8.2	26.9	23.4	74.8	74.6	9	9.6	0	0	227
2003	0	0	0	0	10.2	35	52.6	26.8	10.4	0.8	0	0	136
2004	0	0	0	0.8	19.2	20.6	44.4	3.8	64.5	6.6	0.6	0.4	161
2005	0	0	0	1.4	33.6	51	83.7	21.6	28.2	22.2	0	0	242
2006	0	0	0	2.9	19.9	31.4	42.6	38.8	11.6	7.4	0	0	155
2007	0	0	0	2.4	3	36.8	50.7	24.5	51	4	0	0	172
2008	0	0	0	1	9.2	22.6	73.8	105.4	37.4	14.8	0	0	264
Max	0	0.3	2.5	22.3	81.6	71.0	117.9	105.4	77.6	33.4	10	5.1	323
Mean	0.0	0.0	0.2	3.4	22.1	36.1	54.0	38.4	26.7	7.5	0.3	0.1	189.9
Min	0	0	0	0.0	3.0	3.3	5.4	3.8	2.6	0	0.0	0	98
Count	55	55	54	54	53	55	55	55	55	55	55	56	51
Standard Deviation	0.0	0.0	0.6	5.0	13.9	15.7	25.2	21.3	15.3	7.3	1.4	0.7	47.0
Sum of Average Months													188.8
Average of Completed Years													189.9

Table 4: Pelly River Ranch Total Snowfall (mm)

Year\Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1951												48.3	
1952	48.4	5.1	6.4	2.6	0	0	0	0	4.1	0	18.9	27.6	113
1953													
1954													
1955	22.4	5.4	8.2	0	0	0	0	0	0.3	3.3	26.4	23.9	90
1956	12.8	11.8		6.8	0	0	0	0	0.3	22	33.2	17.9	
1957	14.7	24	13.7	0.3	0	0	0	0	6.4	2.4	30.9	21.1	114
1958	20.9	16.4	1.3	3.1	0	0	0	0	4.3	40.9	35.1	12.5	135
1959	10.2	21.2	24.6	10.7	0.5	0	0	0	0	6.4	20.2	14.6	108
1960	11.3	15.3	12.8	2.8	0	0	0	0	0	1.1	24.1	17.8	85
1961	13.5	10.9	11.3	6.7	0	0	0	0	0	29.6	24.4	29.2	126
1962	25.4	17.3	4.1	4.1	0	0	0	0	0	1.3	15	38	105
1963	47.7	7.4	10.7	6		0	0	0	0	12.8	14.7	47.7	
1964	24.2	19.1	16.6	15.9	6.3	0	0	0	0	15.3	19	20.3	137
1965	12.4	10	5.1	3.3	0	0	0	0	0	32	17.8	24.9	106
1966	7.6	26.1	6.6		0	0	0	0	0	26.7	61.1	10.4	
1967	37.8	26.7	31.6	12.9	0	0	0	0	0	4.4	15.1	18.7	147
1968	31	12.3	17.4	10.7	0	0	0	0	8.9	14.4	27.4	10.8	133
1969	11.8	3.7	14.6	11.2	0	0	0	0	0	6.4	25.5	14.5	88
1970	8.4	15.9	2.1	6.6	1.3	0	0	0	8.6	23.4	23.2	35.3	125
1971	4.8	6.6	7.8	3.8	0	0	0	0	0	24.4	28.7	40.8	117
1972	23.3	13.7	7.9	12.7	1.8	0	0	0	6.1	51.3	20.3	12.3	149
1973	25.4	12.4	17.8	8.0	0.0	0.0	0.0	0.0	0.0	15.8	22.7	34.3	136
1974	4.8	37.5	9.6	18.3	1	0	0	0	0	15.3	14.1	30.6	131
1975	20.3	4.6	0.3	10.9	0	0	0	0	0	17.7	15.9	12.3	82
1976	30.7	14.2	27	10.7	0	0	0	0	0	13	22.1	13.8	132
1977	31.1	3.8	16.8	23.2	0.0	0.0	0.0	0.0	0.0	1.3	21.7	11.7	110
1978	10.8	3.3	3.4	8.9	0	0	0	0	0	24.2	23.7	26.9	101
1979	23.8	19.5	18.4	4.6	0	0	0	0	0	1.8	8.9	17.6	95
1980	24.3	11.5	2.8	0	0	0	0	0	3.5	6.4	21.5	1.8	72
1981	5.4	27	3.5	3.4	0	0	0	0	2	11.6	41.5	6	100
1982	11.3	13.1	6.4	13.9	0	0	0	0	0	23.1	22	13.2	103
1983	30.1	27.2	3.3	1	0	0	0	0	2.3	10.8	6.6	11.3	93
1984	24.1	23.6	8.2	5.1	0	0	0	1	0	5.7	14.7	28.9	111
1985	27.6	17	5.6	8.9	0	0	0	0	0	20.7	17.2	10.9	108
1986	27.7	4.7	16.9	5.8	0	0	0	0	0	0	20.9	14.5	91
1987	11.7	25.7	6.3	7.2	4.4	0	0	0	0	9.5	32.4	25.2	122
1988	12.4	14.8	13.9	1.2	0	0	0	0	0.2	26.6	22	21.3	112

Table 4: Pelly River Ranch Total Snowfall (mm) (....continued)

Year\Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1989	14	6	5.6	0	0	0	0	0	2.8	15.8	35.9	12	92
1990	11.6	21.9	6.8	1	0	0	0	0	0	21.6	23.2	40	126
1991	16.6	23.8	9.9	4	0	0	0	0	0	8.8	40.1	30	133
1992	32	11.2	15.2	28.6	3.8	0	0	0	22.2	36.6	31	19.4	200
1993	24.9	6.8	34.4	1	0	0	0	0	2	13.9	34.8	7	125
1994	24.6	4.8	15.9	6.3	0	0	0	0	0	20	27.4	3.6	103
1995	5.8	12.4	4.2	0	0	0	0	0	0	8.3	15.8	22.4	69
1996	12.8	16.6	9.9	9	0	0	0	0	0	32.8	6.2	23.4	111
1997	7.6	17	18.4	6.8	0	0	0	0	0	30	24.7	18.2	123
1998	12.6	1.8	2.8	2.4	0	0	0	0	4.8	9.1	14	22.8	70
1999	21.2	21	8.2	7	0	0.2	0	0	10	31.8	33.9	31.8	165
2000	33.2	7.4	9.6	5.4	0	0	0	0	6.8	15.2	26.4	13.8	118
2001	16	7	5.6	3.2	0	0	0	0	0	16.6	23.2	12.4	84
2002	22.2	14.8	3.8	4	0	0	0	0	0	4	18	27.8	95
2003	8.7	13.4	15.2	3	3.4	0	0	0	10	9	50.6	34	147
2004	48.7	36.5	26.9	3.1	0	0	0	0	6.2	19.2	33.2	22.6	196
2005	25.8	15.9	3	0	0	0	0	0	0	15	42.5	5.5	108
2006	24.4	3.6	12.5	1.8	0	0	0	0	0	7	12.5	25.4	87
2007	19.3	7.4	29.8	1.4	0	0	0	0	0	19.9	18.8	26	123
2008	22	8.9	1.9	16.3	0	0	0	0	5	11	0	20.8	86
Max	48.7	37.5	34.4	28.6	6.3	0.2	0	1	22.2	51.3	61.1	48.3	200
Mean	20.3	14.3	11.2	6.6	0.4	0.0	0.0	0.0	2.1	15.8	24.0	21.2	114.1
Min	4.8	1.8	0.3	0.0	0.0	0	0	0	0	0	0.0	1.8	69
Count	55	55	54	54	54	55	55	55	55	55	55	56	52
Standard Deviation	10.8	8.4	8.2	6.0	1.2	0.0	0.0	0.1	4.0	11.3	10.8	10.7	27.4
Sum of Average Months													115.8
Average of Completed Years													114.1

Table 5: Pelly River Ranch Wet Period Precipitation

																			Winter Precipitation			
	Maximum One Months						Maximum Two Months					Maximum Three Months				Maximum 4 Months			Maximum 5 Months	Maximum 6 Months	Maximum 7 Months	Maximum 8 Months	Maximum 12-Months
Year\Month	May	Jun	Jul	Aug	Sep	Max	M/J	J/J	J/A	A/S	Max	M/J/J	J/J/A	J/A/S	Max	M/J/J/A	J/J/A/S	Max	M/J/J/A/S	Oct - March	Oct - Apr	Oct - May	Oct - September
1951																							
1952	6.5	6.2	40.7	17.9	23.4	**40.7**	12.7	46.9	58.6	41.3	**58.6**	53.4	64.8	82.0	**82.0**	71.3	88.2	**88.2**	**94.7**				
1953																							
1954																							
1955	7.1	43.3	14	86	10.7	**86.0**	50.4	57.3	100	96.7	**100.0**	64.4	143.3	110.7	**143.3**	150.4	154	**154.0**	**161.1**				
1956	40.1	45	48.5	41	2.8	**48.5**	85.1	93.5	89.5	43.8	**93.5**	133.6	134.5	92.3	**134.5**	174.6	137.3	**174.6**	**177.4**	**79.8**	**86.6**	**126.7**	**264.0**
1957	15.4	12.8	34.9	19.6	19.8	**34.9**	28.2	47.7	54.5	39.4	**54.5**	63.1	67.3	74.3	**74.3**	82.7	87.1	**87.1**	**102.5**	**140.7**	**148.7**	**164.1**	**251.2**
1958	14.3	33.5	62	67.1	17.2	**67.1**	47.8	95.5	129.1	84.3	**129.1**	109.8	162.6	146.3	**162.6**	176.9	179.8	**179.8**	**194.1**	**95.5**	**98.6**	**112.9**	**292.7**
1959	19.2	46.8	29	37.7	25.4	**46.8**	66	75.8	66.7	63.1	**75.8**	95	113.5	92.1	**113.5**	132.7	138.9	**138.9**	**158.1**	**149.1**	**159.8**	**179.0**	**317.9**
1960	18.7	26.7	117.9	36.6	28.5	**117.9**	45.4	144.6	154.5	65.1	**154.5**	163.3	181.2	183	**183.0**	199.9	209.7	**209.7**	**228.4**	**80.6**	**85.7**	**104.4**	**314.1**
1961	23.5	45.1	44.5	26	18.3	**45.1**	68.6	89.6	70.5	44.3	**89.6**	113.1	115.6	88.8	**115.6**	139.1	133.9	**139.1**	**157.4**	**86.5**	**93.2**	**116.7**	**250.6**
1962	16.3	56	35.7	39.5	13	**56.0**	72.3	91.7	75.2	52.5	**91.7**	108	131.2	88.2	**131.2**	147.5	144.2	**147.5**	**160.5**	**142.5**	**167.4**	**183.7**	**327.9**
1963		47.4	58.7	18.6	35.1	**58.7**	47.4	106.1	77.3	53.7	**106.1**	106.1	124.7	112.4	**124.7**	124.7	159.8	**159.8**	**159.8**	**125.2**	**136.3**	**136.3**	**296.1**
1964	26.2	53.8	88.2	31	21.2	**88.2**	80	142	119.2	52.2	**142.0**	168.2	173	140.4	**173.0**	199.2	194.2	**199.2**	**220.4**	**149.8**	**165.7**	**191.9**	**386.1**
1965	14	30.1	42.1	17.7	40.7	**42.1**	44.1	72.2	59.8	58.4	**72.2**	86.2	89.9	100.5	**100.5**	103.9	130.6	**130.6**	**144.6**	**86.7**	**90.3**	**104.3**	**234.9**
1966	5.9	28.3	7.2	20.5	16.1	**28.3**	34.2	35.5	27.7	36.6	**36.6**	41.4	56	43.8	**56.0**	61.9	72.1	**72.1**	**78.0**	**125.5**	**125.5**	**131.4**	**203.5**
1967	16.6	46.2	65.1	56.3	28.6	**65.1**	62.8	111.3	121.4	84.9	**121.4**	127.9	167.6	150	**167.6**	184.2	196.2	**196.2**	**212.8**	**203.1**	**217.3**	**233.9**	**430.1**
1968	25.2	21.6	29.9	25.8	59.8	**59.8**	46.8	51.5	55.7	85.6	**85.6**	76.7	77.3	115.5	**115.5**	102.5	137.1	**137.1**	**162.3**	**111.2**	**127.0**	**152.2**	**289.3**
1969	30.7	3.3	81.7	12.3	22.8	**81.7**	34	85	94	35.1	**94.0**	115.7	97.3	116.8	**116.8**	128	120.1	**128.0**	**150.8**	**82.7**	**94.7**	**125.4**	**245.5**
1970	48.9	24.4	5.4	42.7	50.2	**50.2**	73.3	29.8	48.1	92.9	**92.9**	78.7	72.5	98.3	**98.3**	121.4	122.7	**122.7**	**171.6**	**74.4**	**82.0**	**130.9**	**253.6**
1971	7.4	11.7	24.2	45	22.2	**45.0**	19.1	35.9	69.2	67.2	**69.2**	43.3	80.9	91.4	**91.4**	88.3	103.1	**103.1**	**110.5**	**115.6**	**120.4**	**127.8**	**230.9**
1972	14.8	71	47.4	23.2	23.6	**71.0**	85.8	118.4	70.6	46.8	**118.4**	133.2	141.6	94.2	**141.6**	156.4	165.2	**165.2**	**180.0**	**142.9**	**155.6**	**170.4**	**335.6**
1973	5.2	51.0	47.6	54.1	8.7	**54.1**	56.2	98.6	101.7	62.8	**101.7**	103.8	152.7	110.4	**152.7**	157.9	161.4	**161.4**	**166.6**	**142.3**	**172.6**	**177.8**	**339.2**
1974	7.3	14.8	66	31.7	8.7	**66.0**	22.1	80.8	97.7	40.4	**97.7**	88.1	112.5	106.4	**112.5**	119.8	121.2	**121.2**	**128.5**	**126.2**	**145.3**	**152.6**	**273.8**
1975	13.8	16.5	71.8	29	32.3	**71.8**	30.3	88.3	100.8	61.3	**100.8**	102.1	117.3	133.1	**133.1**	131.1	149.6	**149.6**	**163.4**	**97.9**	**116.2**	**130.0**	**279.6**
1976	43	37.5	46.7	19.3	14.6	**46.7**	80.5	84.2	66	33.9	**84.2**	127.2	103.5	80.6	**127.2**	146.5	118.1	**146.5**	**161.1**	**121.1**	**131.8**	**174.8**	**292.9**
1977	24.2	44.8	30.3	18.3	14.9	**44.8**	69	75.1	48.6	33.2	**75.1**	99.3	93.4	63.5	**99.3**	117.6	108.3	**117.6**	**132.5**	**105.2**	**130.2**	**154.4**	**262.7**
1978	17.8	33.4	100	46.7	23.8	**100.0**	51.2	133.4	146.7	70.5	**146.7**	151.2	180.1	170.5	**180.1**	197.9	203.9	**203.9**	**221.7**	**69.0**	**81.9**	**99.7**	**303.6**
1979	29.5	47.7	54.1	10.2	33.5	**54.1**	77.2	101.8	64.3	43.7	**101.8**	131.3	112	97.8	**131.3**	141.5	145.5	**145.5**	**175.0**	**139.5**	**144.1**	**173.6**	**319.1**
1980	9.2	24.8	44.4	33	53.4	**53.4**	34	69.2	77.4	86.4	**86.4**	78.4	102.2	130.8	**130.8**	111.4	155.6	**155.6**	**164.8**	**79.1**	**82.3**	**91.5**	**247.1**
1981	13.2	33.3	87.9	43.6	52.9	**87.9**	46.5	121.2	131.5	96.5	**131.5**	134.4	164.8	184.4	**184.4**	178	217.7	**217.7**	**230.9**	**77.6**	**88.6**	**101.8**	**319.5**
1982	33.7	13.3	62.7	22.4	31.7	**62.7**	47	76	85.1	54.1	**85.1**	109.7	98.4	116.8	**116.8**	132.1	130.1	**132.1**	**163.8**	**121.3**	**135.2**	**168.9**	**299.0**
1983	29	50.3	53.8	82.2	26	**82.2**	79.3	104.1	136	108.2	**136.0**	133.1	186.3	162	**186.3**	215.3	212.3	**215.3**	**241.3**	**121.2**	**127.0**	**156.0**	**368.3**
1984	33.5	27	44.6	48.7	25	**48.7**	60.5	71.6	93.3	73.7	**93.3**	105.1	120.3	118.3	**120.3**	153.8	145.3	**153.8**	**178.8**	**94.4**	**102.9**	**136.4**	**281.7**
1985	20.5	69.8	88.4	48.8	28.5	**88.4**	90.3	158.2	137.2	77.3	**158.2**	178.7	207	165.7	**207.0**	227.5	235.5	**235.5**	**256.0**	**108.2**	**117.1**	**137.6**	**373.1**
1986	30	47.4	73	44.5	8	**73.0**	77.4	120.4	117.5	52.5	**120.4**	150.4	164.9	125.5	**164.9**	194.9	172.9	**194.9**	**202.9**	**100.5**	**106.3**	**136.3**	**309.2**
1987	22.3	26.6	53.4	34.6	43.1	**53.4**	48.9	80	88	77.7	**88.0**	102.3	114.6	131.1	**131.1**	136.9	157.7	**157.7**	**180.0**	**90.1**	**99.3**	**121.6**	**279.3**
1988	23.8	26.2	68.8	28.6	9.8	**68.8**	50	95	97.4	38.4	**97.4**	118.8	123.6	107.2	**123.6**	147.4	133.4	**147.4**	**157.2**	**141.6**	**145.7**	**169.5**	**302.9**
1989	32.6	49.1	13.1	20.4	23.8	**49.1**	81.7	62.2	33.5	44.2	**81.7**	94.8	82.6	57.3	**94.8**	115.2	106.4	**115.2**	**139.0**	**95.5**	**95.7**	**128.3**	**234.7**
1990	48.4	57	13	41	45	**57.0**	105.4	70	54	86	**105.4**	118.4	111	99	**118.4**	159.4	156	**159.4**	**204.4**	**106.8**	**108.4**	**156.8**	**312.8**
1991	25.1	30	47.8	34.7	43	**47.8**	55.1	77.8	82.5	77.7	**82.5**	102.9	112.5	125.5	**125.5**	137.6	155.5	**155.5**	**180.6**	**147.5**	**151.5**	**176.6**	**332.1**
1992	28.2	32.2	44.3	47.4	56.4	**56.4**	60.4	76.5	91.7	103.8	**103.8**	104.7	123.9	148.1	**148.1**	152.1	180.3	**180.3**	**208.5**	**152.7**	**199.3**	**227.5**	**407.8**
1993	18.4	16.8	61.9	40	20.8	**61.9**	35.2	78.7	101.9	60.8	**101.9**	97.1	118.7	122.7	**122.7**	137.1	139.5	**139.5**	**157.9**	**155.7**	**164.5**	**182.9**	**322.4**
1994	37.8	53.6	36.2	8.6	21.6	**53.6**	91.4	89.8	44.8	30.2	**91.4**	127.6	98.4	66.4	**127.6**	136.2	120	**136.2**	**157.8**	**115.2**	**122.9**	**160.7**	**280.7**

Table 5: Pelly River Ranch Wet Period Precipitation (....continued)

																				Winter Precipitation		
	Maximum One Months						Maximum Two Months					Maximum Three Months				Maximum 4 Months			Maximum 5 Months	Maximum 6 Months	Maximum 7 Months	Maximum 8 Months	Maximum 12-Months
Year\Month	May	Jun	Jul	Aug	Sep	Max	M/J	J/J	J/A	A/S	Max	M/J/J	J/J/A	J/A/S	Max	M/J/J/A	J/J/A/S	Max	M/J/J/A/S	Oct - March	Oct - Apr	Oct - May	Oct - September
1995	16.8	31.8	84.4	78.2	10.6	**84.4**	48.6	116.2	162.6	88.8	**162.6**	133	194.4	173.2	**194.4**	211.2	205	**211.2**	**221.8**	**81.2**	**81.4**	**98.2**	**303.2**
1996		27.9	67.2	58.2	33.6	**67.2**	27.9	95.1	125.4	91.8	**125.4**	95.1	153.3	159	**159.0**	153.3	186.9	**186.9**	**186.9**	**100.4**	**117.0**	**117.0**	**303.9**
1997	81.6	50.6	80.6	36	29.4	**81.6**	132.2	131.2	116.6	65.4	**132.2**	212.8	167.2	146	**212.8**	248.8	196.6	**248.8**	**278.2**	**105.4**	**118.0**	**199.6**	**396.2**
1998	6.4	40.6	19.4	21.4	30.6	**40.6**	47	60	40.8	52	**60.0**	66.4	81.4	71.4	**81.4**	87.8	112	**112.0**	**118.4**	**90.1**	**92.5**	**98.9**	**210.9**
1999	19.8	63	28.2	57.2	35.2	**63.0**	82.8	91.2	85.4	92.4	**92.4**	111	148.4	120.6	**148.4**	168.2	183.6	**183.6**	**203.4**	**99.3**	**111.7**	**131.5**	**315.1**
2000	32.6	45.7	81.2	78.6	84.4	**84.4**	78.3	126.9	159.8	163	**163.0**	159.5	205.5	244.2	**244.2**	238.1	289.9	**289.9**	**322.5**	**154.3**	**166.7**	**199.3**	**489.2**
2001	12.3	47.8	99.4	36.4	23	**99.4**	60.1	147.2	135.8	59.4	**147.2**	159.5	183.6	158.8	**183.6**	195.9	206.6	**206.6**	**218.9**	**84.4**	**97.0**	**109.3**	**315.9**
2002	26.9	23.4	74.8	74.6	9	**74.8**	50.3	98.2	149.4	83.6	**149.4**	125.1	172.8	158.4	**172.8**	199.7	181.8	**199.7**	**208.7**	**98.4**	**110.6**	**137.5**	**319.3**
2003	13.6	35	52.6	26.8	20.4	**52.6**	48.6	87.6	79.4	47.2	**87.6**	101.2	114.4	99.8	**114.4**	128	134.8	**134.8**	**148.4**	**96.7**	**99.7**	**113.3**	**248.1**
2004	19.2	20.6	44.4	3.8	70.7	**70.7**	39.8	65	48.2	74.5	**74.5**	84.2	68.8	118.9	**118.9**	88	139.5	**139.5**	**158.7**	**206.5**	**210.4**	**229.6**	**369.1**
2005	33.6	51	83.7	21.6	28.2	**83.7**	84.6	134.7	105.3	49.8	**134.7**	168.3	156.3	133.5	**168.3**	189.9	184.5	**189.9**	**218.1**	**127.3**	**128.7**	**162.3**	**346.8**
2006	19.9	31.4	42.6	38.8	11.6	**42.6**	51.3	74	81.4	50.4	**81.4**	93.9	112.8	93	**112.8**	132.7	124.4	**132.7**	**144.3**	**125.7**	**130.4**	**150.3**	**274.7**
2007	3	36.8	50.7	24.5	51	**51.0**	39.8	87.5	75.2	75.5	**87.5**	90.5	112	126.2	**126.2**	115	163	**163.0**	**166.0**	**108.8**	**112.6**	**115.6**	**278.6**
2008	9.2	22.6	73.8	105.4	42.4	**105.4**	31.8	96.4	179.2	147.8	**179.2**	105.6	201.8	221.6	**221.6**	211	244.2	**244.2**	**253.4**	**101.5**	**118.8**	**128.0**	**372.2**
Max	81.6	71.0	117.9	105.4	84.4	117.9	132.2	158.2	179.2	163.0	179.2	212.8	207.0	244.2	244.2	248.8	289.9	289.9	322.5	206.5	217.3	233.9	489.2
Mean	22.5	36.1	54.0	38.4	28.8	63.9	57.8	90.1	92.4	67.3	104.3	111.8	128.5	121.2	138.6	150.2	157.3	162.1	179.0	114.7	124.9	147.1	305.8
Min	3.0	3.3	5.4	3.8	2.8	28.3	12.7	29.8	27.7	30.2	36.6	41.4	56.0	43.8	56.0	61.9	72.1	72.1	78.0	69.0	81.4	91.5	203.5
Count	53.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	53.0	53.0	53.0	53.0
Standard Deviation	13.9	15.7	25.2	21.3	16.7	19.3	23.3	29.3	36.1	26.8	30.8	34.1	39.8	39.3	38.7	42.9	42.3	43.0	45.5	30.2	33.1	35.2	55.7

Table 6a: Snow Survey Data - Pelly Farm

Year	February-01	Mar-01	Apr-01	May-01	May-15
1986		**74**	**84**	70	0
1987		**73**	56	0	0
1988		88	**89**	0	0
1989		76	**77**	0	0
1990		**105**	89	0	0
1991		113	**116**	0	0
1992		95	**97**	31	0
1993		95	**113**	15	0
1994		**62**	60	0	0
1995		52	**52**	0	0
1996		50	**73**	0	
1997			**77**	9	
1998		**59**	**56**	0	
1999		54.0	**61**	0.0	0.0
2000		**78**	**82**	38	
2001		58	**70**	0	
2002		58	**67**	55	
2003		42	**48**	5	
2004		**122**	**112**	42	
2005		71	56	0	
Average		75	**76.8**	13.3	0.0
Max.		122	116	70	0
Min.		42	48	0	0
Number Of Maximums		6	14	0	
Average Maximum Snowpack					
1995 to 2004					**71.1**
1986 to 2004					**80.4**

Note: Snow Water Equivalents in mm Water.

Table 6b: Snow Survey Data - Williams Creek

Year	February-01	Mar-01	Apr-01	May-01	May-15
1995		55	**78**	20	
1996		79	**88**	17	
1997		84	**93**	59	
1998		80	**92**	0	
1999		73	**91**	36	0
2000		76	**82**	84	
2001		**99**	**99**	72	
2002		78	**84**	31	
2003		**44**	43	11	
2004		108	**137**	124	
2005		**79**	78	0	
Average		77.7	**87.7**	41.3	
Max.		108	137	124	
Min.		44	43	0	
No. Of Maximums		6	14	0	
Average Maximum Snowpack					
1986 to 2004					**89**

Note: Snow Water Equivalents in mm Water.

Table 7: Wet and Dry Year Precipitation, Rainfall and Snowfall - Williams Creek Site

Condition	Return Period (Year)	Annual Percent Probability	Pelly Ranch Total Precipitation [1]	Williams Creek Total Precipitation[2]	Williams Creek Rainfall[3]	Williams Creek Snowfall[3]
Dry	20	95.0%	228	257	150	107
	5	80.0%	259	292	170	122
Median	2	50.0%	299	338	197	141
Wet	5	20.0%	349	394	229	164
	10	10.0%	379	428	249	178
	20	5.0%	407	459	268	191
	50	2.0%	441	498	290	208
	100	1.0%	466	526	307	219
	200	0.5%	490	553	323	231
	500	0.2%	522	589	343	245

Notes:

1) Frequency analysis results from 3 parameter log normal distribution for Pelly Ranch 1952 to 2008. Elevation 454 m.
2) Williams Creek total annual precipitation estimated assuming 3.24% increase per 100 m elevation increase between Pelly River Ranch and Williams Creek equal to a factor of 1.1282 times Precipitation at Pelly Ranch. Elevation 850 m.
3) Rainfall and Snowfall for extreme years above estimated assuming Rainfall = 58.3% of total precipitation and Snowfall = 41.7% of Annual total precipitation.

Table 8: Summary of Wet Period Orographic Factors

Wet Period Starts	Wet Period Ends	Wet Period Duration	Type of Precipitation	Orographic Factor
October 1	March 31	6 months	Snowfall only	1.2522
	April 30	7	Snowfall only	1.2522
	May 31	8	Snowfall and Rain	1.23*
	June 30	9	Snowfall and Rain	1.20*
	July 31	10	Snowfall and Rain	1.18*
	August 31	11	Snowfall and Rain	1.15*
	September 30	12	Snowfall and Rain	1.1282
Any Day May to September		**One Day**	**Rainfall only**	**1.3**
May 1	May 31	1 month	Rainfall only	1.11
	June 30	2	Rainfall only	1.10*
	July 31	3	Rainfall only	1.08*
	August 31	4	Rainfall only	1.07*
	September 30	5	Rainfall only	1.0545

Notes:

1) Value for Pelly Ranch times Orographic Factor equals values for Williams Creek.
2) * Values are interpolated.

Table 9a: Pelly River Ranch

				Wet Periods Starting on May 1					Dry Periods Starting on October 1			Annual
Condition	**Return Period (Year)**	**Annual Percent Probability**	**One Day**	**1-Month Rainfall**	**2-Month Rainfall**	**3-Month Rainfall**	**4-Month Rainfall**	**5-Month Rainfall**	**6-Month Snowfall**	**7-Month Snowfall**	**8-Month Snowfall**	**12-Month Snowfall**
Dry	20	95.0%	9.3	37	59	81	98	110	77	84	100	228
	5	80.0%	13.5	48	78	106	126	140	89	97	117	259
Median	2	50.0%	18.7	61	102	135	159	176	109	117	141	299
Wet	5	20.0%	24.8	79	129	170	197	216	137	149	174	349
	10	10.0%	28.4	90	145	190	219	239	156	172	195	379
	20	5.0%	31.6	100	159	208	238	258	175	195	216	407
	50	2.0%	35.5	113	176	229	262	282	200	227	242	441
	100	1.0%	38.3	123	188	245	278	298	220	252	262	466
	200	0.5%	40.9	133	200	259	294	314	240	279	282	490
	500	0.2%	44.3	145	215	278	314	333	268	316	308	522

Notes:

1) Orographic Factors (See Table CC6-9a Clearwater 2006) times Pelly River values equals Williams Creek Values.

2) Snowmelt for 6 to 8 month duration wet periods will allow for 20 mm sublimation loss from snowpack.

Table 9b: Williams Creek Site

				Wet Periods Starting on May 1					Dry Periods Starting on October 1			Annual
Condition	**Return Period (Year)**	**Annual Percent Probability**	**One Day**	**1-Month Rainfall**	**2-Month Rainfall**	**3-Month Rainfall**	**4-Month Rainfall**	**5-Month Rainfall**	**6-Month Snowfall**	**7-Month Snowfall**	**8-Month Snowfall**	**12-Month Snowfall**
	Ororaphic Factor		**1.3**	**1.11**	**1.10**	**1.08**	**1.07**	**1.0545**	**1.252**	**1.252**	**1.2300**	**1.1282**
Dry	20	95.0%	12.1	42	64	88	105	116	96	105	122	257
	5	80.0%	17.6	53	86	114	134	148	112	121	144	292
Median	2	50.0%	24.3	68	112	146	170	186	136	147	174	338
Wet	5 2	20.0%	32.2	87	142	183	210	228	171	186	214	394
	10 2	10.0%	36.9	100	160	205	234	252	195	215	240	428
	20 2	5.0%	41.1	111	175	224	255	272	219	244	265	459
	50 2	2.0%	46.2	126	194	248	280	297	251	284	298	498
	100 2	1.0%	49.8	137	207	264	298	314	276	316	322	526
	200 2	0.5%	53.2	147	220	280	315	331	301	349	347	553
	500 2	0.2%	57.6	161	236	300	336	351	336	396	379	589

Notes:

1) Orographic Factors (See Table CC6-9b Clearwater 2006) times Pelly River values equals Williams Creek Values.

2) Snowmelt for 6 to 8 month duration wet periods will allow for 20 mm sublimation loss from snowpack.

Table 10: Average Monthly Precipitation Conditions - Williams Creek Site

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Pelly River Ranch at Elevation 454 m													
Average Conditions - Monthly Depths - mm													
Average Rainfall	0.0	0.0	0.2	3.4	22.0	36.0	54.7	38.7	27.1	7.4	0.4	0.1	189.9
Average Snowfall	20.3	14.2	11.3	6.5	0.4	0.0	0.0	0.0	2.3	15.2	23.6	20.4	114.2
Average Precipitation	20.3	14.2	11.5	9.9	22.5	36.0	54.7	38.7	29.4	22.5	24.0	20.5	304.1
Percent per month of Total Annual Precipitation													
Average Rainfall	0.0%	0.0%	0.1%	1.1%	7.2%	11.8%	18.0%	12.7%	8.9%	2.4%	0.1%	0.0%	62.4%
Average Snowfall	6.7%	4.7%	3.7%	2.2%	0.1%	0.0%	0.0%	0.0%	0.8%	5.0%	7.8%	6.7%	37.6%
Total Precipitation	6.7%	4.7%	3.8%	3.3%	7.4%	11.8%	18.0%	12.7%	9.7%	7.4%	7.9%	6.7%	100.0%
Williams Creek Site at Elevation 850 m													
Percent per month of Total Annual Precipitation													
Average Rainfall	0.0%	0.0%	0.1%	1.0%	6.8%	11.1%	16.8%	11.9%	8.3%	2.3%	0.1%	0.0%	58.3%
Average Snowfall	7.4%	5.2%	4.1%	2.4%	0.2%	0.0%	0.0%	0.0%	0.8%	5.5%	8.6%	7.4%	41.7%
Total Precipitation	7.4%	5.2%	4.2%	3.4%	6.9%	11.1%	16.8%	11.9%	9.2%	7.8%	8.7%	7.5%	100.0%
Average Conditions - Monthly Depths - mm													
Average Rainfall	0.0	0.0	0.2	3.6	23.2	37.9	57.6	40.8	28.5	7.8	0.4	0.1	200.2
Average Snowfall	25.4	17.8	14.1	8.2	0.6	0.0	0.0	0.0	2.9	19.0	29.6	25.5	143.0
Average Precipitation	25.4	17.8	14.3	11.8	23.8	38.0	57.6	40.8	31.4	26.7	30.0	25.6	343.2

Notes: Williams Creek % per month for rainfall, snowfall, and Total Precipitation estimated assuming annual rainfall = 58.3% and annual snowfall = 41.7% of total precipitation.

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Western Copper Corporation

2009 ANNUAL QUARTZ MINING LICENCE REPORT

SUBMITTED TO YUKON GOVERNMENT, ENERGY MINES AND RESOURCES

YUKON QUARTZ MINING LICENCE QML-0007

Appendix F

Results of the 2008 Supplemental Geochemical Test Work on Waste Rock and Neutralized Spent Ore (March 2010)

March 26, 2010

CELEBRATING 50 YEARS in 2010

REPORT ON

Results of the 2008 Supplemental Geochemical Test Work on Waste Rock and Neutralized Spent Ore Carmacks Copper Project, Yukon Territory

Submitted to:
Western Copper Corporation
2050 – 1111 West Georgia
Vancouver, BC
V6E 4M3

Attention: Mr. John Clegg

REPORT

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Executive Summary

As part of the feasibility study for the Carmacks Copper Project (Carmacks), Golder Associates Ltd. (Golder) conducted a review of historic geochemical data characterizing the acid rock drainage (ARD) and metal leaching (ML) properties of the waste rock and ore materials to be mined during the proposed mine life.

Results of the data review indentified limitations in the historic data with respect to the number and types of tests conducted and the number and types of samples tested. Golder proposed a three phase supplemental waste rock and spent ore sampling and testing program that would address the limitations of the historic data. The first phase of the sampling and testing program (2007 waste rock) was conducted on waste rock samples collected from historic drill core (the result of which are described in detail under separate cover and used in this report for comparative purposes). Since most of the historic drilling was collared primarily in the hanging wall (east wall) of the pit, and inclined to the west, the shallow west wall of the pit lacked drilling and geochemical characterization. The second phase of the sampling and testing program (2008 waste rock) was conducted to characterize the shallow west wall of the pit. Samples were collected from geotechnical holes drilled during the 2008 geotechnical drilling program. The third phase of the supplemental sampling and testing program was conducted to characterize the geochemical properties of ore material in the heap, at closure, after the ore had been leached with acid, rinsed and then neutralized (neutralized spent ore). Eight samples of waste rock (seven granodiorite and one mixed gneiss/granodiorite) were collected for phase two and three samples of neutralized spent ore were collected for phase three. The waste rock and spent ore samples were characterized using: major and trace element whole rock analyses, short term leach testing using shake flask extraction (SFE), and acid base accounting (ABA) testing). The neutralized spent ore samples were additionally tested for their mineralogy and long term leach testing using humidity cell tests.

Results of the ABA tests show that the 2008 and 2007 granodiorite samples have low to undetectable concentrations of sulphur (*i.e.,* an absence of pyrite) and sufficient neutralization potential based on the bulk neutralizing potential (Bulk NP) to be considered non-acid generating. The ABA data for the 2008 and 2007 mixed gneiss/granodiorite samples suggest that the mixed gneiss/granodiorite rock type has insufficient bulk NP, and as such, are considered to be potentially acid generating. However it is emphasized that the gneiss either; occurs beneath the proposed pit bottom and is unlikely to be mined or, if mined, will be treated as ore and delivered to the heap leach pad. The ABA data for the neutralized spent ore samples suggest the samples have a range of acid generating potential. All of the samples are sulphate dominant and have low sulphide-sulphur concentrations. Based upon the Bulk NP, two samples of neutralized spent ore are non-acid generating while one sample is possibly acid generating.

The SFE leachates for the Golder 2008 and 2007 waste rock samples are near neutral (pH of 7.4 to 8.1). Although not directly applicable to laboratory test results, the metal concentrations in the SFE leachate metal are low, all below the respective Metal Mining Effluent Regulation (MMER) guidelines. The SFE leachates for the neutralized spent ore samples were acidic for one sample and slightly alkaline for the other two samples. The SFE leachates for all neutralized spent ore samples comply with the MMER guidelines, with the exception of pH for the one sample (acidic pH of 5.96 compared to 6.0).

Kinetic testing for two of the three neutralized spent ore samples began in March 2008 and kinetic testing for the third neutralized spent ore sample began on February 2009. All kinetic tests were terminated in March 2010 on cycle 100 and 55 for the March 2008 and February 2009 cells, respectively. Results of the kinetic tests show that the leachate derived from the neutralized spent ore samples are neutral to alkaline and within MMER guideline limits, with the exception of one of the samples which is slightly acidic and less than or equal to the minimum MMER guideline (pH of 6.0). MMER metals concentrations in the humidity cell leachate are all below the MMER - Maximum Monthly Mean concentration (the minimum guideline) and appear to be declining over time.

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1.0 INTRODUCTION

Western Copper Corporation (WCC) is advancing the plans to develop the Carmacks Copper mine (Carmacks), near Carmacks, Yukon Territory. M3 Engineering and Technology Corporation (M3) prepared an updated Feasibility Study for the Project for WCC and Golder Associates (Golder) assisted in the preparation of portions of the Feasibility Study.

As part of our role in the Feasibility Study, Golder conducted a review of historic geochemical data from Carmacks to characterize the acid rock drainage (ARD) and metal leaching (ML) properties of the waste rock and ore materials to be mined during the proposed 6 to 8 year mine life. Results of the data review identified several limitations (Golder, 2007a) in both the number and types of tests conducted and the type and number of samples tested. Golder proposed and WCC authorized a supplemental sampling and testing program (Golder, 2007b) to better characterize the ARD/ML properties of waste rock and neutralized spent ore.

The first phase of the supplemental sampling and testing program (2007 waste rock samples) was completed in March 2007 (Golder, 2007c). The 2007 samples were recovered from core collected from historic drill holes collared primarily in the hanging wall (east wall of the pit) and inclined to the west. As such, the deeper footwall rocks were sampled and characterized. With the exception of the 2007 samples collected from exploration holes collared in the footwall and drilled parallel to mineralization, the shallow west wall of the pit lacked drilling and geochemical samples.

The second phase of the supplemental sampling and testing program (2008 waste rock samples) was completed in November, 2008 and was intended to characterize the geochemical properties of the waste rock in the shallow west wall of the pit. The rock types in the shallow footwall of the Carmacks deposit are identical to those in the hanging wall, however, the 2008 samples complete the original objectives of the supplemental investigation (*i.e.,* to characterize all of the waste rock types across the entire deposit). Samples for the 2008 program were collected from geotechnical drill holes completed as part of the 2008 geotechnical drilling program.

The third phase of the supplemental sampling and testing program (neutralized spent ore samples) was intended to characterize the geochemical properties of ore in the heap at closure after: the ore had been leached with acid to recover the copper ore; rinsed to flush acid out of the heap; and then neutralized with alkalis to return the heap to a neutral pH (Golder, 2007d). Bulk samples of ore, representative of run-of-mine material, were collected by Access Consulting Group (ACG) (ACG, 2007) (Appendix I) for metallurgical testing conducted by Process Research Associates (PRA) after which the samples were neutralized and released for geochemical testing (PRA, 2009a and PRA, 2009b).

The objective of this report is to present the results of the second and third phases of the geochemical characterization program: static geochemical testing of waste rock from the shallow footwall of the Carmacks deposit and static and kinetic testing of neutralized spent ore.

Comparison of the static and kinetic results to water quality guidelines are provided for reference purposes only. The data presented in this report are not intended to characterize either the short-term or long-term performance at the site. However, the data presented in the report are the results of industry standard test procedures that can be used in conjunction with other models (*i.e.,* surface water discharge models) to estimate or predict discharge water quality.

2.0 GEOLOGY

The geology of the Carmacks deposit consists of two major rock types: granodiorite and gneiss (ACG, 2006); and volumetrically minor igneous textural subfacies. Alteration assemblages reported in the ACG summary include: silicate, oxide, and sulphate gangue mineral assemblages (primarily potassium feldspar, gypsum, and hematite); and oxide and sulphide mineralization. Alteration typically amounts to narrow veins and thin alteration salvages adjacent to veins rather than pervasive alteration haloes as observed in typical porphyry copper type deposits. For this reason, alteration assemblages were excluded in the rock model.

The ore is confined to the gneiss and so the oxide ore zone is synonymous with mineralized gneiss. The mine plan assumed only oxide ore will be mined and since the overburden over the ore zone is very thin, the rock type model consisted of granodiorite (waste rock) and gneiss (ore). The overburden and other igneous rock types were not included in the model. The model used the hanging wall and footwall contacts as surfaces to bound the mineralized zones. The hanging wall and footwall waste rock tonnages were not distinguished in the model results although geochemical samples were collected from both the footwall and hanging wall. The mineralized gneiss/granodiorite contact of the ore zone is reported to be very sharp and it is anticipated that the ore will be mined back to unmineralized granodiorite. Unmineralized or low grade gneiss or mixed gneiss/granodiorite is included in the ore reserve model as “ore” to be placed on the heap leach pad.

3.0 SAMPLING PROGRAM

The supplemental sampling and testing program was designed to augment existing test work in order to characterize the geochemical characteristics of all of the material including waste rock and neutralized spent ore that would be present at the Carmacks Project site at the time of closure. This includes both material present in the waste rock pile(s) and the heap leach pad.

3.1 Sample Selection

3.1.1 Waste Rock

The supplemental waste rock sampling plan consisted of 8 samples collected from three drill holes from the 2008 open pit geotechnical drilling program. Table 3.1 summarizes the samples collected for the 2008 testing program including the rock type, alteration, and mineralization from drill hole logs provided by WCC. Waste rock samples were collected by WCC staff at the beginning of 2008 and sent to Golder's warehouse in Burnaby, BC. Golder senior staff inspected the samples and shipped them to Canadian Environmental & Metallurgical Inc. (CEMI), in Vancouver, BC to be analysed.

Figure 3-1 shows the proposed pit outline, the collar locations of the 2006 and 2008 drill holes and the sampled drill holes for both the 2007 and 2008 supplemental sampling programs. Figure 3-2 to Figure 3-4 are cross-sections of areas along the drill hole traces for GA-01-08 (GA1), GA-02-08 (GA2), and GA-03-08 (GA3), respectively. These cross-sections include the drill hole traces, approximate locations of the 2008 geochemical samples, the sample ID (drill hole ID and footage), the pit outline, and geology. The geological data includes the location of the ore zones as well as the waste rock types used in the block model. The waste rock in the cross sections is simplified to include granodiorite (granodiorite, pegmatite, aplite and gneissic granodiorite) and gneiss (mixed gneiss and granodiorite and gneiss).

Table 3.1: Summary of 2008 Samples Collected for Geochemical Testing

Sample ID	Rock Type	Alteration	Mineralization
GA-01-08 50.5-52	Granodiorite	Fresh	None
GA-01-08 95-96	Granodiorite	Fresh	None
GA-02-08 55.5-57	Granodiorite	Veining (qz-k-spar, clay-calcite), Minor Clay Alt	None
GA-02-08 75-76.5	Granodiorite	Veining (qz-k-spar, clay-calcite), Minor Clay Alt	None
GA-02-08 95-96.5	Granodiorite	Veining (qz-k-spar, clay-calcite), Minor Clay Alt	None
GA-03-08 50-51.5	Granodiorite	Veining (k-spar/calcite/quartz)	None
GA-03-08 98.5-100	Granodiorite	Veining (k-spar/calcite/quartz)	None
GA-02-08 31-32.5	Mixed Gneiss/Granodiorite	Amphibolite	Chalcopyrite (1-2%)

Seven of the eight 2008 samples are from the footwall granodiorite lying structurally beneath the mineralization. The current samples are from roughly 50 to 100 m depths along the drill holes and are designed to characterize the waste rock mined rather than the rock outside of the pit boundary.

A single sample of mixed gneiss/granodiorite was collected as part of the program, as an additional representative sample of mixed gneiss/granodiorite to broaden the range of material types in the geochemical database. Sampling of gneiss is not considered part of the waste rock characterization study as the mineralization is fundamentally confined to the "gneiss" and WCC intends to selectively mine the gneiss as the marker for mineralization. Thus, the mixed gneiss/granodiorite unit represents ore rather than waste and as such will be delivered to the heap rather than the waste rock pile (WCC, personal communication, 2007).

3.1.2 Neutralized Spent Ore

Ore samples for metallurgical testing were collected by ACG (ACG, 2007) and details of the sampling procedure are provided in Appendix I. Bulk samples of ore, representative run-of-mine (ROM) material, were collected by ACG from four historic trenches using a Bobcat 863 loader (ACG, 2007). The material was collected either directly from the trench, where the trench was accessible, or from material stockpiled beside the trench. Approximately 350 kg of material were collected, to make up each bulk sample, and placed in a 200 litre steel drum. Table 3.2 lists the collection details for the ore samples used in the neutralized spent ore testing program.

Table 3.2: Collection Details for Ore Samples

Barrel	Trench Sampled	Collection Details
A	91-18	In trench
B	92-68	Historic trench composite pile
C	92-20	Historic trench composite pile
D	91-22	Historic trench composite pile

The ore material was sent to PRA for metallurgical testing where the bulk samples were mixed to make one composite sample. The composite sample of ore was crushed to a p80 of ½ inch material, loaded in columns (1 meter of material) leached with sulphuric acid to simulate ore recovery. To simulate closure, two columns were rinsed with water, rinsed with gypsum saturated water, neutralized with sodium carbonate, and then rinsed a final time (PRA, 2009a and PRA, 2009b). Two of the three spent ore samples were collected from within the same column test (Column 3) and one was collected from the second column (Column 6). One of the two samples from Column 3 was collected from the bottom portion (B1 (-1/2 inch)) of the column; and, the second sample was collected from the top portion (T1 (-1/2 inch. A single composite sample was collected from Column 6 (Col-6 (0700601) representing the entire height of the column. PRA sent the neutralized spent ore samples to Golder's warehouse in Burnaby, BC where Golder Senior staff inspected the samples and shipped them to Canadian Environmental & Metallurgical Inc. (CEMI), in Vancouver, BC for analysis.

4.0 GEOCHEMICAL TESTING

The section that follows discusses the tests and criteria used to evaluate the results. A more detailed discussion of the historic test work and the test protocols is included in Appendix II.

The 2007 test program for waste rock included a broad spectrum of static and kinetic testing. The 2008 waste rock test program was limited to static test work designed to be compatible with the static testing conducted in 2007 and to complete the overall waste rock characterization work at the Carmacks Project. Table 4.1 summarizes the testing and the number of tests for the waste rock samples.

Historic testing of neutralized spent ore samples was limited to a few tests on raw ore and unspecified material. The 2008 neutralized spent ore testing program included both static and kinetic tests of neutralized spent ore to characterize the overall geochemistry of the material in a consistent manner (*i.e.,* compatible with the testing conducted on the waste rock samples). Table 4.1 also includes the testing conducted for the spent ore samples.

Table 4.1: Summary Waste Rock and Spent Ore Samples

Geochemical Test Protocol	Waste Rock	Neutralized Spent Ore
Acid Base Accounting (ABA)	8	3
Whole Rock	8	3
24-hour Leach Tests	8	3
Kinetic Test	n/a	3
Mineralogy	n/a	2

4.1 Whole Rock Analysis

The whole rock major and trace element chemical composition of mineralized rock is used to identify samples with anomalous (*e.g.,* elevated or depleted) concentrations of metals when compared to equivalent, unmineralized rock. The application of whole rock analyses is based on the assumption that water in contact with unmineralized rock will have a “normal” chemical composition, meeting standard water quality guidelines. Elevated whole rock metal concentrations suggest the increased potential for metal leaching and elevated metal concentrations in the adjacent water. The actual availability of an element to leach depends upon factors not measured in the whole rock chemical analyses such as mineralogy or water rock interaction.

4.2 24-hour Leach Tests - Shake Flask Extraction (SFE)

The shake flask extraction test (SFE) is a short term leaching test (24 hours or less) that measures the solubility of acids and metals produced from readily solubilized mineral acidity and soluble salts (*e.g.,* oxidation products), respectively, within the sample.

4.3 Acid Base-Accounting (ABA)

ABA tests were performed to evaluate the ARD potential of the waste rock and neutralized spent ore material. The samples underwent a standard suite of ABA analyses, including the measurement of the paste pH, sulphur species (total sulphur - S_T, sulphate sulphur – S_{SO4}, and sulphide sulphur - S_{S-2}), total inorganic carbon (TIC), and carbonate and bulk neutralizing potentials ($CaCO_3$ NP and NP, respectively). From these parameters, derived functions were calculated to estimate the ARD potential of the samples: acid generating potential (AP), net neutralizing potential (NNP = NP – AP or $CaCO_3$ NNP = $CaCO_3$NP – AP) and acid neutralizing potential ratio (NPR = NP/AP or $CaCO_3$NPR = $CaCO_3$NP/AP). Each of these parameters and functions is discussed in detail in Appendix II.

4.4 Mineralogy

Two of the three neutralized spent ore samples (B1 and T1) were analysed for their mineralogy using the Rietveld method of quantitative X-Ray Diffraction (XRD) analysis (see Appendix III). The mineralogical analyses provide information upon the actual mineral sources of acidity, neutralizing potential, and leachable metals.

4.5 Kinetic Test

The humidity cell test, often called the accelerated weathering test, is a long term laboratory protocol designed to simulate the natural cycles of precipitation that occur in mine facilities. The long duration of the test coupled with the short cycle times of flushing followed by rest periods (typically one week) promotes the aggressive oxidation of metal-bearing sulphide minerals, acid production, and metals leaching.

The results of humidity cell testing can be compared with water quality guidelines but are most often applied to predictive geochemical modeling to estimate the long term discharge water chemistry from waste rock piles or other mine facilities and pit wall runoff for pit lake water chemistry estimates. Although ABA analyses are commonly used to estimate the acid generating and neutralizing potential of mined material, humidity cell tests are considered to be a more reliable measure of the on-set of sulphide oxidation and acid generation, particularly for low sulphur and low NP systems where silicate neutralizing potential may be significant (Maest et al., 2005).

5.0 COMPARATIVE GUIDELINES

5.1 Metal Leaching Potential

Results of the SFE tests and the leachate from the humidity cells were compared with the Metal Mining Effluent Regulations (MMER) and the Canadian Council of Ministers of the Environment (CCME) fresh water aquatic life water quality standards for reference purposes only. The MMER guidelines are the federal environmental regulations applied to all metal mines (except placer mines) in Canada. The CCME fresh water aquatic life standards are receiving water quality guidelines.

The comparison of the SFE generated leachates or leachate from the humidity cell tests to either the MMER and CCME guidelines is strictly qualitative and intended only to provide a mechanism to estimate which elements are more or less mobile compared to a set of reference concentrations. The measured concentrations in the SFE and humidity cell leachate cannot be directly used as estimates of the actual site discharge concentrations because:

- The water to rock ratio (3:1) of the SFE may or may not simulate the actual water to rock ratio at the site (*e.g.,* precipitation infiltrating a waste storage facility);
- Both tests are aggressive, which may over estimate the rates of the dissolution of soluble minerals and mineral crusts; and
- The grain size and surface area of the sample material prior to leaching is also not representative of actual conditions at the site.

5.2 ARD Potential

5.2.1 Net Potential Ratio (NPR) Criteria

ABA results were compared to the B.C. Ministry of Employment and Investment Guidelines outlined in and provided in Table 5.1: *Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia* (Price, 1997).

Table 5.1: NPR Acid Rock Drainage Screening Criteria (Price, 1997)

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

5.2.2 Net Neutralizing Potential (NNP) Criteria

The criteria for the ARD potential based on the NNP are from the BC *Draft Acid Rock Drainage Technical Guide* (SRK, 1992) and provided in Table 5.2:

Table 5.2: NNP Acid Rock Drainage Screening Criteria (SRK, 1992)

Potential for Acid Generation	NNP Criteria
	t $CaCO_3$ /1000 t
Non-acid generating	NNP > 20
Uncertain acid generating potential	20 > NNP > -20
Potentially acid generating	-20 > NNP

6.0 RESULTS

The text that follows summarizes the results of the whole rock major and trace element analyses, SFE, testing mineralogy analyses, and ABA analyses for the 2008 supplemental waste rock and neutralized spent ore geochemical samples. The results of the kinetic testing of the neutralized spent ore samples are also discussed. All of the results of the 2008 geochemical testing are presented in Appendix IV, Tables IV.1 to IV.5. Results of the analyses for the 2007 supplemental waste rock geochemical samples are presented in Attachment V and are used in the text and figures of this report to provide a broader context for the geochemistry of the waste rock from the Carmacks Project.

6.1 Major Element Chemistry

The granodiorite, mixed gneiss/granodiorite, and spent ore are all aluminum and silicate dominant materials. Figure 6-1 presents plots of the average major element chemistries for the 2008 and 2007 granodiorite and mixed gneiss/granodiorite samples and neutralized spent ore samples as compared with the “average” granodiorite (Price, 1997). The average concentrations for results have been used for simplicity of presentation and because all of the granodiorite samples analysed represent a single rock type in the ore reserve model.

The average major element chemistry for the 2008 granodiorite samples have slightly higher concentrations of iron, calcium, and sodium and the 2008 mixed gneiss/granodiorite sample has higher concentrations of iron, calcium, and magnesium as compared to “average” granodiorite.

Figure 6-1 shows that the major element compositions of the three neutralized spent ore samples are similar. The samples have elevated concentrations of iron as compared to the “average” granodiorite.

6.2 Trace Element Chemistry

Figure 6-2 presents plots of the average metal concentrations for granodiorite and mixed gneiss/granodiorite for the 2008 and 2007 samples as well as the neutralized spent ore samples as compared with “average” high calcium granitic rock (Price, 1997) for MMER and CCME regulated parameters. The average concentrations for results have been used for simplicity of presentation and because all of the granodiorite samples analysed represent a single rock type in the ore reserve model.

The concentrations of regulated parameters arsenic, cadmium, mercury, and thallium are near or below the respective detection limits for the 2008 samples. Figure 6-2 shows that the average trace element composition for granodiorite and mixed gneiss/granodiorite for 2008 samples are similar to the 2007 samples with the exception of copper and molybdenum. The 2008 samples for both granodiorite and mixed gneiss/granodiorite contain less copper compared to the 2007 samples and the 2008 mixed gneiss/granodiorite contains less molybdenum compared to the 2007 mixed gneiss/granodiorite samples.

In general, the average trace metal concentrations of the 2008 granodiorite samples are similar to equivalent unmineralized rock with the exception of silver and chromium which are elevated when compared to the “average” high calcium granite. In addition, a single sample of granodiorite has elevated concentrations of copper and silver.

The trace metal concentrations in the 2008 mixed gneiss/granodiorite sample are similar to the "average" high calcium granite (Price, 1997) with the exception of elevated silver, chromium, copper and molybdenum concentrations. The elevated copper in the mixed gneiss/granodiorite sample is consistent with the presence of chalcopyrite ($CuFeS_2$) reported in the drill hole logs

The trace metal concentrations of the neutralized spent ore samples, B1, T1, and Col-6 are similar to each other and to the equivalent unmineralized rock; with the exception of the regulated parameters silver, copper, and molybdenum which are elevated as compared to the "average" high calcium granite (Price, 1997).

6.3 Shake Flask Extraction (SFE)

The average concentrations in the SFE leachate for the granodiorite samples, the mixed gneiss/granodiorite sample, and the neutralized spent ore samples are shown graphically in Figure 6-3 and Figure 6-4 for the MMER and the CCME fresh water aquatic life water quality standards, respectively. Figures 6-3 and 6-4 use one half the detection limit for concentrations reported below the detection limit. As noted in Section 5.0, the MMER guidelines and CCME reference standards do not directly apply to the SFE leachates but are provided for reference purposes and used as a metric for relative mobility. Individual analyses may exceed specific reference standards, however, average concentrations have been used for simplicity of presentation and because all of the granodiorite analyses represent a single rock type in the ore reserve model.

The SFE leachates from all eight samples have circum-neutral pH values (7.4 to 8.1) and have low dissolved metals concentrations. Figure 6-3 shows that the average SFE leachate concentrations for 2007 and 2008 granodiorite and mixed gneiss/granodiorite are one to three orders of magnitude below the respective MMER, Maximum Authorized Monthly Mean Concentration (the most rigorous of the MMER guidelines). Figure 6-4 shows that with the exception of average aluminum for the 2008 granodiorite samples, the average metal concentrations in the SFE leachates for the 2008 granodiorite and mixed gneiss/granodiorite are near or below all of the CCME freshwater aquatic life standards. The 2007 granodiorite samples have elevated concentrations of aluminum, cadmium, and copper while the mixed gneiss/granodiorite samples have elevated concentrations of aluminum and cadmium.

SFE leachate from the neutralized spent ore samples is generally neutral or near neutral. The leachate from B1 was slightly acidic (5.96) and below both the MMER and CCME minimum acceptable range value for pH. SFE leachate for T1 and Col-6 were slightly alkaline (8.09 and 7.67, respectively) and were within the MMER and CCME acceptable range for pH.

Figure 6-3 shows that the SFE leachate concentrations for the neutralized spent ore are all below the MMER, Maximum Monthly Mean Concentration (the most rigorous of the MMER Guidelines). However, leachate from sample B1 had elevated copper and zinc concentrations as compared to leachate from the T1 and Col-6 samples. Figure 6-4 shows that all of the neutralized spent ore samples exceed the CCME- fresh water aquatic life guidelines for cadmium, copper, and selenium. Additionally, leachate from B1 exceeds the CCME guideline for aluminum and zinc; leachate from T1 exceeds the CCME guideline for aluminum and molybdenum; and, leachate from Col-6 exceeds the CCME guideline for molybdenum.

6.4 ABA

The ABA results for the 2008 Golder samples are summarized in Figures 6-5 to 6-9. The ABA results for the 2007 Golder samples are presented in Appendix V and used in Figures 6-5 to 6-9 for comparative purposes. Table 6.1 summarizes the results of the ABA analyses.

6.4.1 Paste pH and Sulphide Sulphur Concentration

Figure 6-5 is a plot of paste pH and sulphide sulphur for the 2008 and 2007 waste rock samples and the 2008 neutralized spent ore samples. The figure shows that the 2008 and 2007 granodiorite samples are similar, reporting alkaline paste pH and low sulphide sulphur and that the 2008 mixed gneiss/granodiorite sample reports slightly more acidic paste pH and lower sulphide sulphur as compared to the 2007 mixed gneiss/granodiorite samples.

Samples T1 and Col-6 report paste pH values of 7.85 and 7.89 and very low sulphide sulphur concentrations. Sample B1 reports slightly lower paste pH and a slightly higher sulphide sulphur concentration.

Table 6.1: ABA Summaries for the 2008 Waste Rock and Spent Ore Samples

Rock Type	Paste	S(T)	S(SO4)	S(S-2)	NP	$CaCO_3$
	pH	%	%	%		NP
Granodiorite	8.1 - 8.39	<0.01	<0.01	<0.01	7.3 - 16.5	0.83 - 10
Mixed Gneiss/Granodiorite	6.81	0.18	0.03	0.15	11.6	<0.8
Neutralized Spent Ore	5.91 - 7.89	0.12 - 0.55	0.07 - 0.42	0.05 - 0.13	6.3 - 10.8	0.83 - 6.67

6.4.2 Sulphur Speciation

Figure 6-6 is a plot of sulphide content as a function of total sulphur for the 2008 and 2007 waste rock samples and the neutralized spent ore samples. A reference line of 1:1 is presented in the figure to assess the dominant form of sulphur. In general, the 2008 granodiorite and mixed gneiss/granodiorite samples report lower concentrations of total sulphur, sulphate, and sulphide sulphur as compared to 2007 samples.

All of the 2008 granodiorite samples have total sulphur concentrations (and sulphur species concentrations) below the method detection limits of 0.01 %. Non-detectable levels of the various sulphur species indicates that the 2008 granodiorite samples have little to no sulphide mineralization that could be oxidized or sulphate sulphur due to previous oxidation of sulphide mineralization. The 2008 mixed gneiss/granodiorite sample reports sulphide sulphur as the dominant form of sulphur with relatively minor sulphate sulphur concentrations. The measured sulphide sulphur in the mixed gneiss/granodiorite is consistent with observed chalcopyrite ($CuFeS_2$).

The neutralized spent ore samples have sulphate sulphur as the dominant form of sulphur with sulphide sulphur concentrations of between 0.05 to 0.13 %. The higher measured sulphate sulphur concentration as compared to the waste rock samples is consistent with having undergone oxidation as part of the leaching process.

6.4.3 Neutralization Potential

Two static procedures were used to measure the neutralization potential of the waste rock samples: 1) Bulk NP (NP) and 2) Carbonate NP ($CaCO_3$ NP). The bulk NP is the total neutralizing potential of a rock from carbonate and other forms of acid-neutralizing chemical species such as the hydroxide ion (OH^-) and aluminosilicate minerals. Aluminosilicate minerals include alkali feldspars which are commonly present in granodiorite (Price, 1997). The $CaCO_3$ NP is an estimate of the amount of carbonate ion (HCO_3^- and CO_3^{-2}) neutralizing material present in a rock. The use of $CaCO_3$ NP can be considered a more conservative estimate of the acid neutralizing potential of a rock.

Figure 6-7 is a plot of the NP versus $CaCO_3$ NP for the 2008 and 2007 granodiorite and mixed gneiss/granodiorite samples as well as the neutralized spent ore samples. The figure is used to illustrate the source of neutralization potential of the Carmacks waste rock and neutralized spent ore that is attributed to carbonate and non-carbonate sources. The 2008 granodiorite samples report generally lower bulk NP values compared to the 2007 samples and higher $CaCO_3$ NP values. The 2008 and 2007 mixed gneiss/granodiorite samples have $CaCO_3$ NP below the detection limit but measureable bulk NP.

The bulk NP and $CaCO_3$ NP for the 2008 granodiorite samples is weighted in favour of the bulk NP over the $CaCO_3$ NP suggesting, a significant portion of the neutralization potential of the granodiorite samples is provided by aluminosilicate minerals. Most of the neutralization potential for the mixed gneiss/granodiorite sample is also attributed to aluminosilicate minerals.

The NP of the neutralized spent ore samples appears in part to be determined by the post-leaching neutralization. Sample B1 has moderate bulk NP and very low $CaCO_3$ NP suggesting that the non-carbonate sources of acid neutralizing potential are dominant. Samples T1 and Col-6 have slightly higher bulk NP compared to B1 but much higher $CaCO_3$ NP suggesting that non-carbonate NP may be present in the samples but that the differences in bulk NP are likely related to the increase in $CaCO_3$ NP. The likely source of the $CaCO_3$ NP is residual sodium carbonate used in the neutralization step which may be retained in the sample and providing added acid neutralizing capacity.

6.4.4 ARD Criteria for the Supplemental Waste Rock Samples

Two sets of ARD criteria have been applied to the waste rock and neutralized spent ore samples: NPR and NNP. Results of the two ARD criteria are summarized in Table 6.2.

6.4.4.1 NPR Criteria

Figure 6-8 is a plot of Bulk NP versus AP for the 2008 and 2007 waste rock samples and the neutralized spent ore samples. The figure shows that the ARD potentials of the 2008 and 2007 granodiorite samples are classified as “none” under the Price (1997) screening criteria. The two 2007 and the single 2008 samples of mixed gneiss/granodiorite range from “low” to “likely” ARD potential. As noted in Section 2.0 however, the mixed gneiss/granodiorite rock, regardless of grade, will report to the leach pad and none will be shipped to the waste rock storage facility.

Figure 6-9 is a plot of the $CaCO_3$ NP versus AP for the waste rock and spent ore samples. The figure shows that under the more conservative criteria of $CaCO_3$ NP, seven of the eight 2008 granodiorite samples are non-acid generating. However, since there is no measurable sulphide sulphur in any of the granodiorite samples, it is unlikely any of the samples will be acid generating. The 2008 mixed gneiss/granodiorite would be classified as having a "likely" ARD potential but again the mixed gneiss/granodiorite will be shipped to the leach pad and not the waste rock pile.

The ARD potential of the 2007 granodiorite samples are more variable and are classified as "possible", "likely", and "low" with only one sample characterized as having an acid generating potential of "none" under the Price guidelines based upon the more conservative $CaCO_3$ NP. The 2007 mixed gneiss/granodiorite samples are characterized as having a "likely" ARD potential.

The plot of Bulk NP versus AP (Figure 6-8) for the neutralized spent ore samples shows that the acid generating potentials range from "none" to "possibly" ; but range from "none" to "likely" using the $CaCO_3$ NP (Figure 6-9).

Figure 6-10 is a plot of sulphide sulphur verus NPR and indicates that even though the sulphide sulphur concentration of all of the samples of waste rock and neutralized spent ore are low, the NPR is still sensitive to sulphide content. Materials with less than 0.1 % sulphide sulphur have acid generating potentials classified as either "low" to "none" while material with greater than 0.1 % sulphide sulphur are generally classified as "possibly" to "likely" acid generating.

Table 6.2: ARD Criteria Summary for the 2008 Waste Rock and Spent Ore Samples

	Net NP	NPR	$CaCO_3$ Net NP	CaNPR
Granodiorite	7.3-16.5	24.3-55.0	0.8-10.0	2.78-33.3
Mixed Gneiss/Granodiorite	6.9	2.5	3.9	0.17
Neutralized Spent Ore	2.2-9.2	1.6-6.9	-3.2-5.1	0.21-4.27

6.4.4.2 NNP Criteria

The NNP is an alternative criteria often used with the NPR although often used in situations with either high sulphide sulphur concentration or high neutralizing potential. Figure 6-11 is a plot of sulphide sulphur versus NNP and indicates that all of the samples fall in the NNP field of uncertain acid generating potential. As expected, the low sulphide sulphur concentrations results in higher NNP and increasing sulphide sulphur concentration (*e.g.*, the two 2007 mixed gneiss/granodiorite samples) results in a corresponding lower NNP. Figure 6-12 is a plot of the NPR versus NNP.

6.5 Mineralogy

Two of the three neutralized spent ore samples (B1 and T1) were analysed for their mineralogy using X-Ray Diffraction. The test method is discussed in Appendix II and the full results of the mineralogical analytical test are provided in Appendix III and IV.

Samples B1 and T1 are composed primarily of feldspar and quartz as suggested by the major element whole rock analyses. Both samples contain relict iron-magnesium silicates (biotite) or secondary iron-magnesium (actinolite) and montmorillinite-like clays. Both samples contain sulphate minerals either jarosite [$K_2Fe_6(SO_4)_4(OH)_{12}$] and/or gypsum ($CaSO_4 \bullet 2H_2O$). Neither sample contained measurable sulphide mineralization.

6.6 Kinetic Testing

The neutralized spent ore humidity cell testing commenced on March 31, 2008 for samples B1 and T1 and February 09, 2009 for the Col-6. The tests were terminated in March 2010 and all data up to February 22, 2010 are presented in Appendix IV, Table IV.6 – to IV.8 for B1, T1 and Col-6 samples, respectively.

6.6.1 Weekly Analyses

Figures 6-13 to 6-15 are time series plots for the results of the weekly parameters pH, alkalinity, and sulphate for the neutralized spent ore sample humidity cells. pH is a MMER regulated parameter and therefore Figure 6-13 includes the MMER guideline pH range. Table 6.3 summarizes Bulk and $CaCO_3$ NPR, the maximum and minimum pH, alkalinity and sulphate for cycles 1-100 for T1 and B1 and the average pH, alkalinity and sulphate for the last five cycles (96 to 100). The table also includes the same set of data for cycles 1-55 of humidity cell tests for Col-6 and the average over cycles 51 to 55.

Results of the weekly analyses of the humidity cell leachate suggest that T1 and Col-6 have maintained neutral pH and measurable, steady alkalinity for the duration of the humidity cell tests. The sulphate concentrations in leachate from the two samples have shown a steady decline and the sulphate concentration is below the detection limits for the leachate from T1 in the later weeks of the test. The leachate from B1 has maintained a steady pH near 6 with a steady but low alkalinity for the duration of the test. B1 is similar to T1 and Col-6 with sulphate concentrations that have declined to near or below the detection limit.

Table 6.3: ABA Results and Summary of Leachate Chemistry for Weekly Humidity Cell Results

Sample	Cell ID	ABA Results		Humidity Cell Results								
				Minimum/Maximum Results						Average for Last Five Analyses		
		Bulk NPR	$CaCO_3$ NPR	pH		Alkalinity		SO4		pH	Alkalinity	SO4 *
				Max	Min	Max	Min	Max	Min			
T1	Neutralized spent ore	6.91	4.27	8.22	7.53	91.0	17.8	328	<1	7.80	54.9	1.5
B1	Neutralized Spent Ore	1.55	0.21	7.58	5.01	48.1	<0.1	1533	<1	5.67	1.3	3.7
Col-6	Neutralized Spent Ore	3.52	1.33	7.93	7.36	56.0	34.3	2531	1	7.73	38.2	5.7

Notes: Average sulphate for T1 and B1 were calculated for cycles 94 – 98 as there were no analyses for cycle 100

6.6.2 Full Chemical Analyses

Results of the 100 cycles of the humidity cell testing for T1 and B1 and 55 cycles for Col-6 indicate that the dissolved metal concentrations are similar for all of the neutralized spent ore samples and are very low. Figures 6-16 to 6-20 are time series plots of the results of MMER parameters arsenic, copper, nickel, lead and zinc. The figures include the MMER maximum monthly mean and maximum grab sample concentrations. Since the beginning of the humidity cell program the concentrations of dissolved MMER metals have been below the guidelines, for all of the humidity cells. Table 6.4 lists the average concentrations of MMER and CCME metals over the last five sampling events. The concentrations of aluminum, cadmium, copper, molybdenum, and selenium are above the CCME guidelines in one or more of the samples of the later weeks of the tests.

Table 6.4: Average Metal Concentrations for the Last Five Analyses of the Humidity Cell Tests

Parameters		Guidelines		T1	B1	Col 6
		CCME	MMER	Neutralized Spent Ore	Neutralized Spent Ore	Neutralized Spent Ore
Aluminum	(mg/L)	0.005 - 0.1		**0.062**	**0.082**	0.015
Arsenic	(mg/L)	0.01	0.50	0.002	0.001	0.002
Cadmium	(mg/L)	0.000005 - 0.000338		**0.00002**	**0.00002**	**0.00006**
Chromium	(mg/L)	0.001/0.0089		<0.0001	<0.0001	<0.0001
Copper	(mg/L)	0.002 - 0.004	0.30	**0.006**	**0.019**	**0.002**
Iron	(mg/L)	0.30		0.113	0.161	0.019
Lead	(mg/L)	0.001 - 0.007	0.20	0.0003	0.0002	0.0001
Mercury	(ug/L)	0.026		<0.01	<0.01	<0.01
Molybdenum	(mg/L)	0.07		0.045	0.021	**0.189**
Nickel	(mg/L)	0.025 - 0.15	0.50	0.0003	0.0006	0.0002
Selenium	(mg/L)	0.001		**0.0038**	0.0005	**0.0111**
Silver	(mg/L)	0.0001		0.00017	0.00004	0.00008
Thallium	(mg/L)	0.001		0.000004	0.000011	0.000006
Zinc	(mg/L)	0.03	0.50	0.001	0.002	0.001

Bold text indicates exceedances in the CCME guideline and **bold/underlined** text indicates exceedances of the MMER guidelines.

Figures 6-21 to 6-25 are time series plots of metals mobile under non-ARD conditions (*i.e.,* neutral conditions) antimony, cadmium, molybdenum, mercury and selenium. Arsenic and zinc are also metals that are mobile under non-ARD conditions, but are discussed as MMER parameters. The metals concentrations generally decline except for molybdenum.

7.0 CONCLUSION

Results of the supplemental sampling and analyses program for the Carmacks Copper Project of waste rock and neutralized spent ore samples lead to the following conclusions:

- The ABA data shows that the total sulphur concentrations of the 2008 granodiorite samples are below the detection limits (*i.e.,* an absence of pyrite) and the samples have sufficient neutralization potential (Bulk NP) with respect to acid generating potential to be considered non-acid generating. Further, the 2007 granodiorite samples have low acid generating potential and significant Bulk NP and are also classified as non-acid generating. For many of the 2007 granodiorite samples (deep footwall and hanging wall) a large proportion of the neutralization potential is attributed to aluminosilicate (non-carbonate) minerals, whereas for the 2008 samples (shallow footwall) a significant proportion of the neutralization potential is attributed to carbonate minerals.
- The ABA data for the 2008 and 2007 mixed gneiss/granodiorite samples suggest that the mixed gneiss/granodiorite rock type does not have sufficient neutralization potential (Bulk NP) with respect to acid generating potential and as such are considered to be potentially acid generating. However, as emphasized in the 2008 report and in Section 3, the gneiss either occurs beneath the proposed pit bottom and is not anticipated to be mined or if mined will be treated as ore and delivered to the heap leach pad. For both the 2007 and 2008 mixed gneiss/granodiorite samples most of the neutralization potential is attributed to aluminosilicate minerals and very little to carbonate minerals.
- The ABA data for the neutralized spent ore samples suggest the samples have a range of acid generating potentials. All of the samples are sulphate dominant and have low sulphide-sulphur concentrations. The neutralizing potential (Bulk NP) in two of the neutralized spent ore samples (T1 and Col-6) consists of both carbonate and non-carbonate NP while the neutralizing potential of one sample (B1) is non-carbonate NP. Based upon the Bulk NP, the acid neutralized potential of two of the neutralized spent ore samples are classified as “none” while one sample is classified as “possibly” acid generating. Using the more conservative $CaCO_3$ NP, the neutralized spent ore samples are classified as “none”, “possibly” and “likely” acid generating.
- The whole rock trace element chemistry of the 2007 and 2008 waste rock samples suggests that the rocks are relatively enriched in chromium, copper and molybdenum compared to average, unmineralized high calcium granite and the neutralized spent ore samples are enriched in silver, cadmium, chromium and molybdenum, although enrichment does not necessarily indicate mobility.
- The SFE leachates for the 2008 and 2007 waste rock samples are near neutral. Although the MMER and CCME guidelines do not directly apply to laboratory test results, the dissolved metal concentrations for all of the 2007 and 2008 waste rock samples are all less than the MMER guidelines. The dissolved concentrations of several metals in the waste rock leachate exceed CCME guidelines and are potentially mobile.
- The SFE leachate for one neutralized spent ore sample was mildly acidic and below the MMER guidelines while the SFE leachate from the other two neutralized spent ore samples were slightly alkaline. All samples report concentrations of dissolved metals less than the MMER guidelines; however, several metals exceed the respective CCME guidelines for several samples and therefore are potentially mobile.

- Results of mineralogical analyses of the neutralized spent ore samples is consistent with the observed ABA data: two of the neutralized spent ore samples are composed of primarily feldspar with trace amounts of calcite while one sample is dominantly feldspar with trace amounts of gypsum. Neither samples contained residual sulphide mineralization.
- Kinetic testing for two of the three neutralized spent ore samples (T1 and B1) were begun in March 2008 the third humidity cell test (Col-6) was begun in February 2009. All of the tests were terminated in March 2010 and results are provided up to February 22, 2010. Results of the kinetic tests to date show that the leachate derived from the T1 and Col-6 neutralized spent ore samples are neutral to alkaline and within MMER guideline limits, while the pH of the leachate from the B1 neutralized spent ore sample is slightly acidic and less than or equal to the minimum MMER guideline. The leachate alkalinity is steady and proportional to the pH while the sulphate concentration has shown a steady decline over the test period. MMER metals concentrations are all below the Maximum Monthly Mean concentration (the minimum guideline) and declining over time. The concentrations of metals leachable under neutral to alkaline pH (antimony, cadmium, mercury, molybdenum, and selenium are generally low or below the respective detection limit and declining except for molybdenum. Several metals are above the minimum CCME guidelines suggesting potential mobility.

8.0 RECOMMENDATIONS

It is recommended that in the near future but certainly early in the mine life, WCC consider initiating onsite, large scale testing such as crib tests or test pads to: 1) confirm the results of the laboratory test work; and, 2) document discharge water chemistry under site specific climatic conditions. These tests will provide invaluable empirical information on the environmental impact of mining operations at the Carmacks operations and information to update and better define closure requirements and closure design.

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REFERENCES

ACG, 2006. Provisional Assessment of ARD Potential of Selected Rock Samples, Carmacks Copper Project, Yukon Territory. November 2006.

ACG, 2007. Letter Report Re: Western Copper Corporation, Carmacks Copper Project, Rock Sampling, Friday, August 21, 1998. January 2007.

Canadian Council of Ministers of the Environment, 2003. Canadian Environmental Quality Guidelines for the protection of aquatic life.

Golder, 2007a. Review of Geochemical Test Work and Information, Carmacks Copper Project, Yukon. January 10, 2007.

Golder, 2007b. Sampling for Geochemical Testing, Carmacks Copper Project, Yukon Territory. February 19, 2007.

Golder, 2007c. Results of the Static Geochemical Test Work Carmacks Copper Project, Yukon Territory (Doc. No. 059 Rev. 1). September 13, 2007.

Golder, 2007d. Test program for Neutralized Spent Ore Samples, Carmacks Copper Project (Doc. No. 019). December 5, 2007.

Golder, 2008, Results of the Static Geochemical Test Work Carmacks Copper Project, Yukon Territory (Rev.2). March 27, 2008.

Hallam Knight Piesold, 1995, Initial Environmental Evaluation Addendum, Carmacks Copper Project, Western Copper Holdings Limited.

Langmuir, D, 1997, Aqueous Environmental Geochemistry, Prentice Hall, pg. 600.

Maest, A. S., Kuipers, J K., Travers, C.L., and Atkins, D.A., 2005, Predicting Water Quality at Hardrock Mines, Methods and Models, Uncertainties, and State-of-the-Art, EARTHWORKS, pg. 77.

Metal Mining Effluent Regulations (MMER) SOR/2002-222, June 6, 2002.

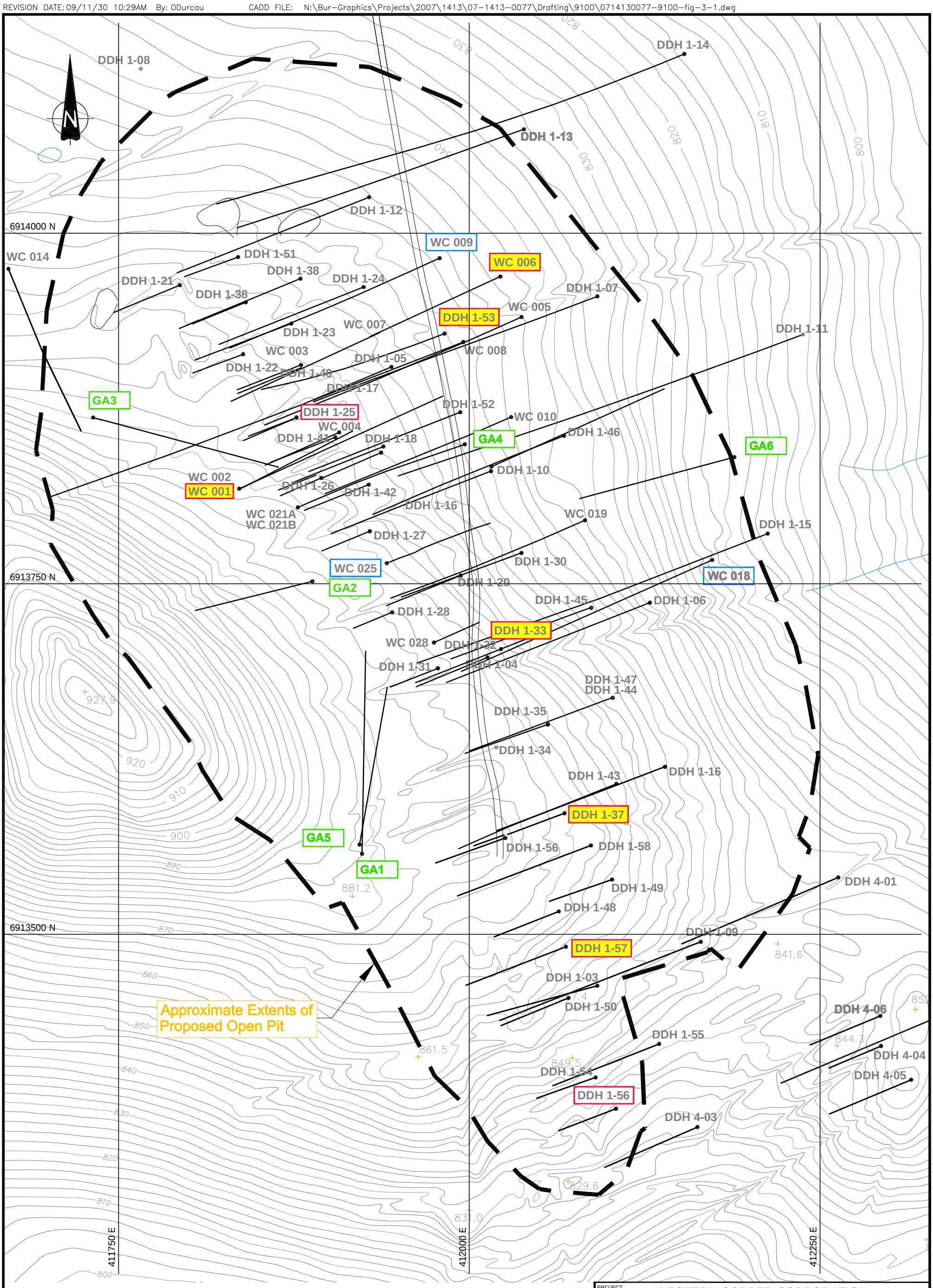
Price, W.A., 1997, DRAFT Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia, Reclamation Section, Energy and Minerals Division, Ministry of Employment and Investment.

Price, W.A., and Errington, J.C., 1998, Guidelines for Metal Leaching and Acid Rock Drainage at Minesites in British Columbia, Ministry of Energy and Mines.

PRA, 2009a – One Meter Copper Column Acid-Leach Test Results, Process Research Associates, April 15, 2009.

PRA, 2009b – Rinse Tests Following Acid Leaching in 1 Meter Columns 3 & 6, Process Research Associates, July 30, 2009.

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LEGEND

GA1	2008 Geotechnical Drill Hole Locations
WC 009	Approximate Golder Sample Location; Samples for 2007 Static Testing
WC 003	Approximate Access Consulting Group Sample Locations
WC 006	Access Consulting Group Samples Used for 2007 Kinetic Testing

PROJECT

WESTERN COPPER CORPORATION
CARMACKS COPPER PROJECT
YUKON TERRITORY

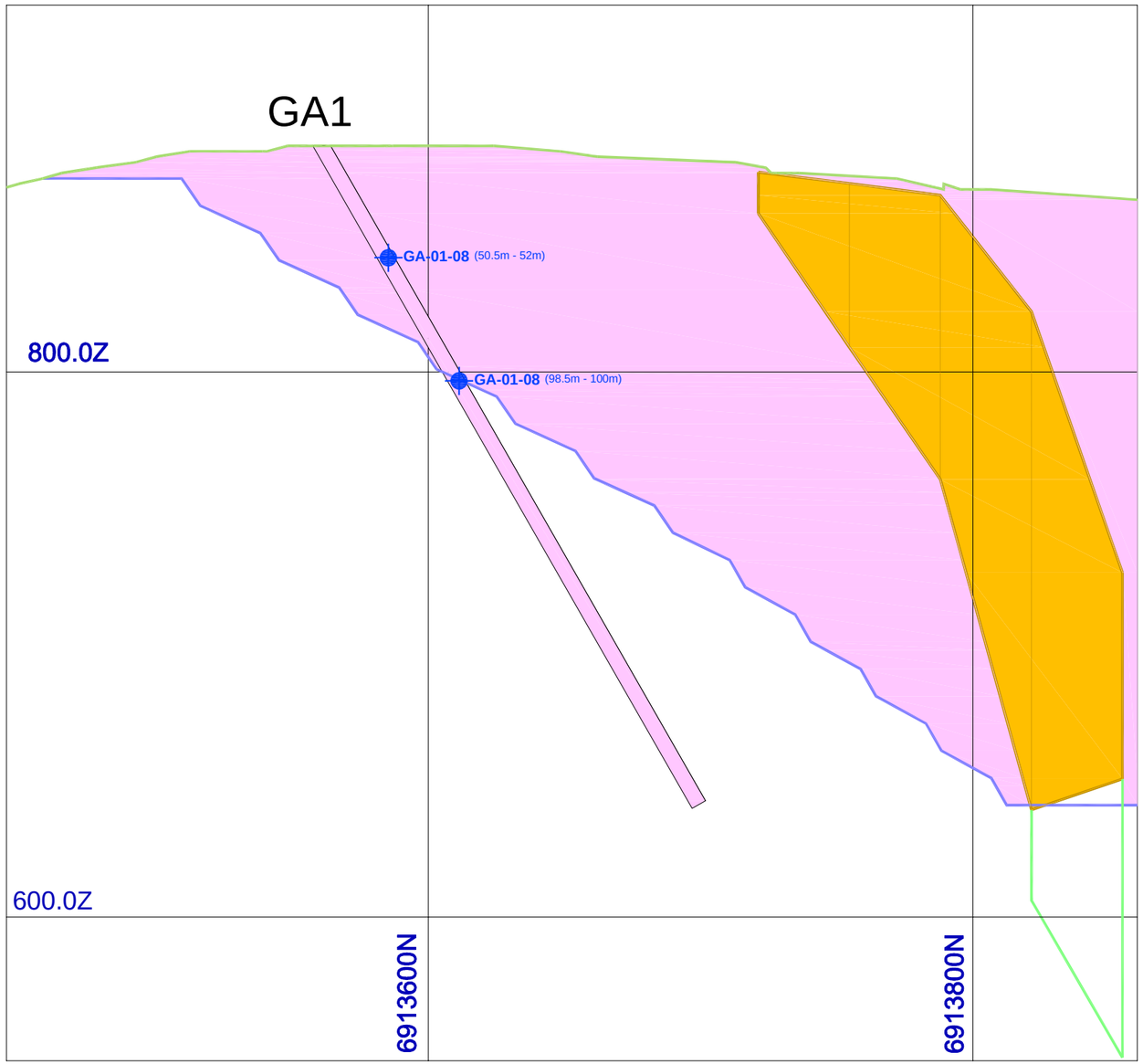
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STATIC AND KINETIC TEST SAMPLING LOCATIONS (2007 and 2008)

Golder Associates
Abbotsford, BC

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CADD	SSS/AS	23SEP08		
CHECK				
REVIEW				

FIGURE 3-1



0 20 40 60 80 100

SCALE IN METRES

LEGEND

GA-01-08 (50.5m - 52m) - Approximate location of Drillhole Sample Interval

- Proposed Ultimate Pit
- Oxide (Gneiss) Ore Zone
- Sulphide (Gneiss) Ore Zone

NUMBER BANDS	L/R	COL	RANGE
nonsul_pct	R		0.2

ROCK CODES Code	L/R	PAT	LABEL	DESCRIPTION
	R		OVB	Overburden
			VOLC	Volcanic
			GRDR	Granodiorite
			PEG	Pegmatite
			APL	Aplite
			GN	Gneiss

PROJECT
WESTERN COPPER CORPORATION
CARMACKS COPPER
YUKON

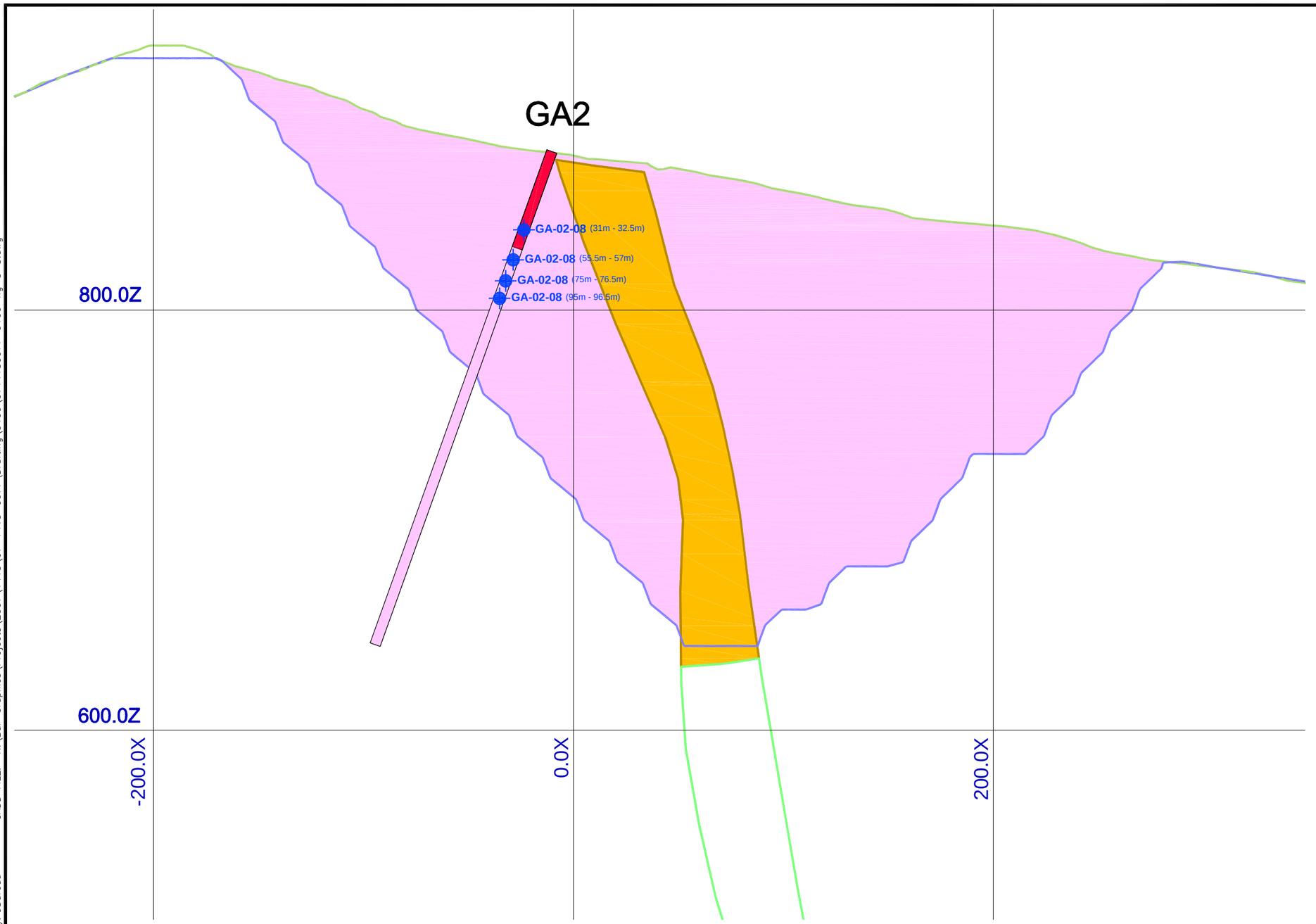
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GEOTECHNICAL DRILLHOLE (GA1) TRACE

Golder Associates

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REVIEW				

FIGURE 3-2

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0 20 40 60 80 100

SCALE IN METRES

LEGEND

GA-02-08 (31m - 32.5m) - Approximate location of Drillhole Sample Interval

- Proposed Ultimate Pit
- Oxide (Gneiss) Ore Zone
- Sulphide (Gneiss) Ore Zone

NUMBER BANDS	L/R	COL	RANGE
nonsul_pct	R		0.2

ROCK CODES Code	L/R	PAT	LABEL	DESCRIPTION
	R		OVB	Overburden
			VOLC	Volcanic
			GRDR	Granodiorite
			PEG	Pegmatite
			APL	Aplite
			GN	Gneiss

PROJECT
WESTERN COPPER CORPORATION
CARMACKS COPPER
YUKON

TITLE
GEOTECHNICAL DRILLHOLE (GA2) TRACE

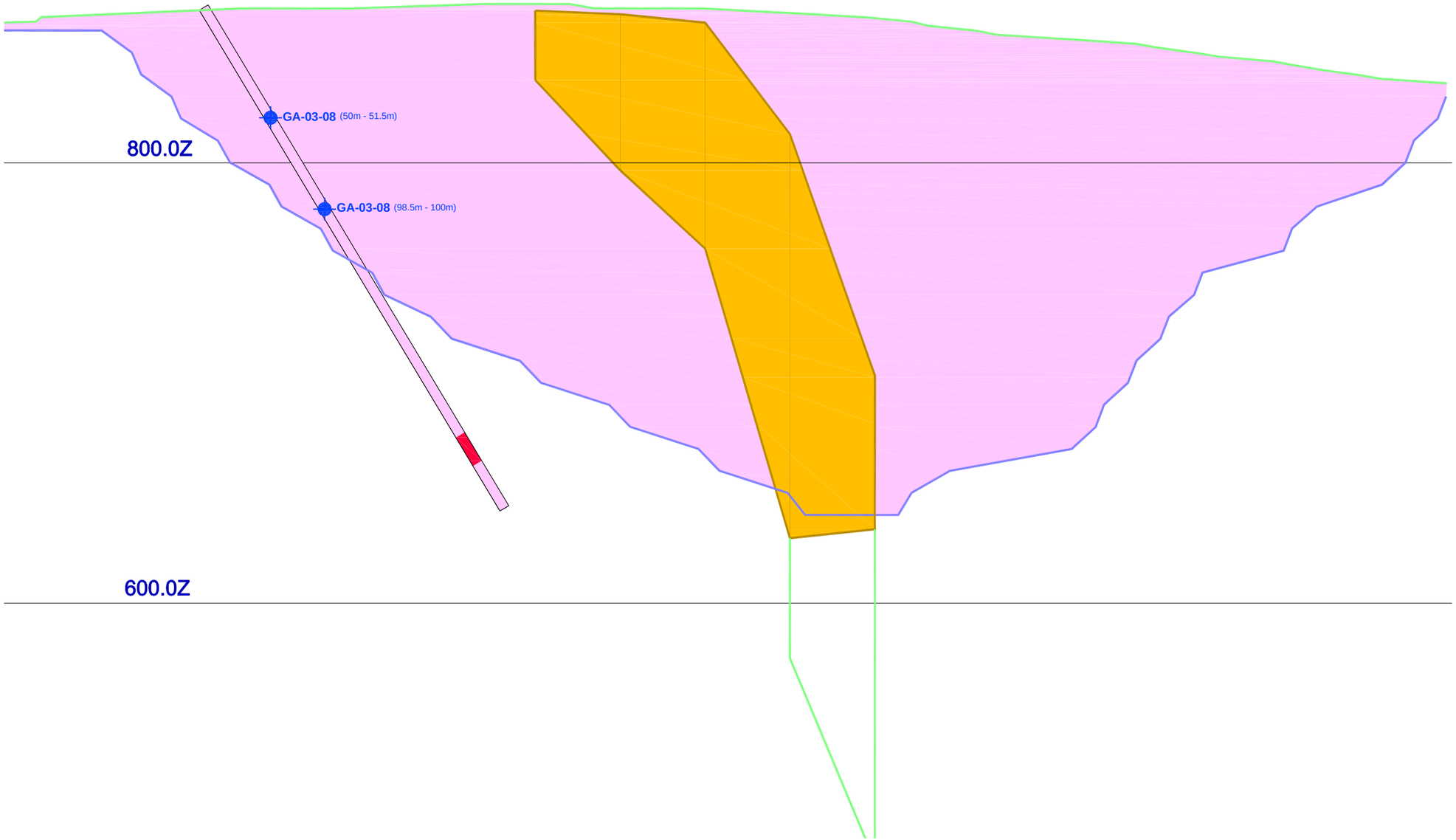
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FIGURE 3-3

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GA3



0 20 40 60 80 100

SCALE IN METRES

LEGEND

- GA-03-08 (50m - 51.5m) - Approximate location of Drillhole Sample Interval
- Proposed Ultimate Pit
- Oxide (Gneiss) Ore Zone
- Sulphide (Gneiss) Ore Zone

NUMBER BANDS	L/R	COL	RANGE
nonsul_pct	R		0.2

ROCK CODES	L/R	PAT	LABEL	DESCRIPTION
Code	R		OVB	Overburden
			VOLC	Volcanic
			GRDR	Granodiorite
			PEG	Pegmatite
			APL	Aplite
			GN	Gneiss

PROJECT
WESTERN COPPER CORPORATION
CARMACKS COPPER
YUKON

TITLE
GEOTECHNICAL DRILLHOLE (GA3) TRACE

Golder Associates

PROJECT No. 07-1413-0077			FILE No.	
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REVIEW				

FIGURE 3-4

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Figure 6-1
Average Major Element Chemistry for 2007 and 2008 Samples
Carmacks Copper Project, YT

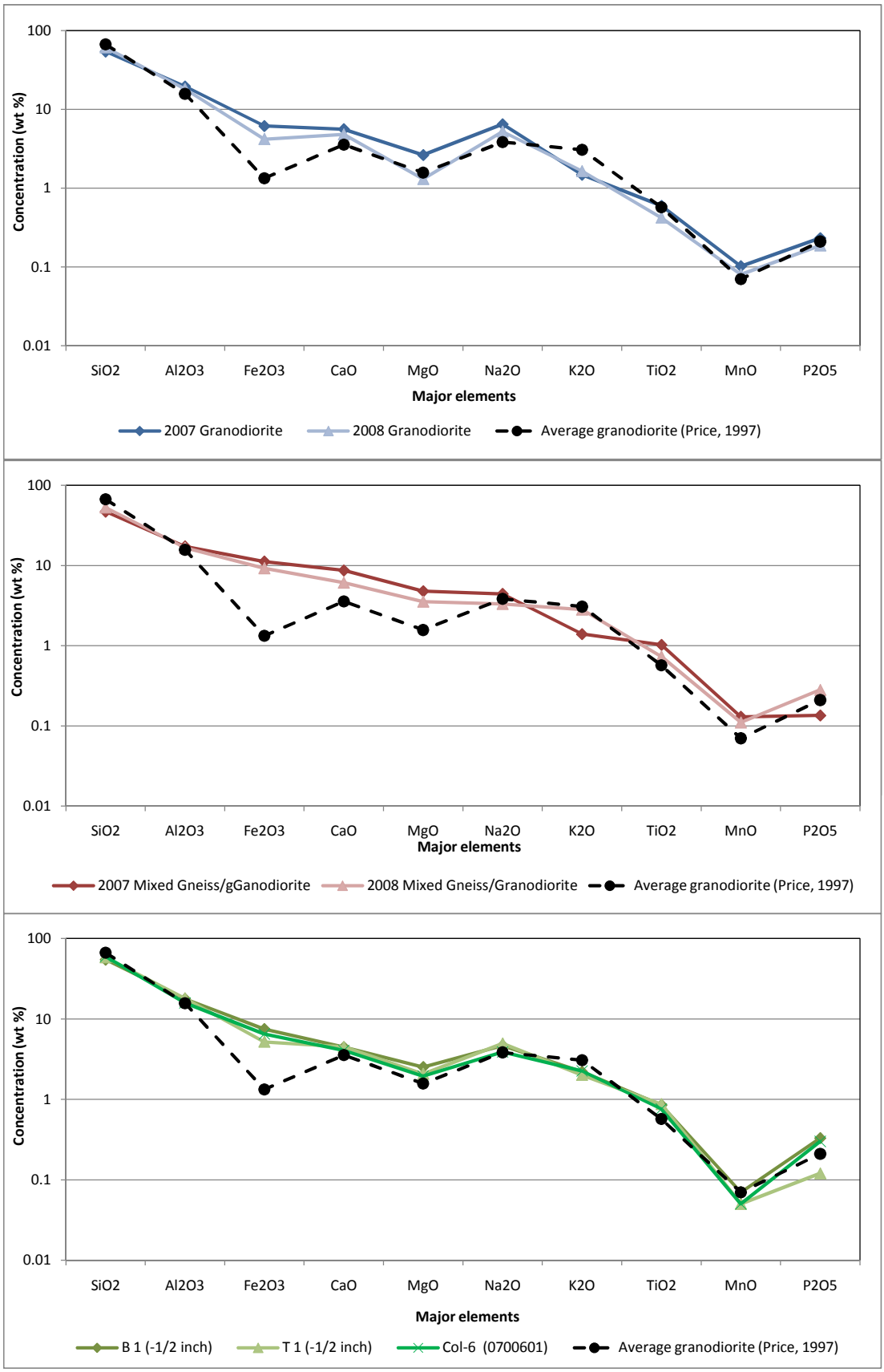


Figure 6-2
Average Trace Element Concntrations for 2007 and 2008 Samples
Carmacks Copper Project, YT

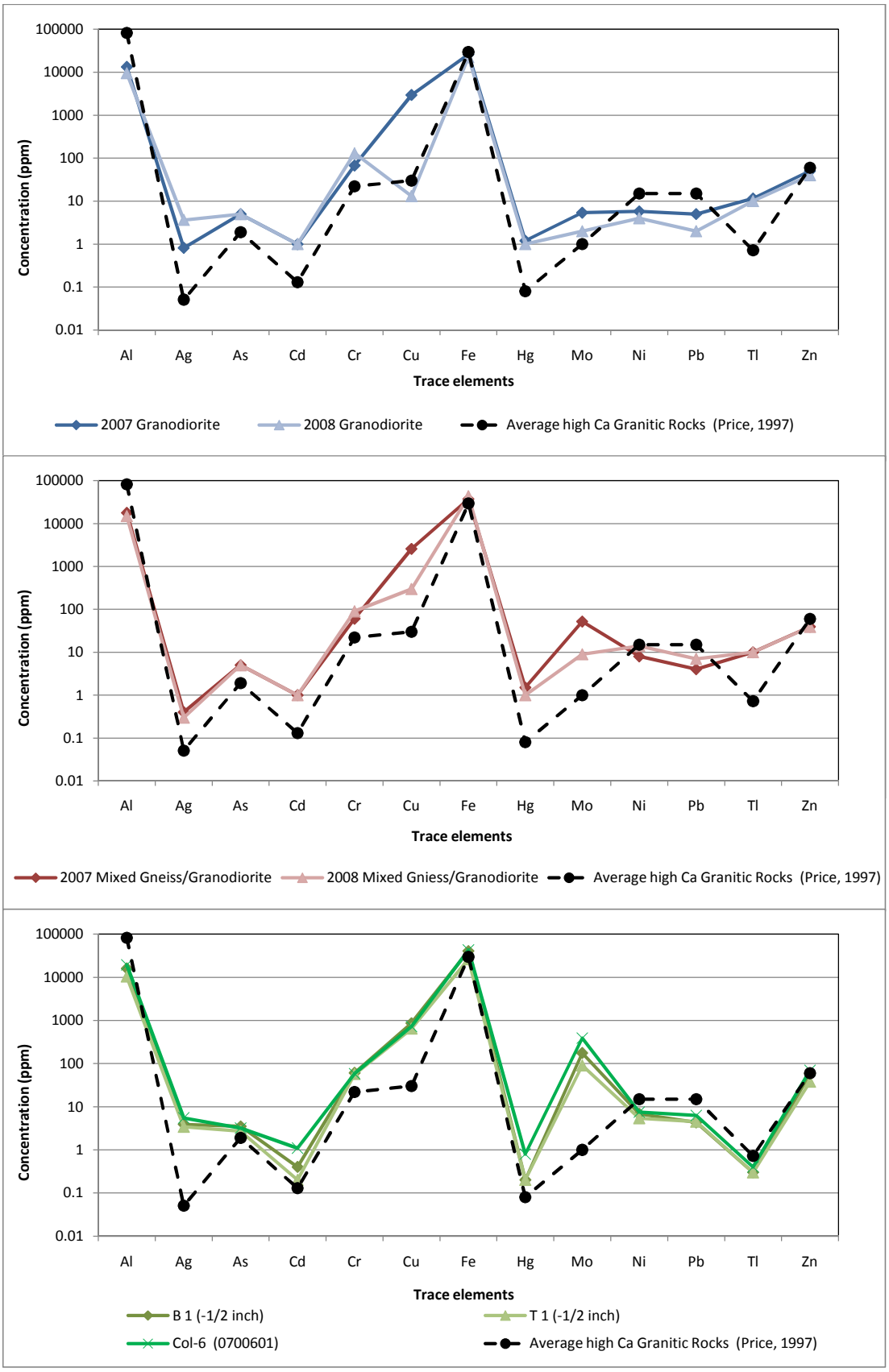


Figure 6-3
Average SFE Leachate Concentrations of MMER Parameters for 2007 and 2008 Samples
Carmacks Copper Project, YT

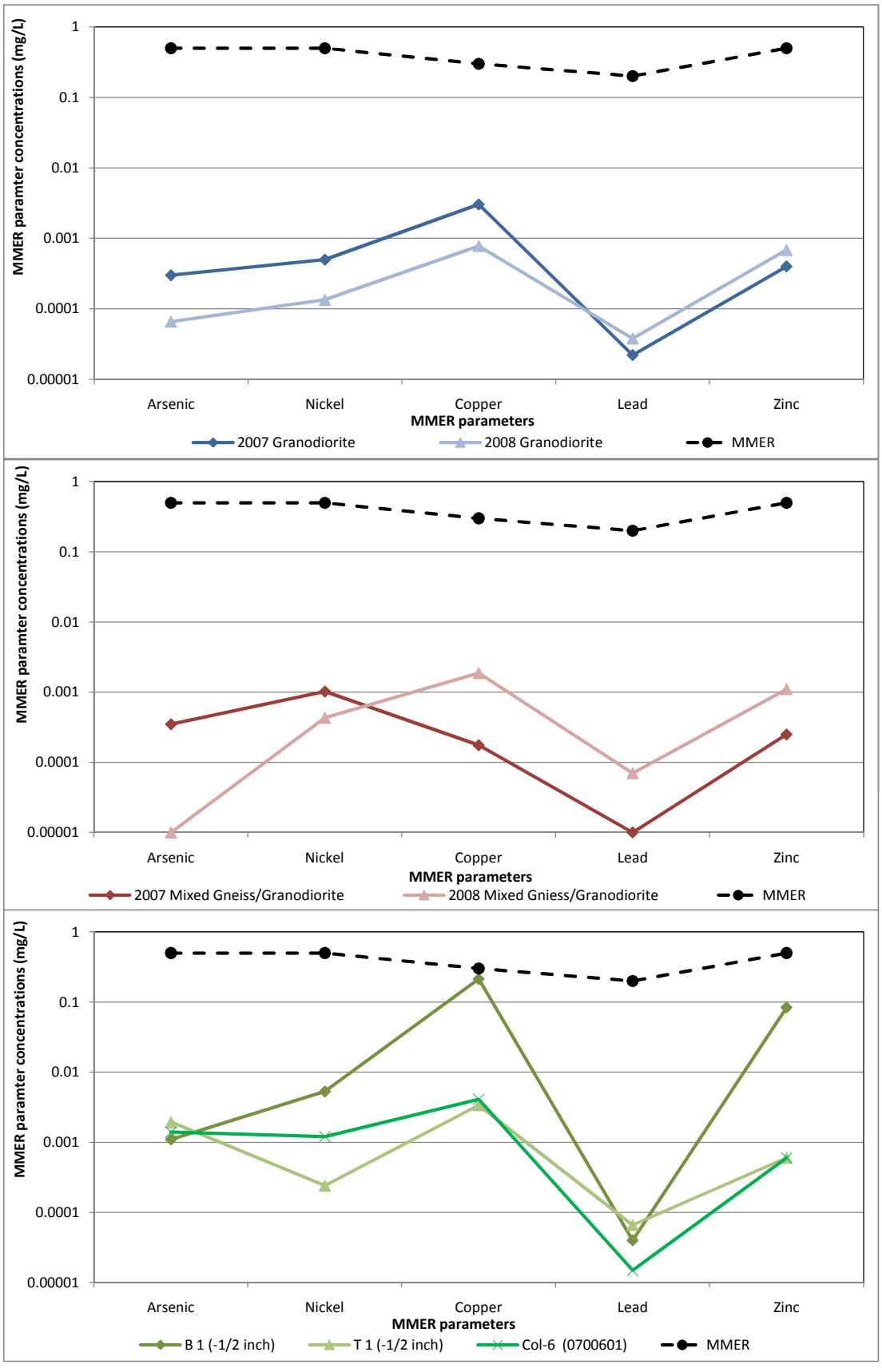


Figure 6-4
Average SFE Leachate Concentrations of CCME Parameters for 2007 and 2008 Samples
Carmacks Copper Project, YT

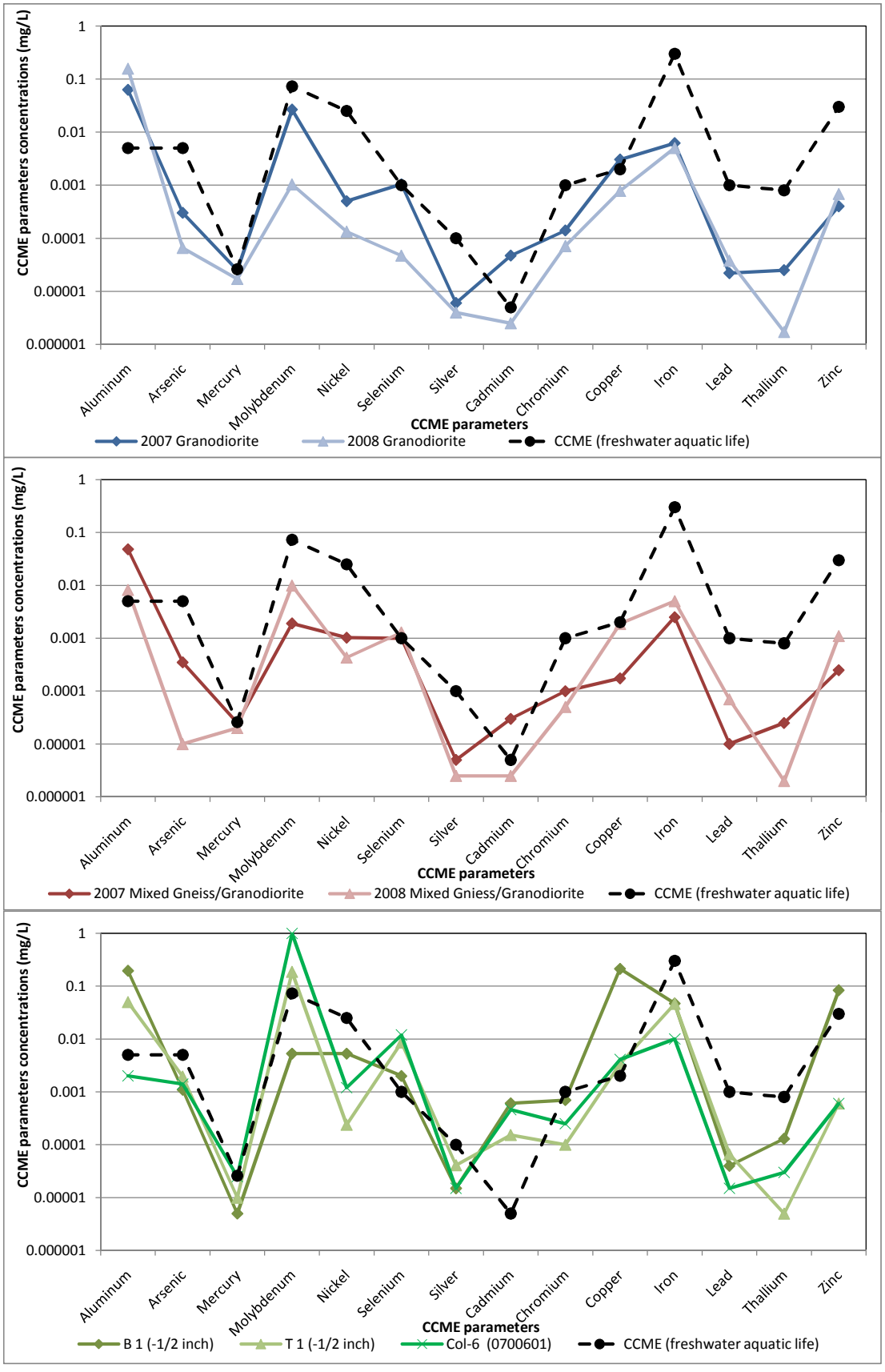


Figure 6-5
Sulphide Sulphur vs. Paste pH for 2007 and 2008 Samples
Carmacks Copper Project, YT

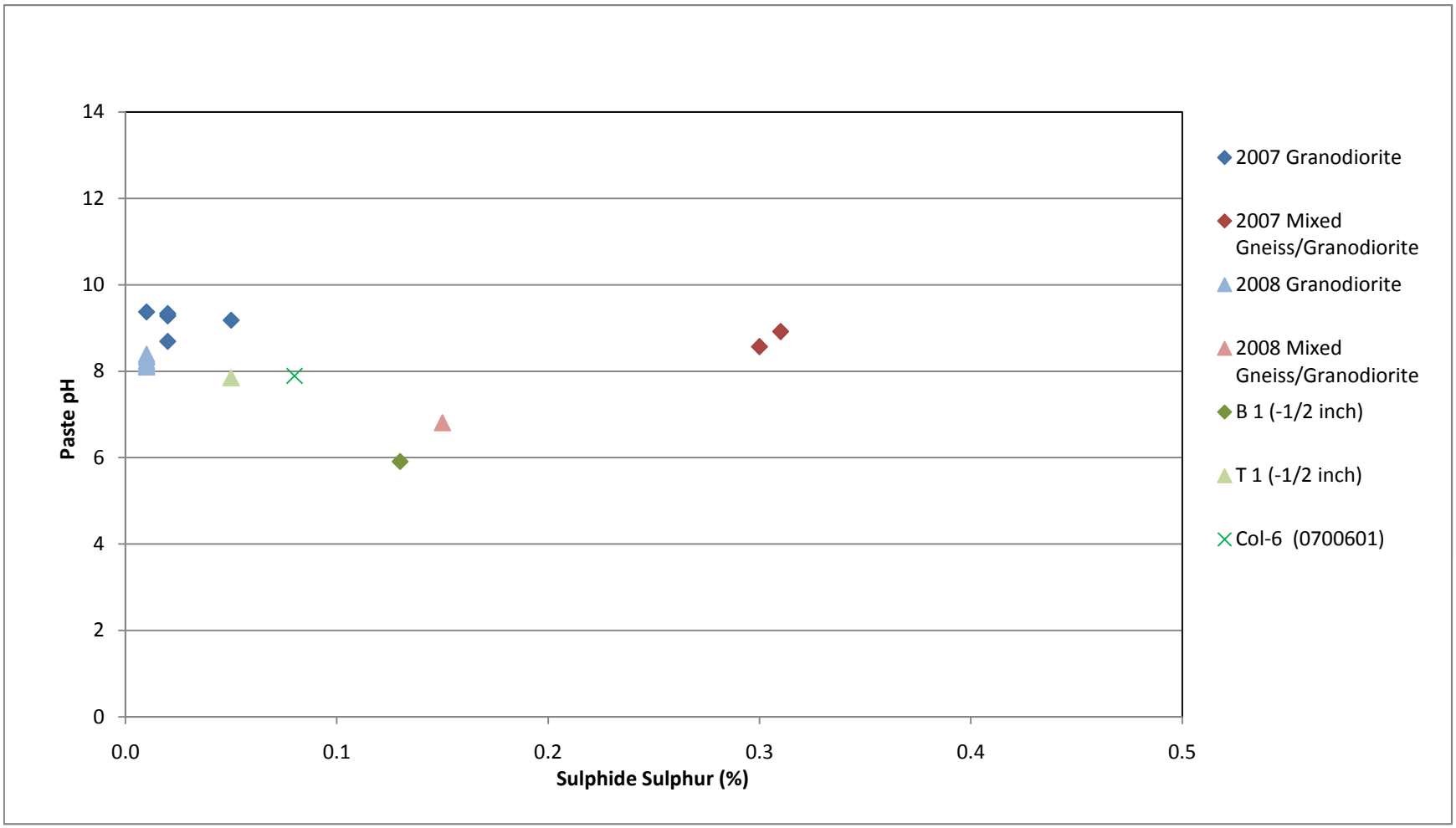


Figure 6-6
Sulphide Sulphur vs. Total Sulphur for 2007 and 2008 Samples
Carmacks Copper Project, YT

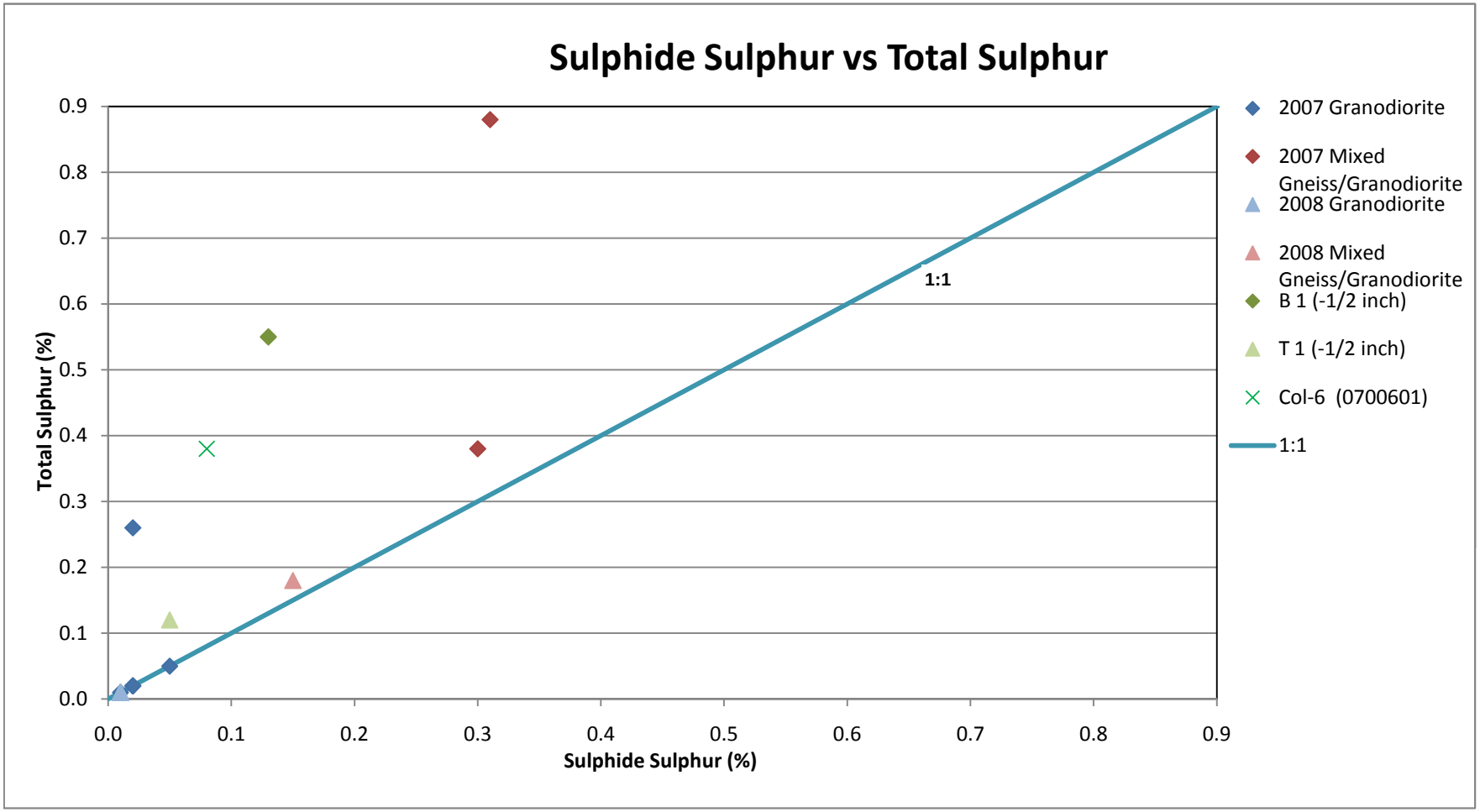


Figure 6-7
CaCO3 NP vs. Bulk NP for 2007 and 2008 Samples
Carmacks Copper Project, YT

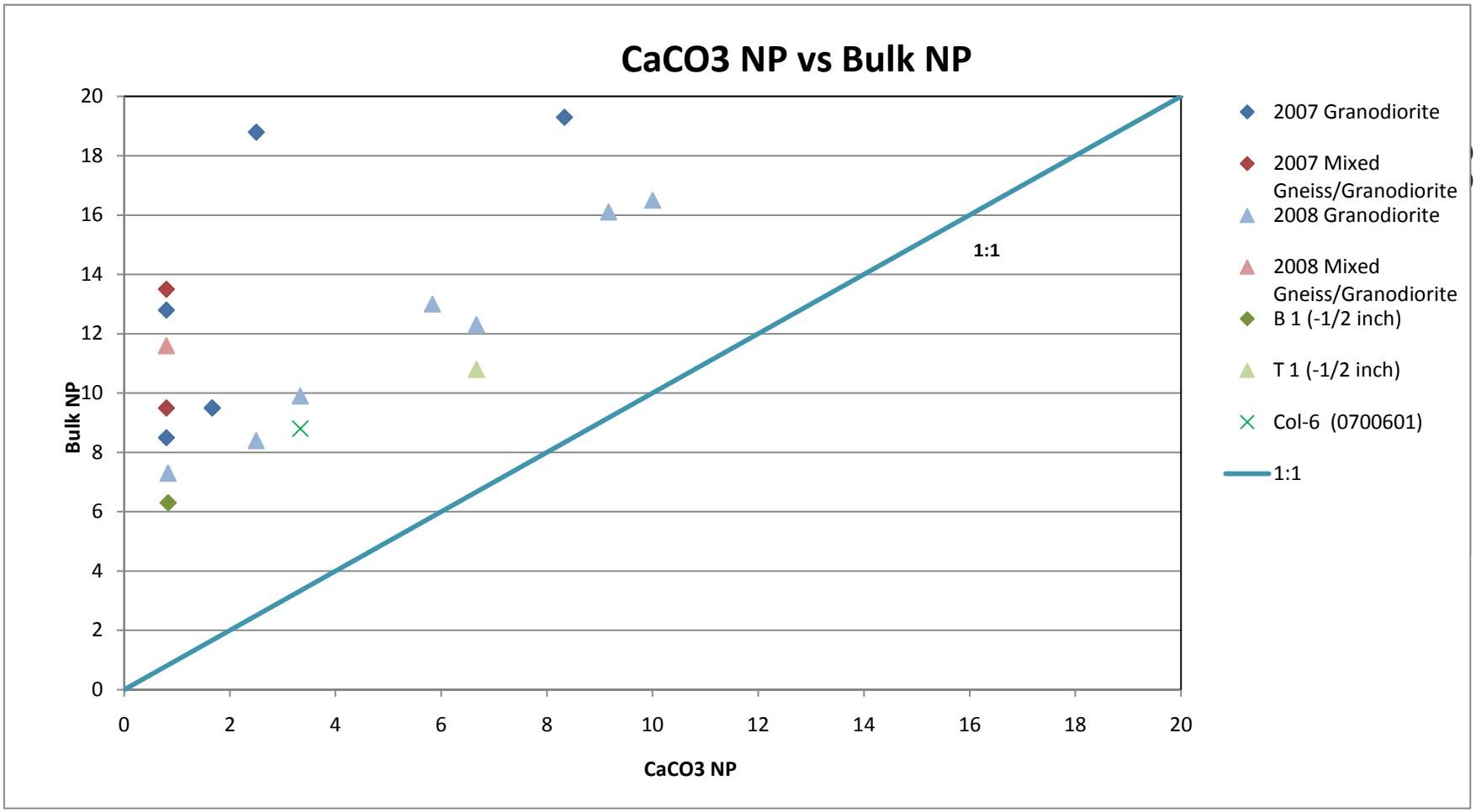


Figure 6-8
Bulk NP vs. AP for 2007 and 2008 Samples
Carmacks Copper Project, YT

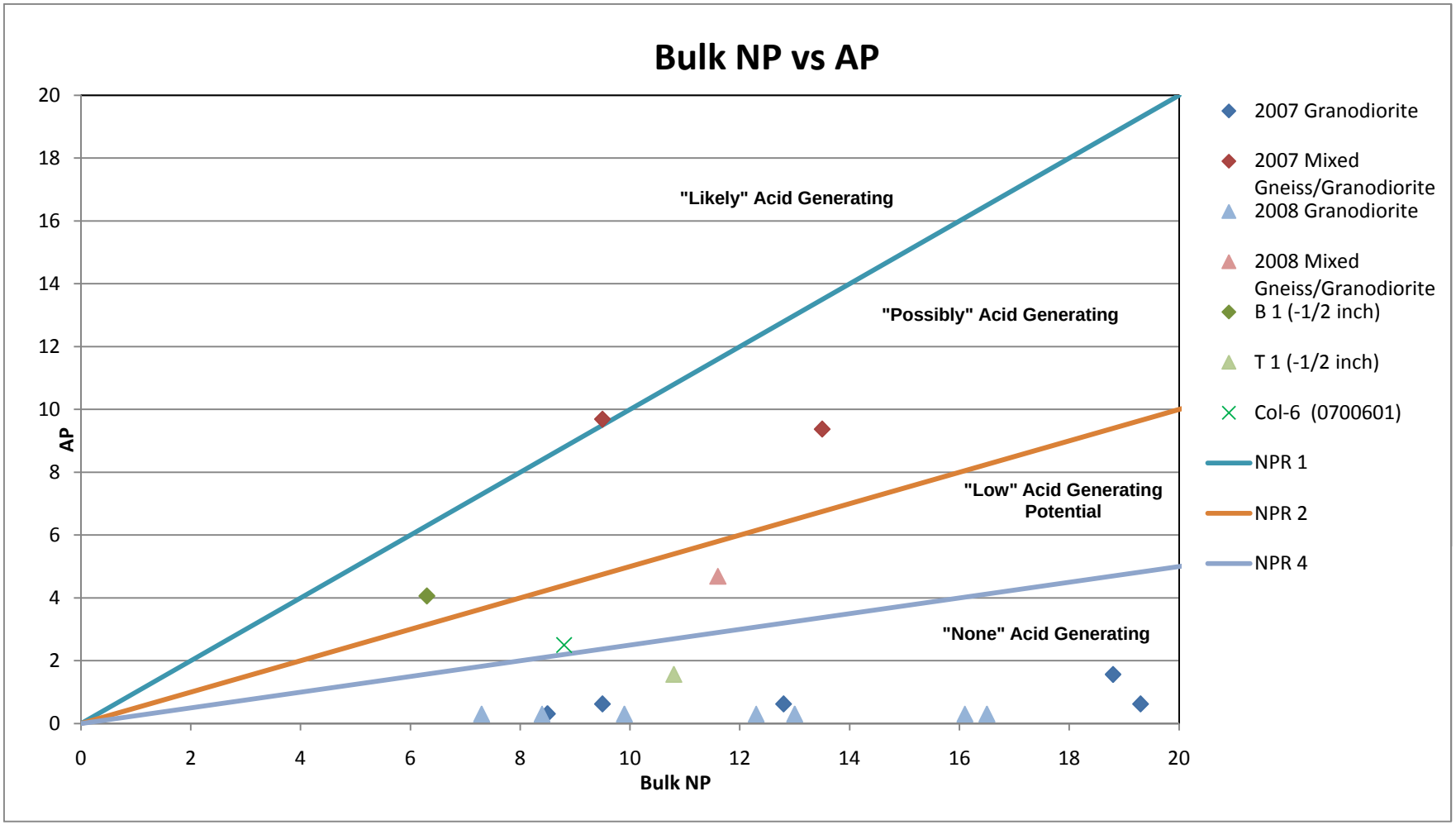


Figure 6-9
CaCO3 NP vs. AP for 2007 and 2008 Samples
Carmacks Copper Project, YT

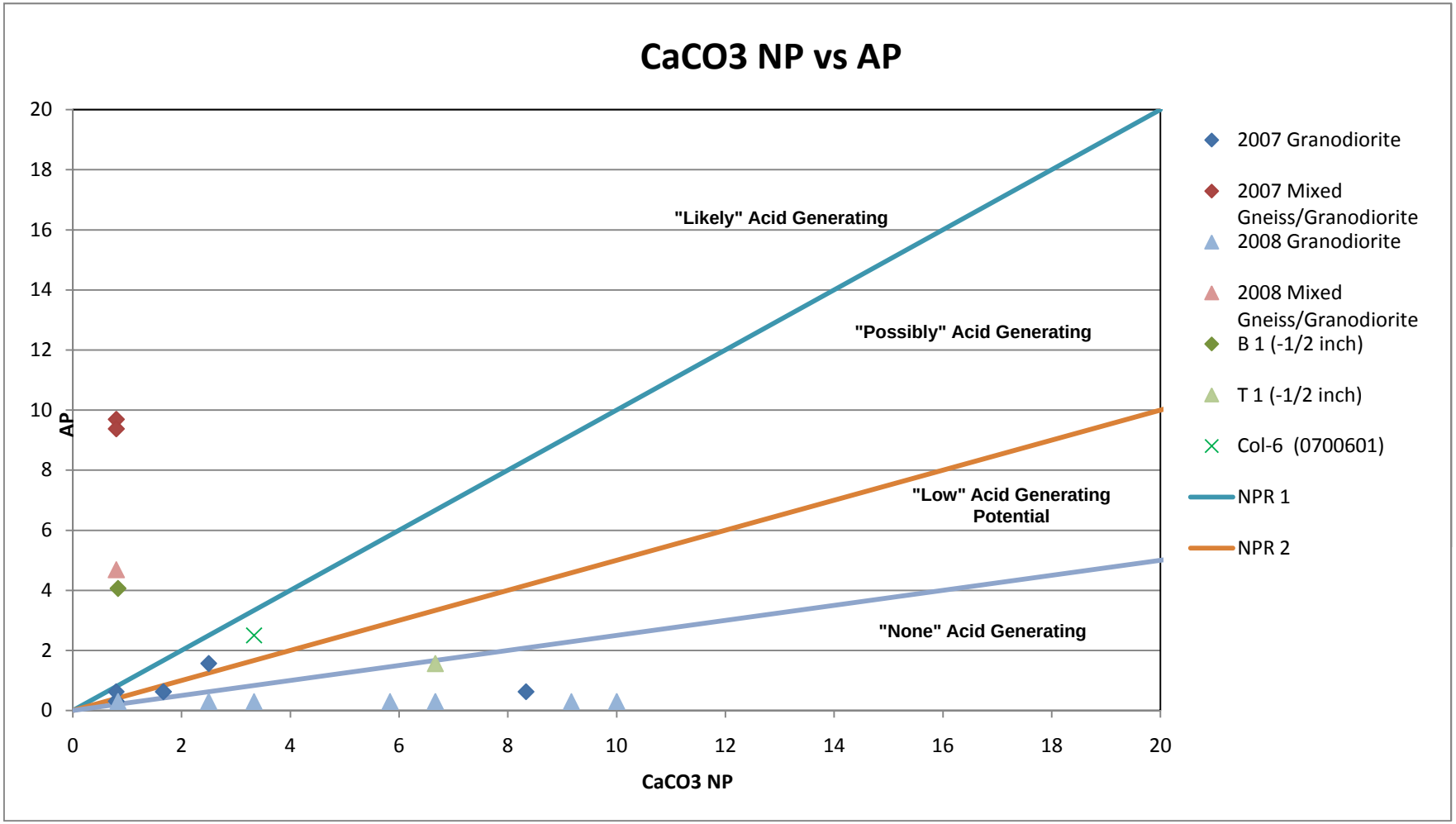


Figure 6-10
Sulphide Sulphur vs. NPR for 2007 and 2008 Samples
Carmacks Copper Project, YT

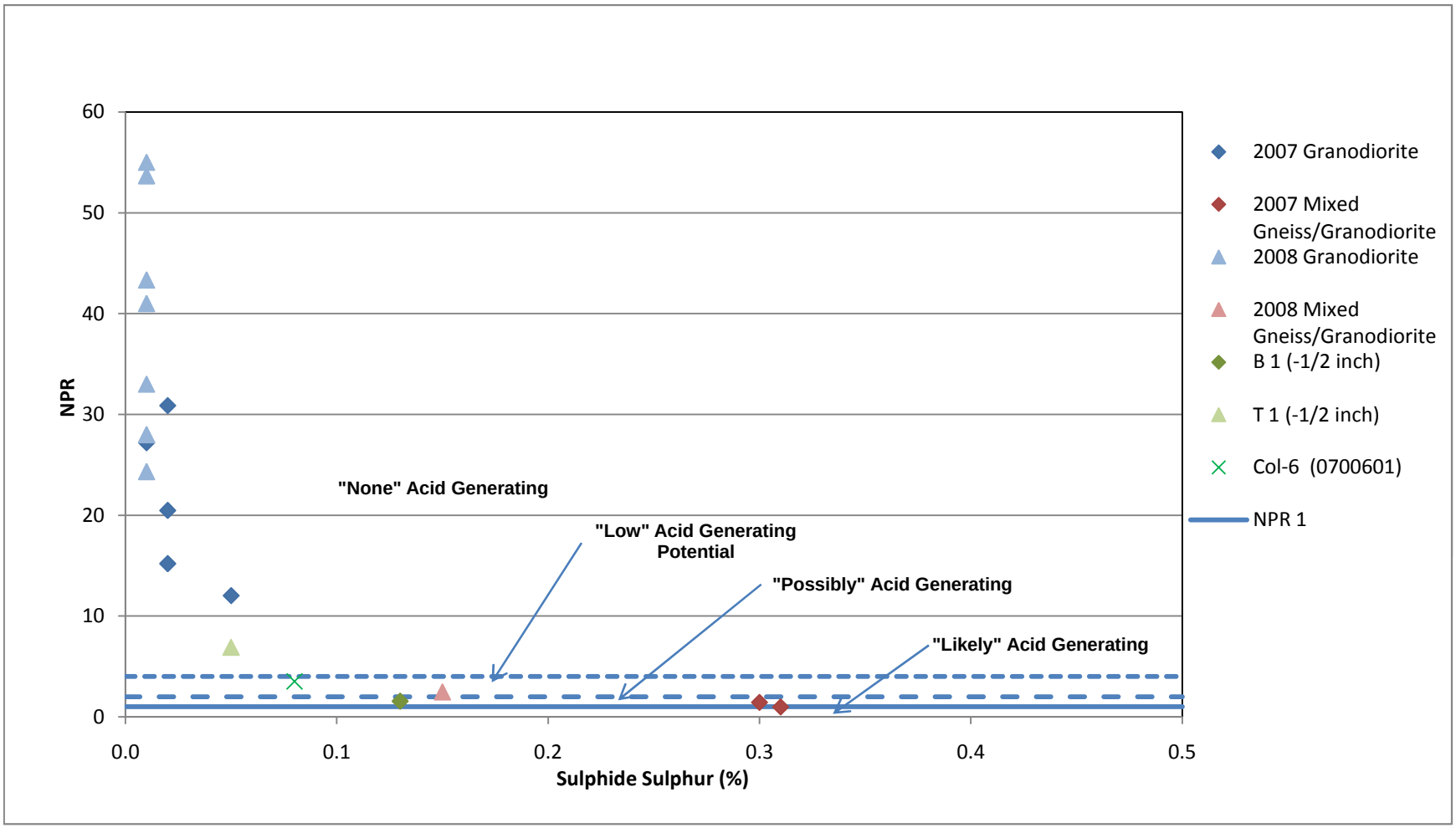


Figure 6-11
Sulphide Sulphur vs. NNP for 2007 and 2008 Samples
Carmacks Copper Project, YT

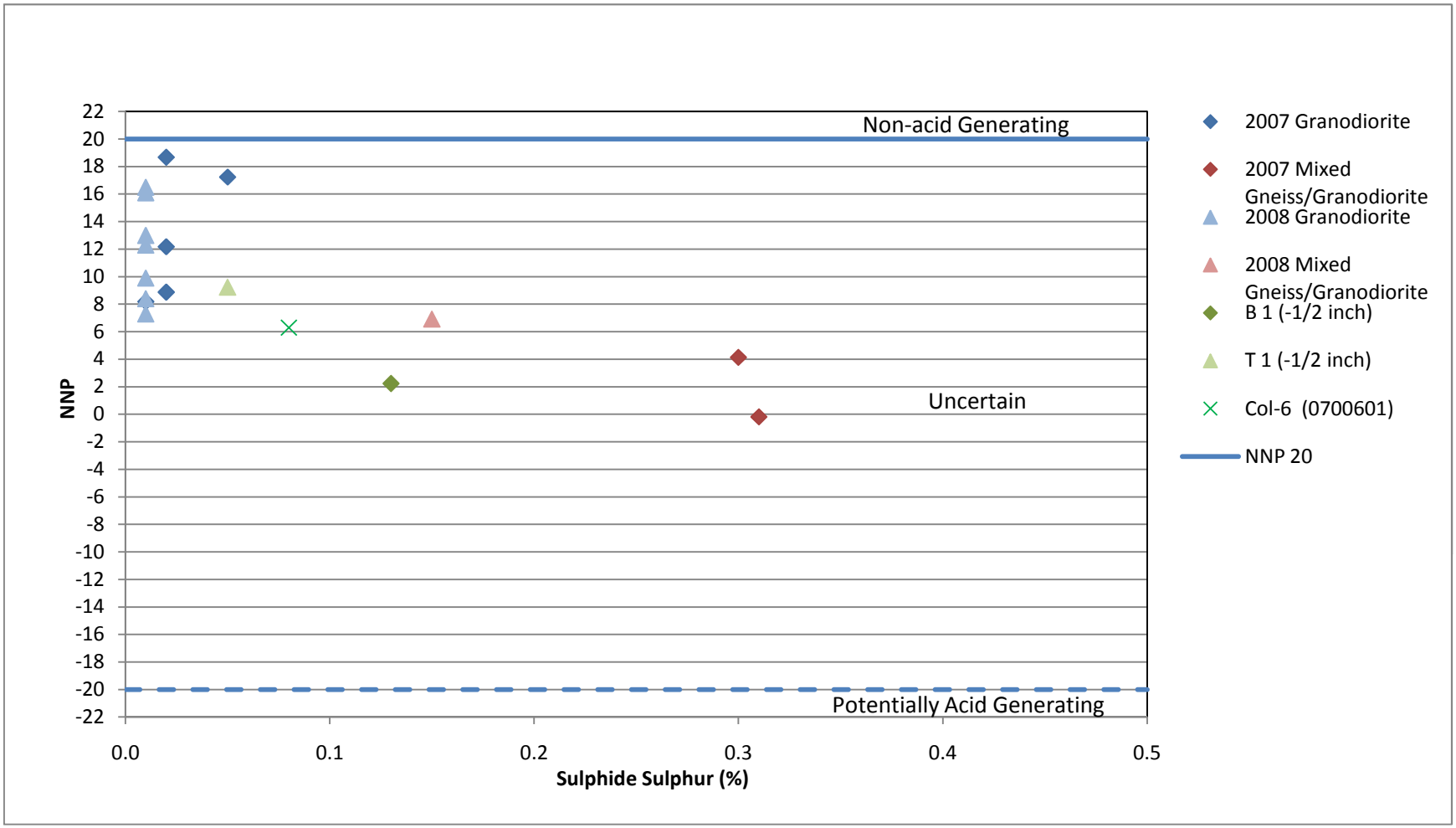


Figure 6-12
NNP vs. NPR for 2007 and 2008 Samples
Carmacks Copper Project, YT

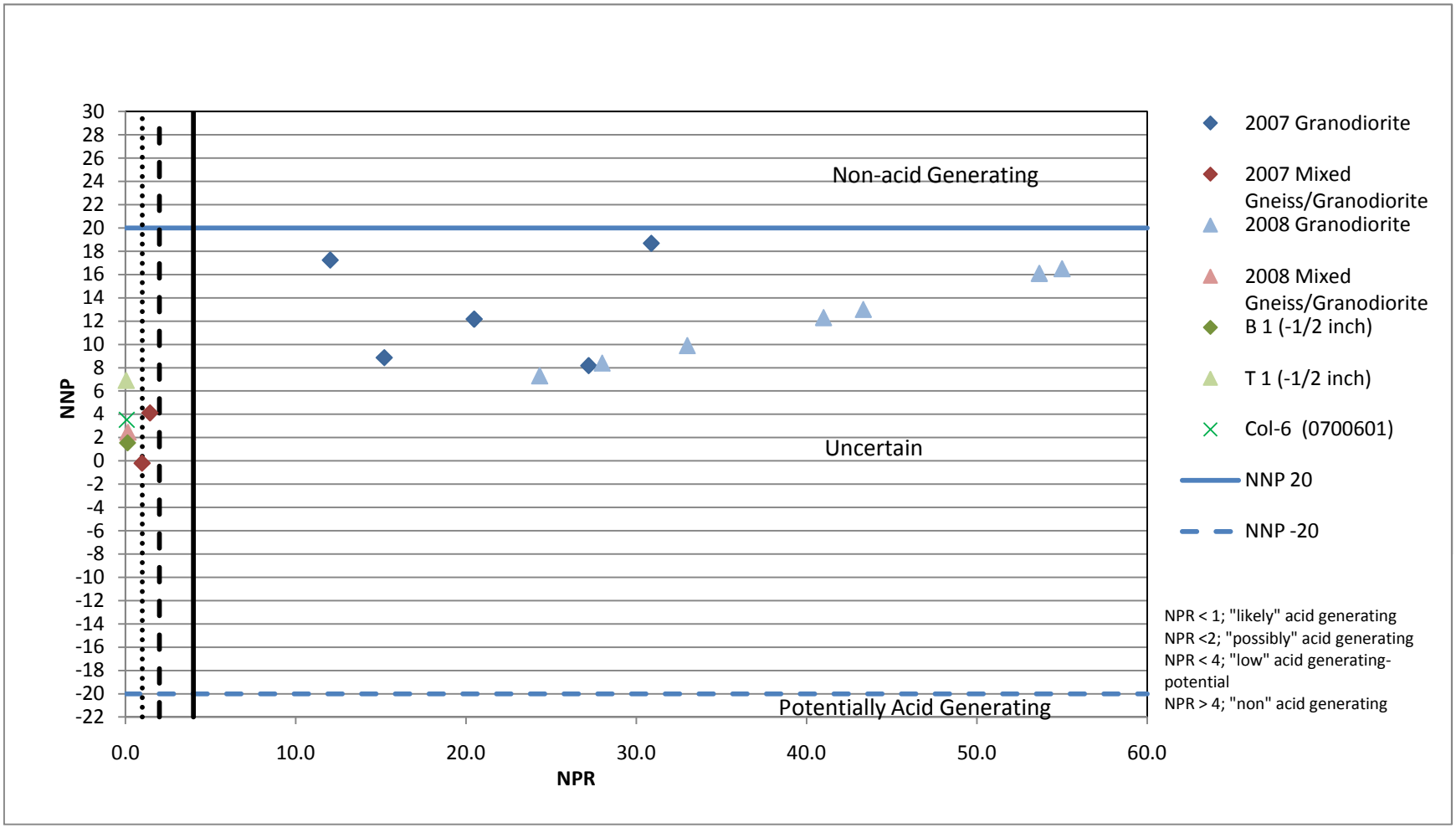


Figure 6-13
pH results for Spent Ore Kinetic Testing
Carmacks Copper Project, YT

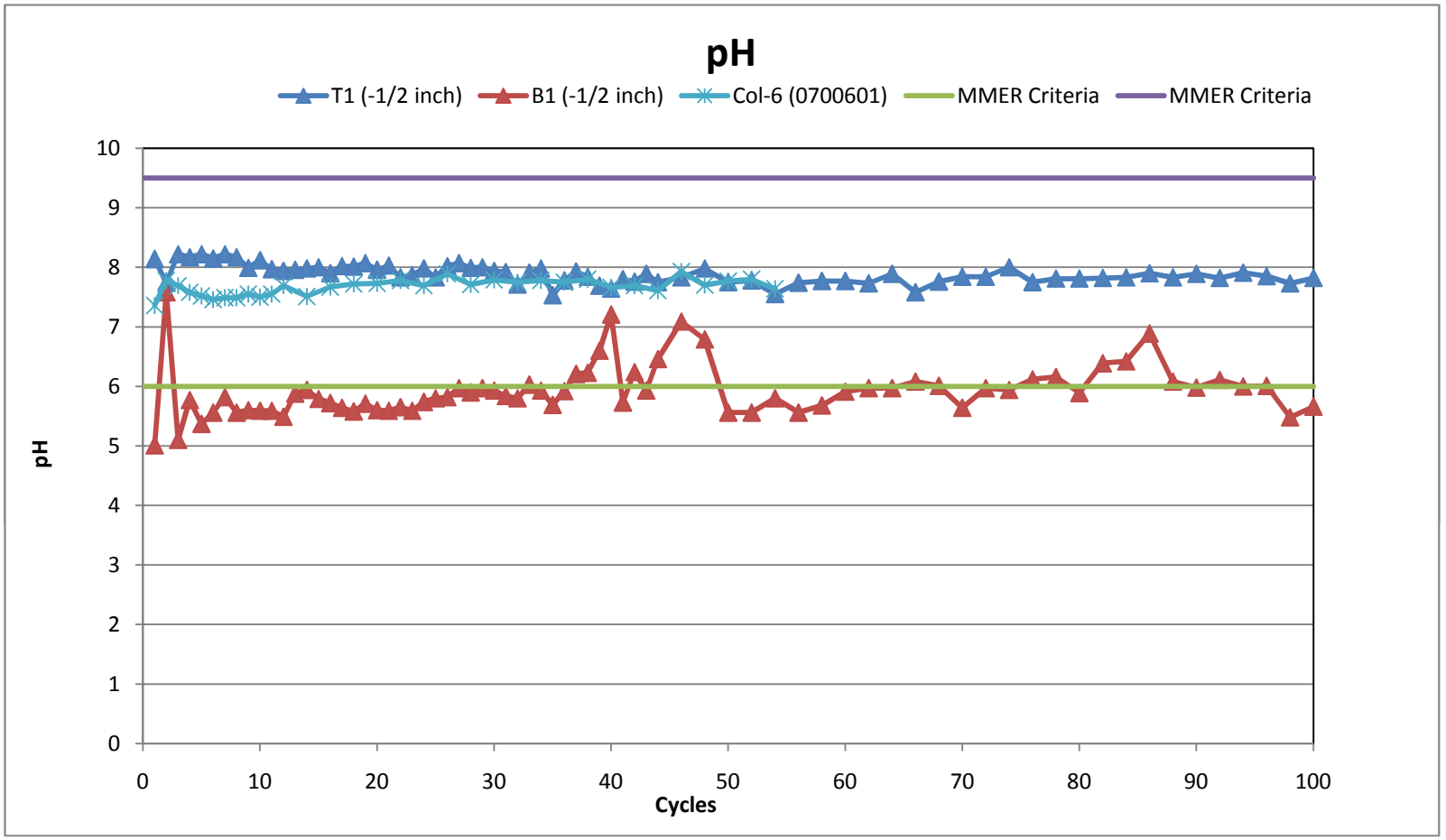


Figure 6-14
Alkalinity results for Spent Ore Kinetic Testing
Carmacks Copper Project, YT

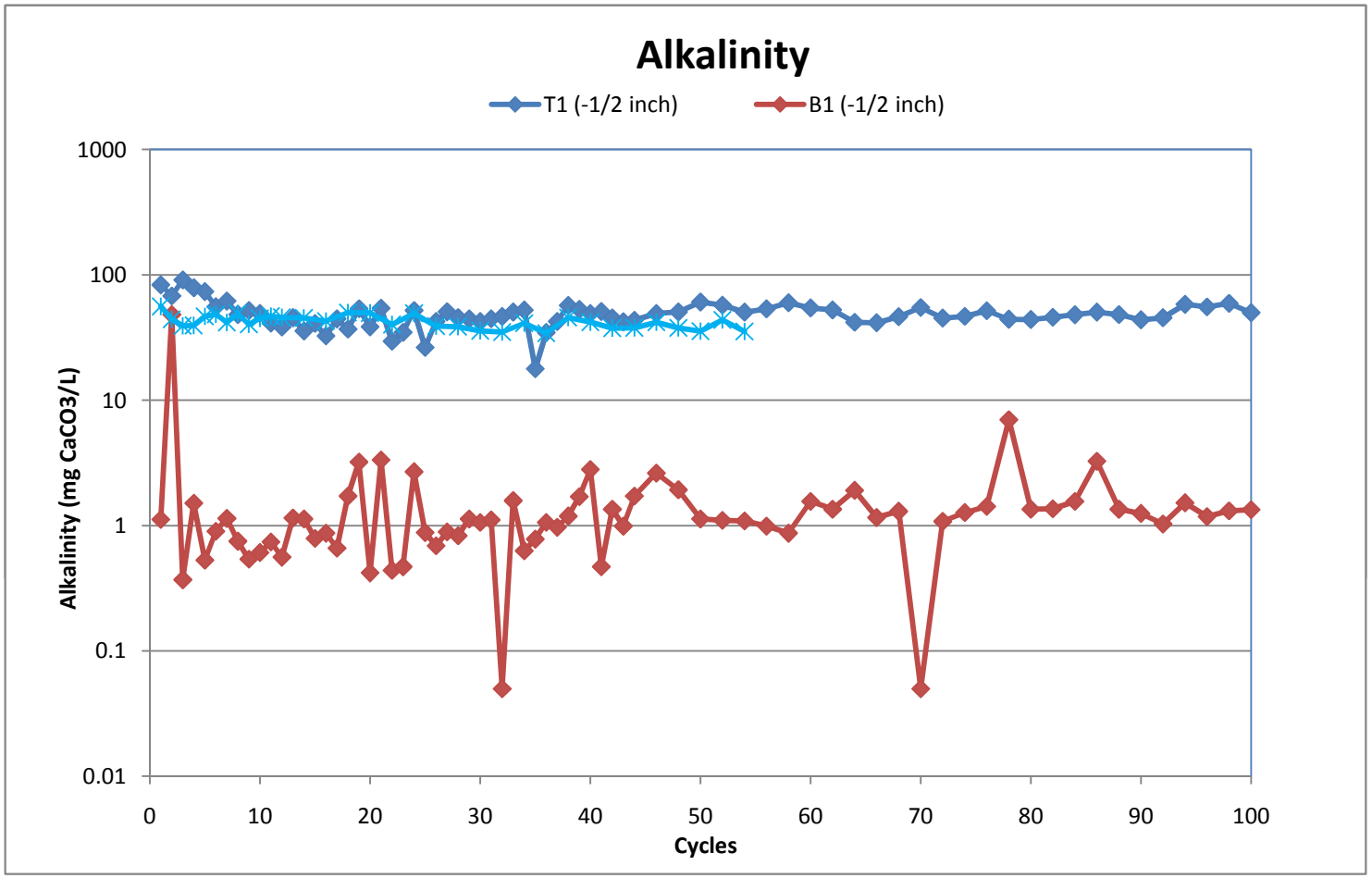


Figure 6-15
Sulphate Results for Spent Ore Kinetic Testing
Carmacks Copper Project, YT

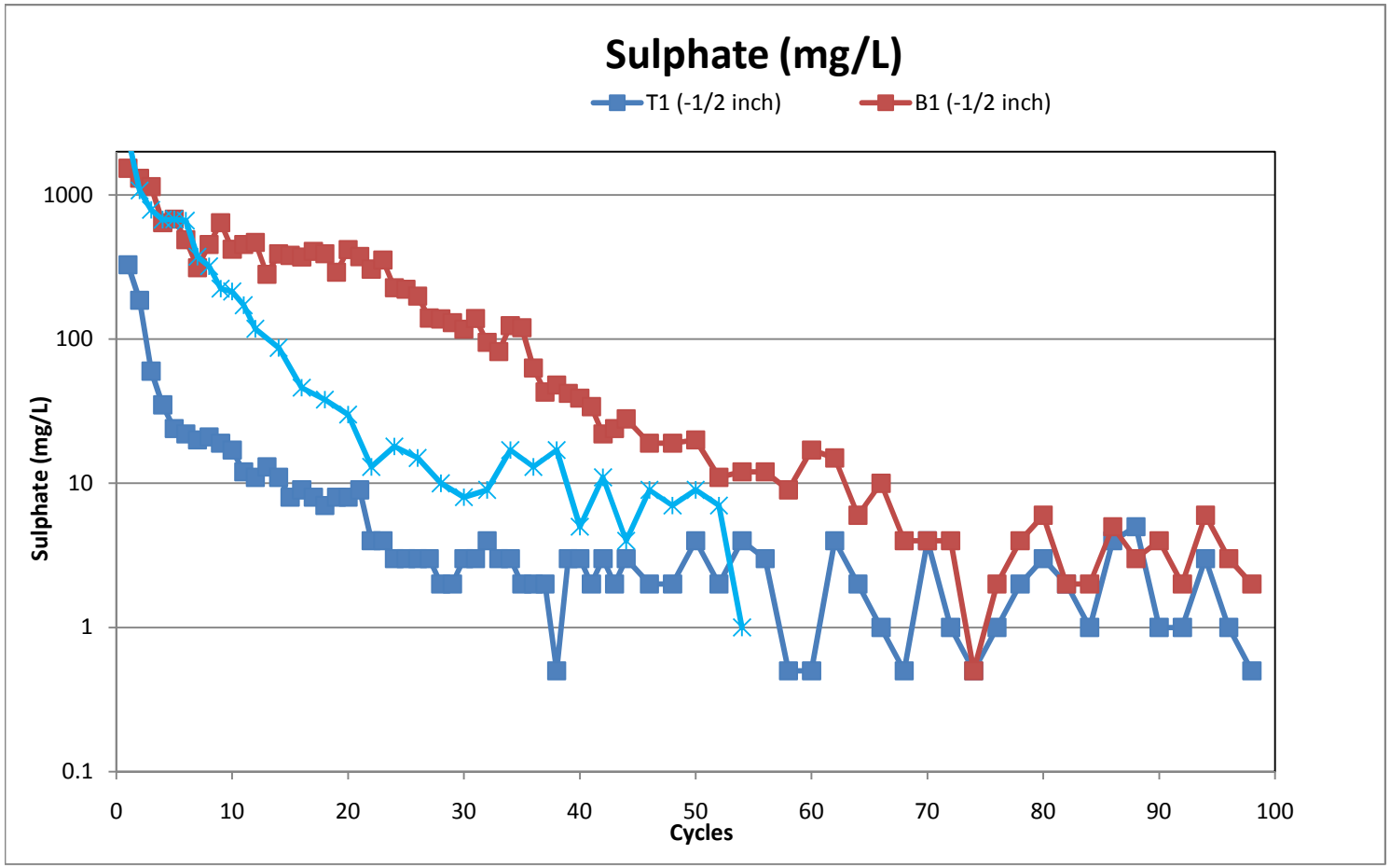


Figure 6-16
Arsenic Results for Spent Ore Kinetic Test
Carmacks Copper Project, YT

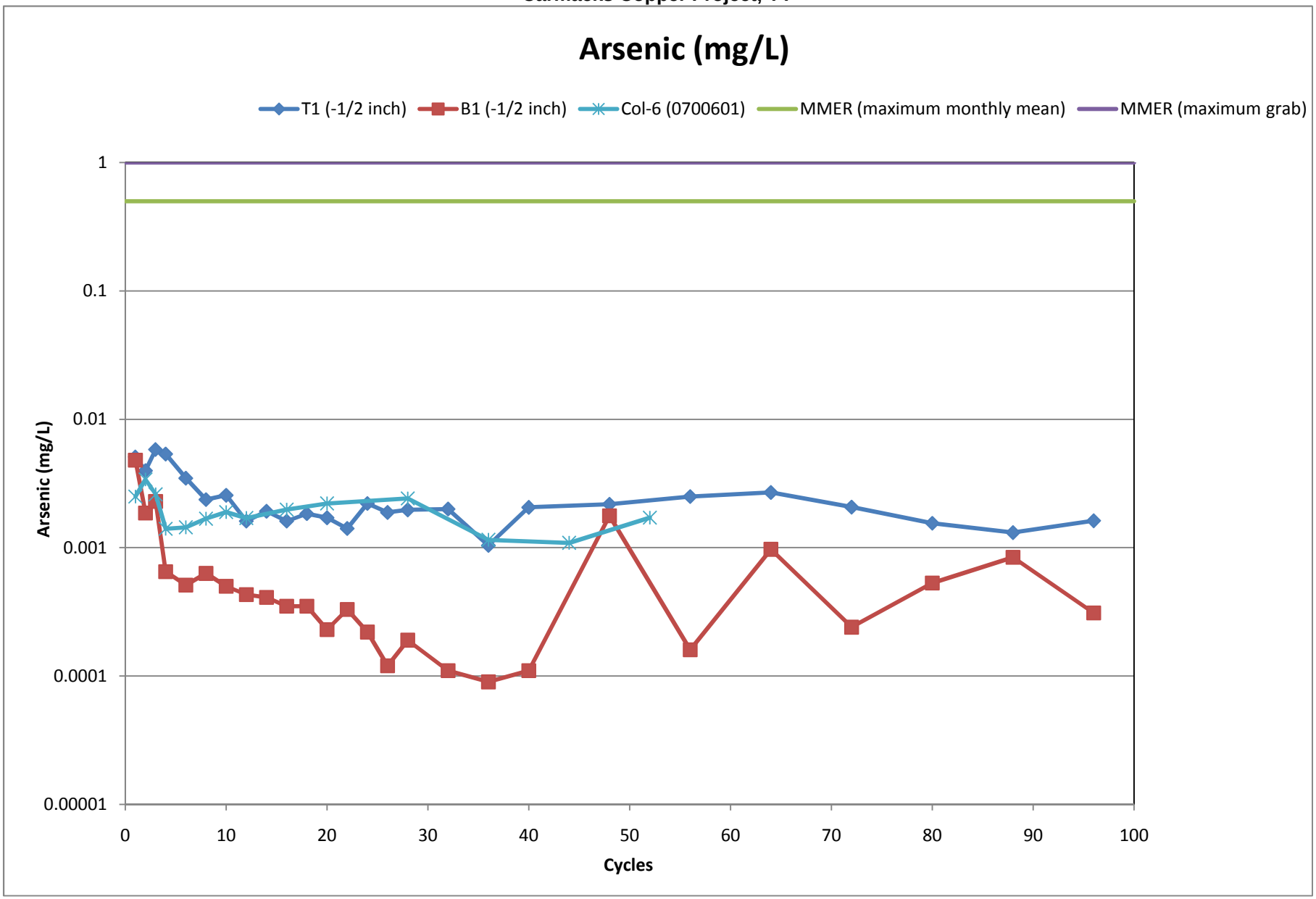


Figure 6-17
Copper Results for Spent Ore Kinetic Test
Carmacks Copper Project, YT

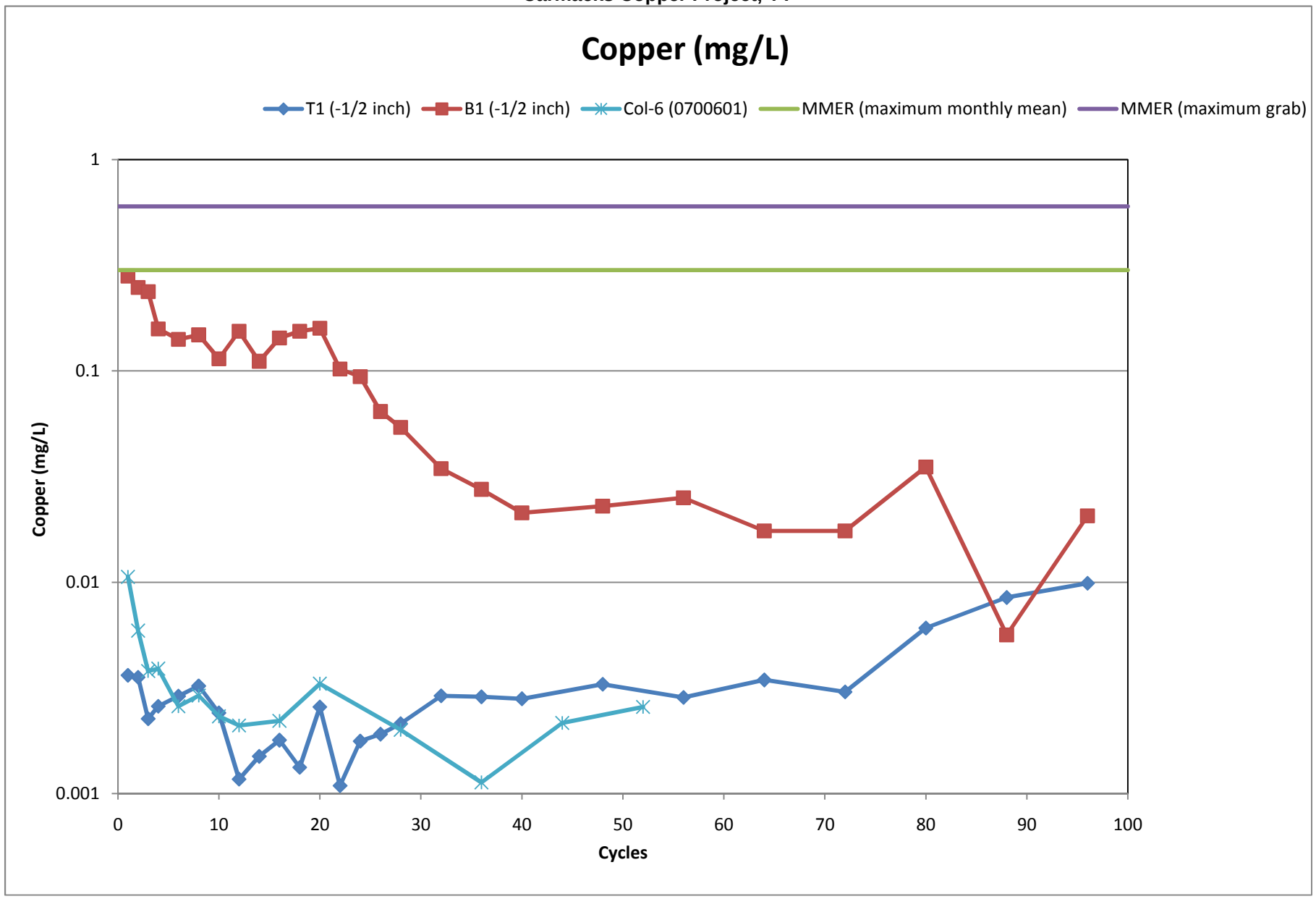


Figure 6-18
Nickel Results for Spent Ore Kinetic Test
Carmacks Copper Project, YT

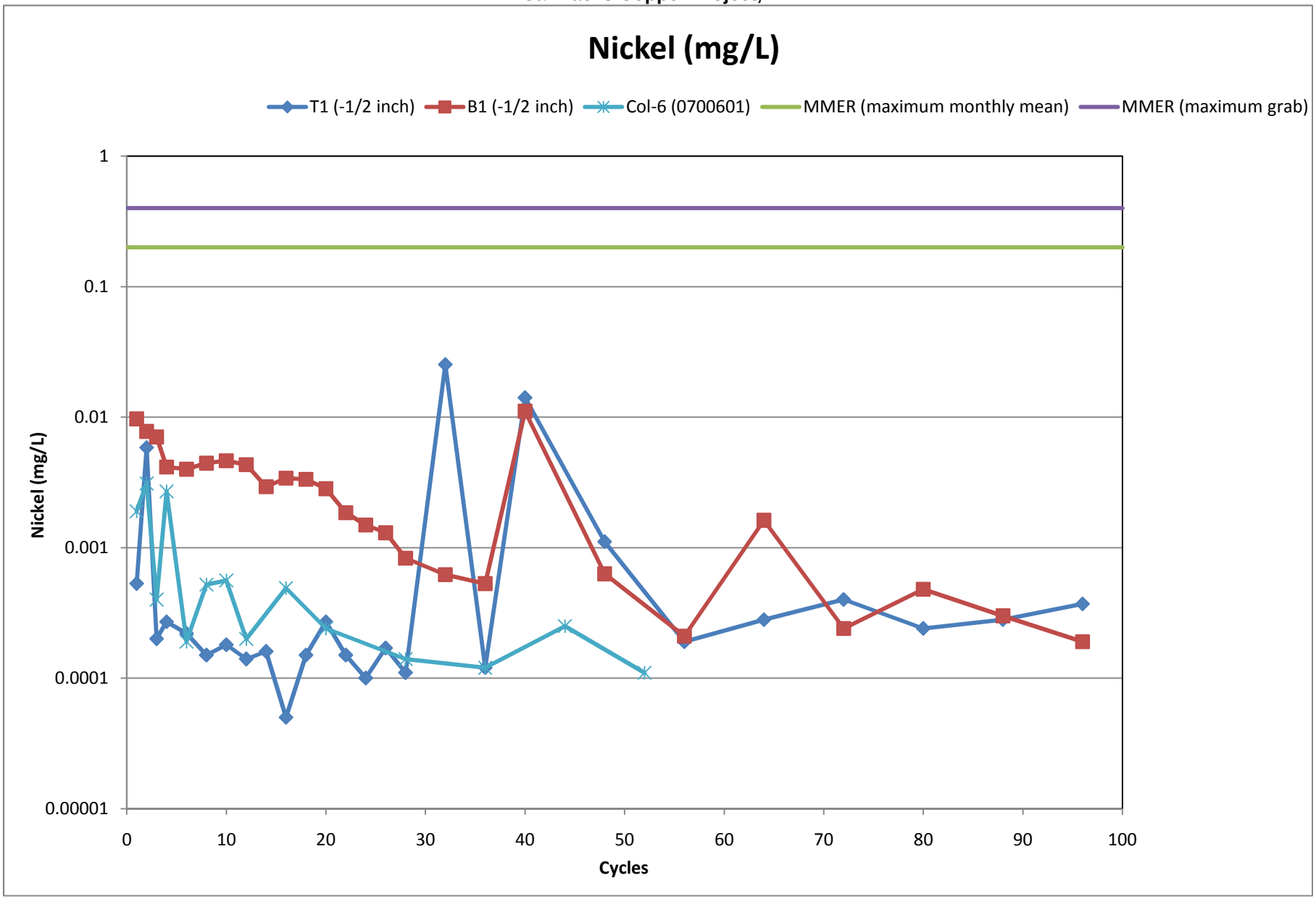


Figure 6-19
Lead Results for Spent Ore Kinetic Test
Carmacks Copper Project, YT

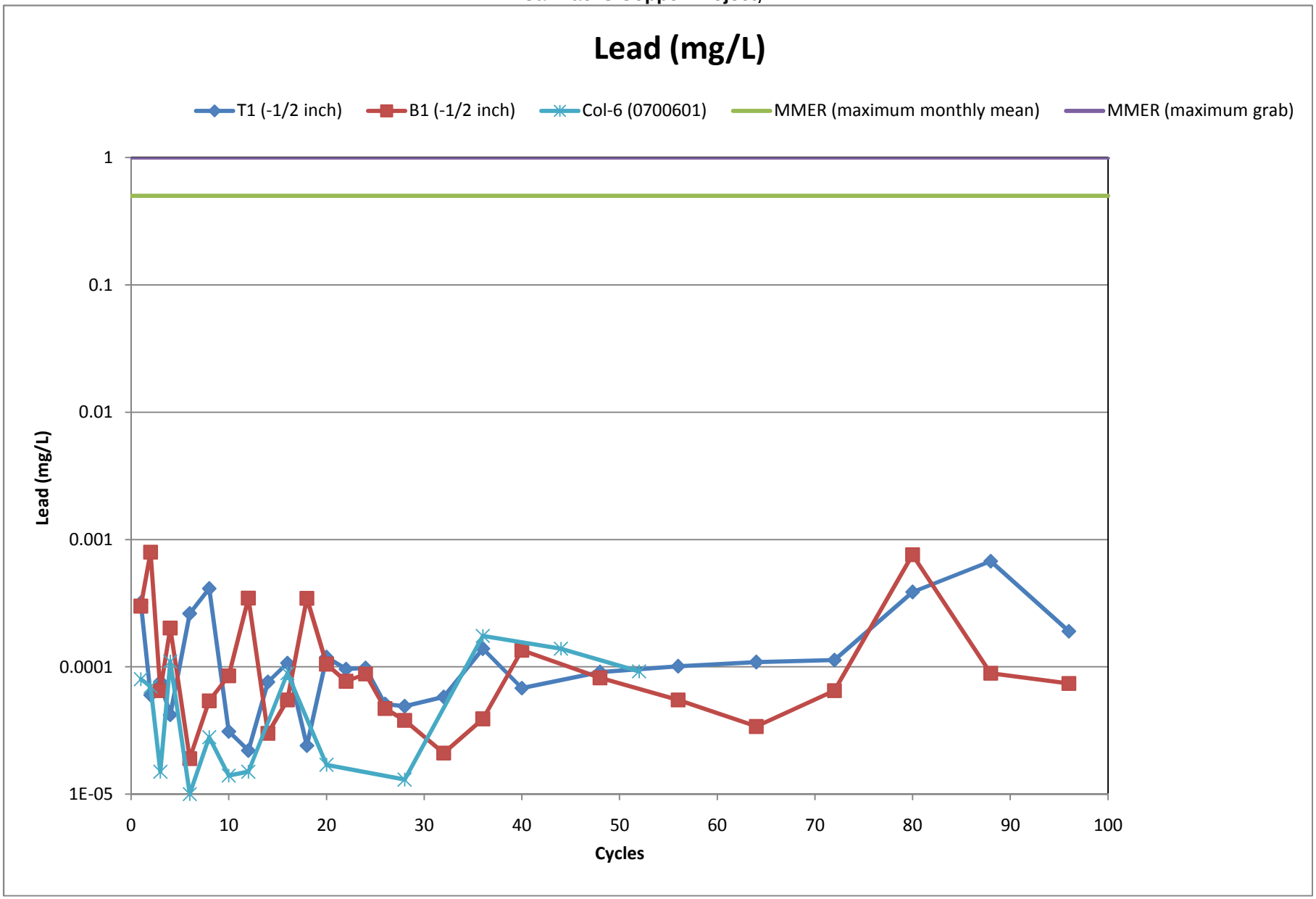


Figure 6-20
Zinc Results for Spent Ore Kinetic Test
Carmacks Copper Project, YT

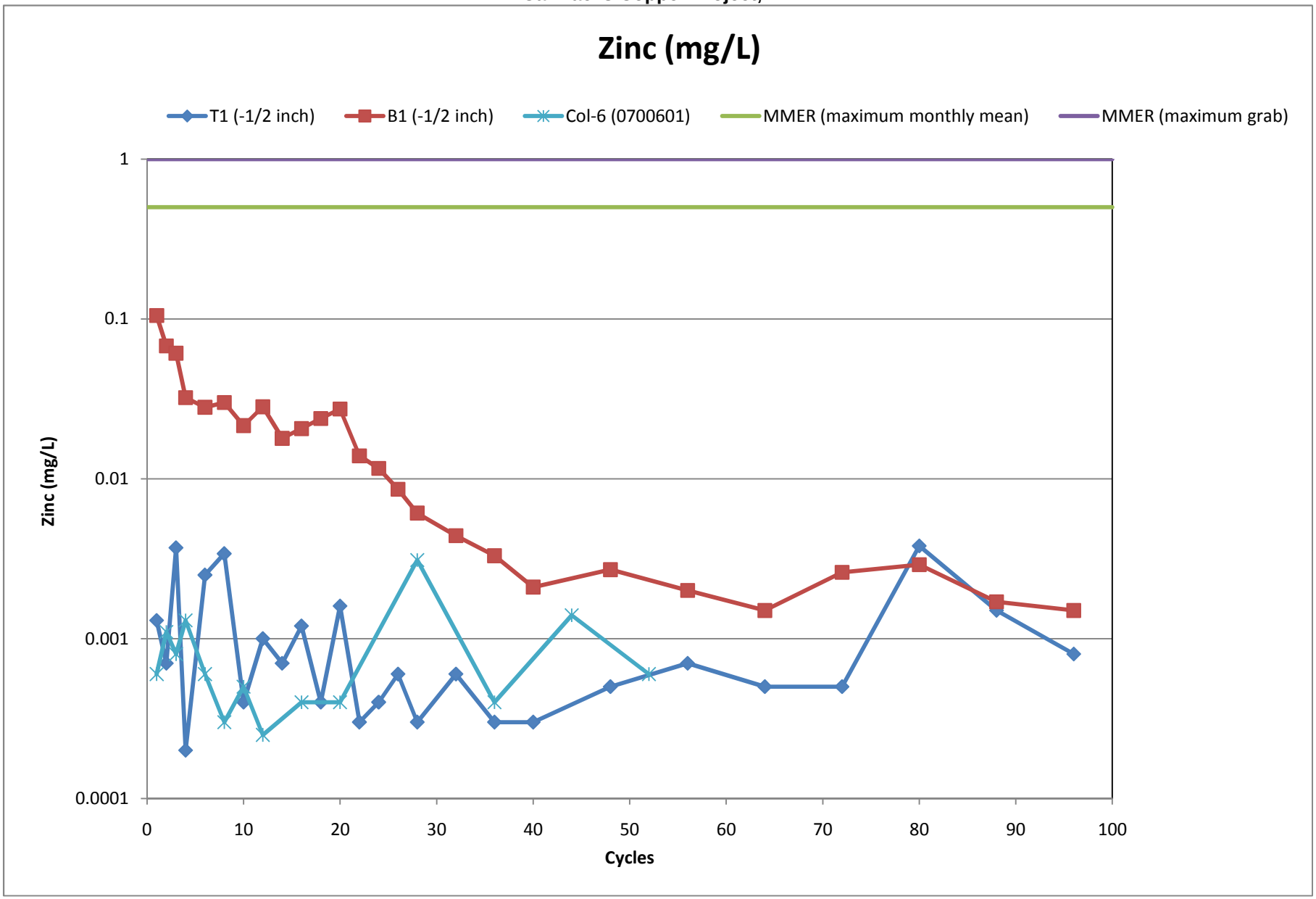


Figure 6-21
Antimony Results for Spent Ore Kinetic Test
Carmacks Copper Project, YT

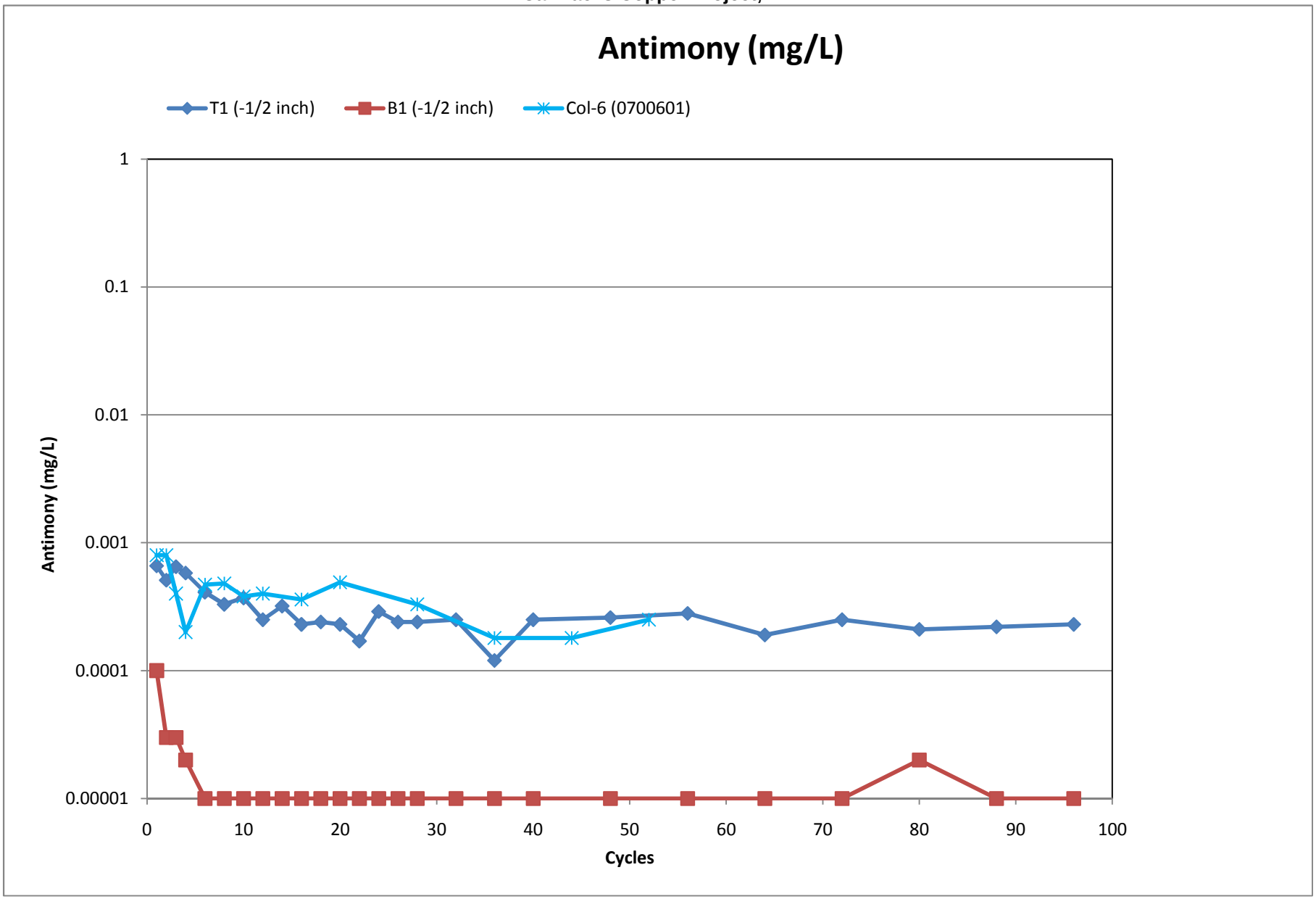


Figure 6-22
Cadmium Results for Spent Ore Kinetic Test
Carmacks Copper Project, YT

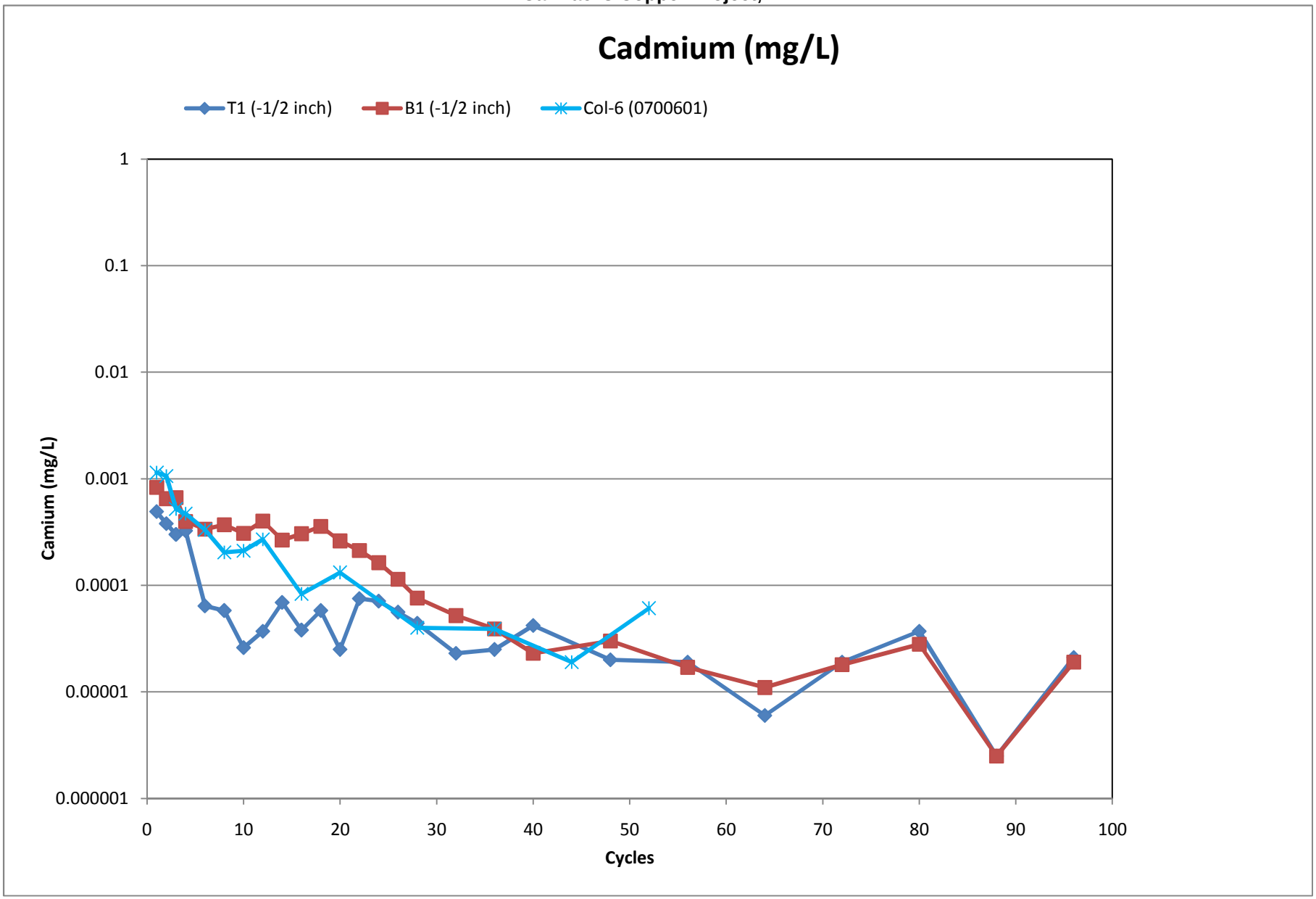


Figure 6-23
Molybdenum Results for Spent Ore Kinetic Test
Carmacks Copper Project, YT

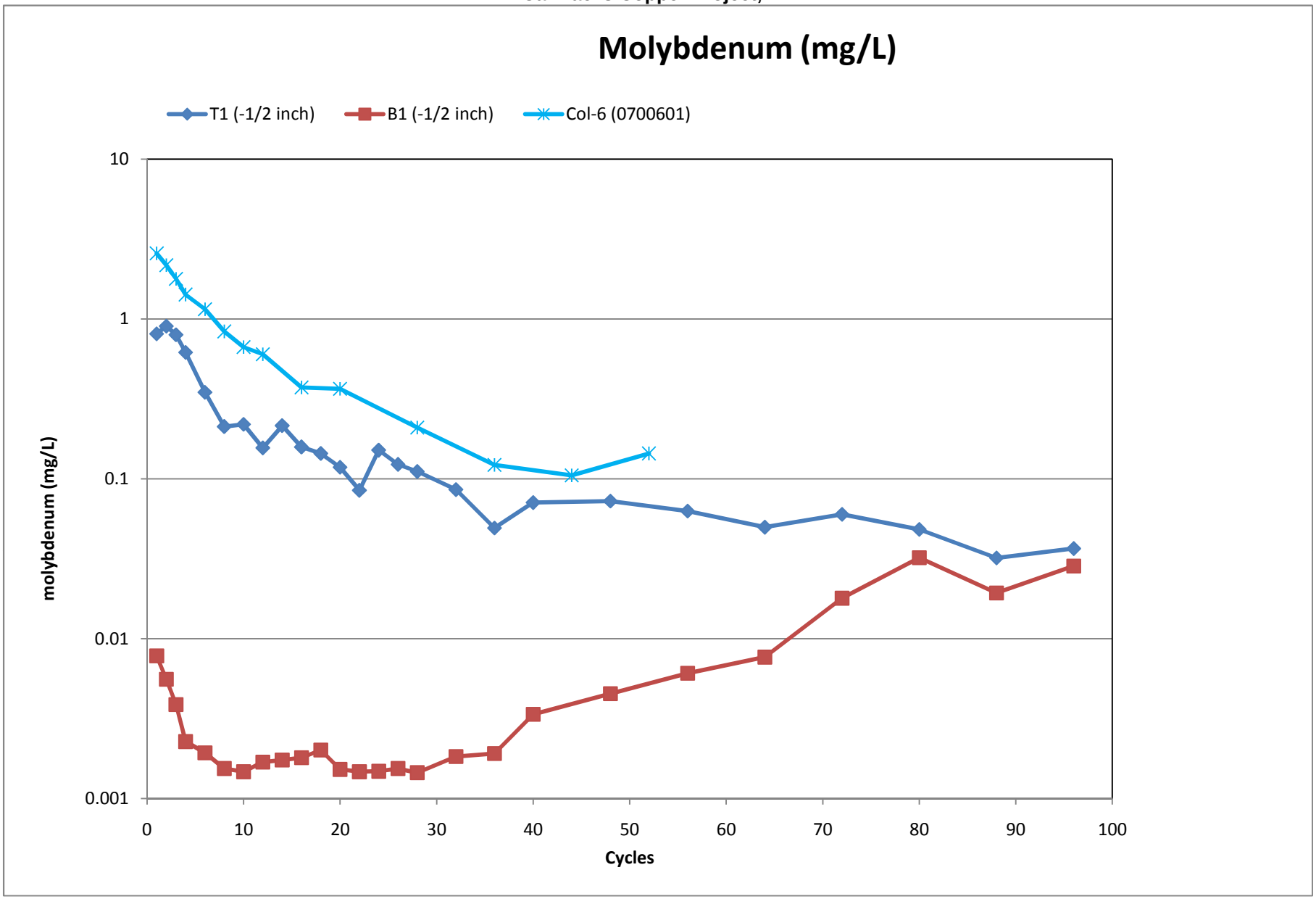


Figure 6-24
Mercury Results for Spent Ore Kinetic Test
Carmacks Copper Project, YT

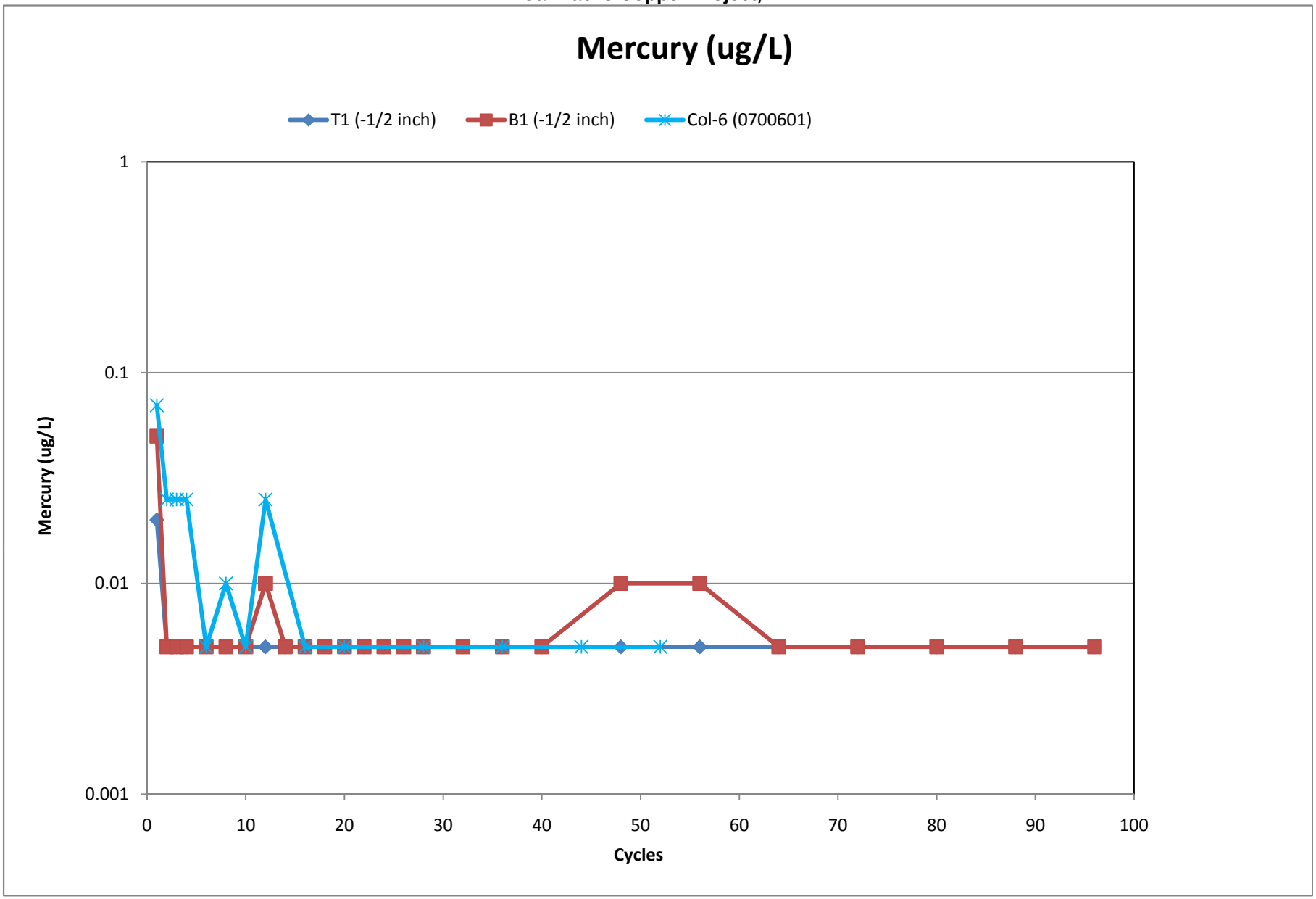
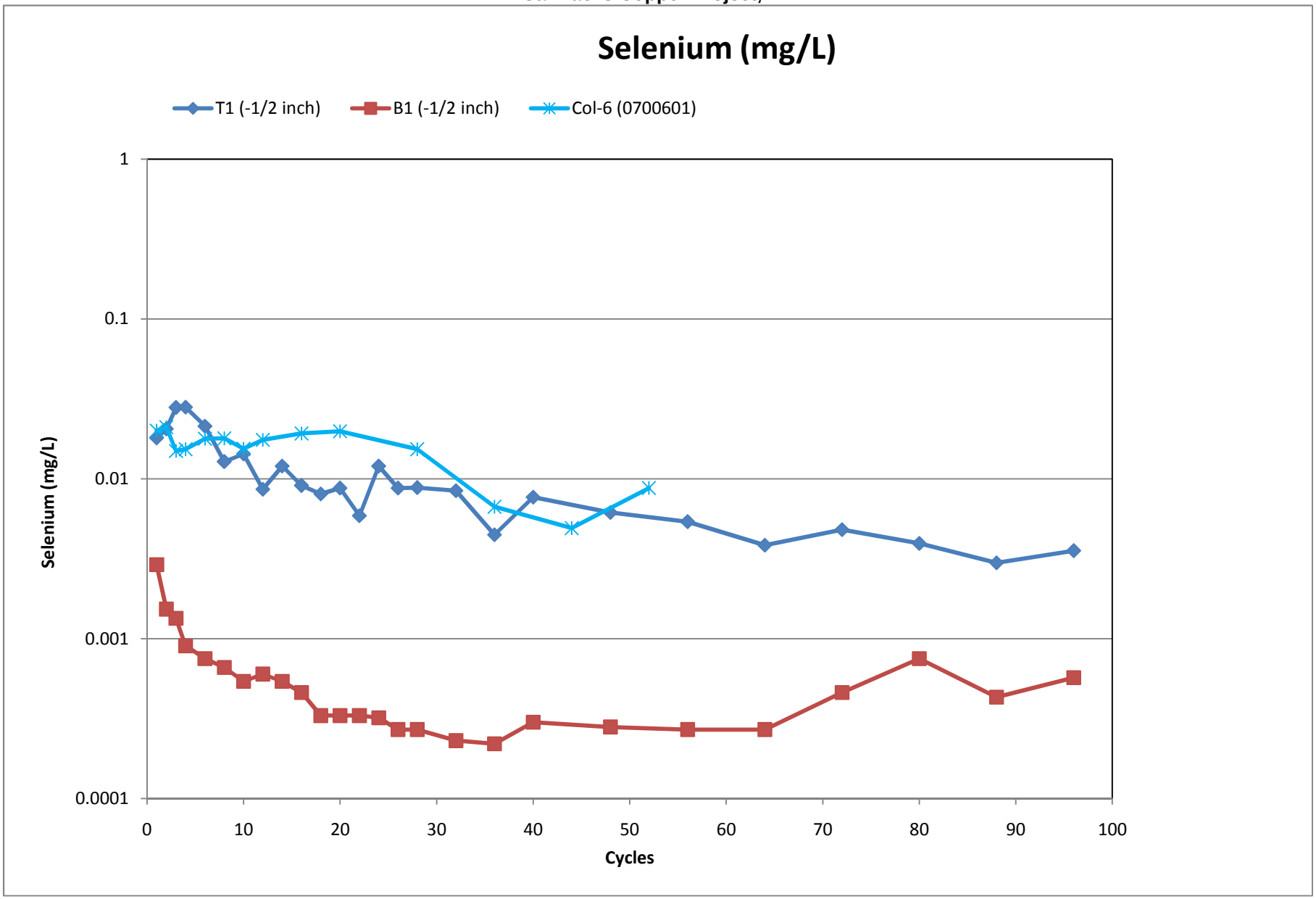


Figure 6-25
Selenium Results for Spent Ore Kinetic Test
Carmacks Copper Project, YT



APPENDIX I

ACG Sampling Procedure

Member of the Alexco Resource Group
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Whitehorse, Yukon Y1A 2V3
PHONE (867) 668-6463 **FAX** (867) 667-6680
www.accessconsulting.ca

To: Jonathan Clegg, Project Manager, Western Copper Corporation
Paul West-Sells, Senior Metallurgist

From: Rob McIntyre, R.E.T., CCEP, President
Dan Cornett, B.Sc., P.Biol., CCEP, Vice President

Date: **January 8, 2007**

Subject: **Letter Report Re: Western Copper Corporation, Carmacks Copper Project, Rock Sampling, Friday, August 21, 1998**

BACKGROUND

Previous metallurgical and permeability test work was conducted by PRA Laboratories and Knight Piesold Ltd. in 1997 on an 18 tonne run-of-mine ore sample, crushed to -¾" size. The material for this testing came from the bulk sample collected by Kilborn Engineering Pacific Ltd. ("Kilborn") from September 23 to October 9, 1997. Please refer to Report 8555-25 by Kilborn dated January, 1998, for a complete description of the procedures undertaken and commentary about the 'Run-of-Mine Bulk Sample Collection Program'.

It was subsequently determined that a 2" size fraction of the bulk sample was not available, and that additional ore should be collected from the property for additional metallurgical and permeability laboratory test work.

The objectives and purpose of the sample collection program that was undertaken by Access Consulting Group ("ACG") on August 21, 1998 were to:

- obtain additional samples, more typical of the physical characteristics of run-of-mine ore, collected from the same source trenches as were sampled during the 1997 ROM Bulk Sample Collection Program, for additional metallurgical test work; and

- to visually inspect the 1997 bulk sample trenches and the remaining stockpiles of blended trench bulk sample, and collect samples from the trench and the bulk composite pile for further test work.

PROCEDURES

Report "Western Copper Holdings Limited, Carmacks Copper Project, Project No. 8555-25, Run-Of-Mine Bulk Sample Collection" by Kilborn, January 1998, was reviewed to determine the sampling locations, procedures followed, and observations made during that program.

Before collection of additional sample material commenced, ACG conducted a visual inspection of the four trenches that were sampled during the 1997 Kilborn Bulk Sample Collection program, and the remaining stockpile of re-handled ore (trench composites) at each site. See attached Figure with the trench and composite sample locations. It was readily observed that in each case, the trench composite piles located beside the trenches exhibited physical characteristics that did not appear to be representative of the ore in place; specifically, it was biased in favour of fine fraction material.

Trench 91-18 (Barrel "A" - see attached Photographs): The trench was measured by hip-chain to be approximately 38 metres in length, from above the hanging wall through the footwall of the deposit. Of the total trench length, visual inspection indicated approximately 16 m (42%) consisting of highly weathered, friable ore (including thoroughly decomposed dyke material), and approximately 22 m (58%) of substantially more competent, blocky-fractured rock.

The trench-composite stockpile, consisting of predominantly sand size material with occasional cobbles to 4" length, was not re-sampled. This trench afforded good access for the heavy equipment on hand (Bobcat 863 loader), and had a suitable amount of excess material piled in a row at the edge of the trench, to enable the collection of new material. Four partial Bobcat buckets were collected from the material along the length of this pile, and placed in the 200 litre steel drum. Barrel "A" contains approximately 350 kg of this material.

Trench 92-68 (Barrel "B" - see attached Photographs): Visual inspection indicated approximately 40% of the ore from the hanging wall to the footwall in this trench was highly weathered, friable to thoroughly decomposed, high moisture content material. The blade of a knife could readily be inserted into this material. The trench was not accessible by the Bobcat, and did not have a stockpile of trench ore along the outer edge of the trench. Therefore, the only re-sampling option available was to split the pile, and obtain material from the centre of the existing trench composite pile. Each bucket load was sampled by hand shovel to bias the sample in favour of coarse material (>2" rock). Barrel "B" contains approximately 350 kg of this material.

Trench 91-20 (Barrel "C"- see attached Photographs): This trench was not accessible by the Bobcat for new sample material collection, nor was the trench composite available. The only stockpile of material was apparently the bulk composite pile that Kilborn had prepared as a composite of all four trenches. Sample selection was similar to that described for Trench 92-68. Barrel "C" contains approximately 350 kg of this material.

Trench 91-22 (Barrel "D"- see attached Photographs): This trench was not accessible by the Bobcat for new sample material collection, therefore the sample was collected from the remaining trench composite pile from the 1997 ROM Bulk Sample. Each bucket load was sampled by hand shovel to bias the sample in favour of coarse material (>2" rock). Barrel "D" contains approximately 350 kg of this material.

OBSERVATIONS AND COMMENTS

Unaided visual examination of the remaining stockpile of the material collected during the 1997 ROM Bulk Sample program, suggests that it may not have been representative of the physical properties of the run-of-mine ore; i.e., there appears to have been an over representation of fine fraction material.

Although much fine fraction material inevitably was included with the sample, an attempt was made to bias the sample in favour of +2" material for the additional laboratory testing.

Probable causes for the overly fine particle size of the ROM Bulk Sample include blasting conditions and sample handling procedures.

Three factors would have contributed to blast violence in excess of that typical for open pit production blasting. First, there appears to have been a high powder factor used for the blasting during the deepening of the trenches (normal for surface trenching operations). The powder factor used for the 1997 Kilborn ROM Bulk Sample trenching is calculated at 1.943 lbs/yd^3, using blasting parameters provided in the report, or approximately fifteen times the proposed open pit production blasting powder factor, stated in the Kilborn 1997 Basic Engineering Report as 0.205 kg/tonne, or 0.128 lbs/yd^3.

Second, the 0.05 m diameter blast hole size used in the trenching, compared to proposed 200 mm blast hole diameters for production, would also result in an increased production of fines. And third, more confined energy release in the sinking cut (trenching) vs. bench cut (production mining) also results in excessive rock breakage. This aspect of the blasting program is discussed by D. Keller in Kilborn Report 8555-25.

The effect of the blast violence as described above would likely be significant. It would predispose the material to thorough physical degradation during subsequent vigorous handling by heavy equipment. It is understood that material excavated from the trenches for the ROM Bulk Sample was handled (during sample coning and splitting by repeated crushing and mixing by heavy equipment) to a degree in excess of that normal for production mining.

It is also possible that some dilution occurred due to inadvertent incorporation of some fine fraction overburden into the sample during sample splitting, coning, and loading into sample shipping containers.

REFERENCES

The following references were relied upon during the preparation of this report:

Run-Of-Mine Bulk Sample Collection, Western Copper Holdings Limited, Carmacks, Yukon Territory, Carmacks Copper Project, Project No. 8555-25, Kilborn Engineering Pacific Ltd., January 1998

1997 Basic Engineering Report and Definitive Cost Estimate, Western Copper Holdings Limited, Carmacks Copper Project, Project No. 8555-25, Kilborn Engineering Pacific Ltd., December 1997

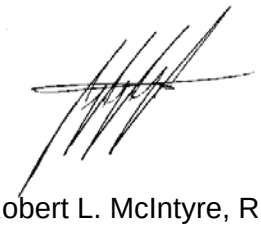
Explosives and Blasting Procedures Manual, United States Department of the Interior, Bureau of Mines Information Circular/1983, IC 8925, Dick, R.A., Fletcher, L.R., D'Andrea, D.V.

Blasting Technical Information and Regulations, Yukon Workers' Compensation Health and Safety Board, 1998. N. Prasad, Chief Mines Safety Officer.

Should you have any further questions regarding this letter report, please contact the undersigned.

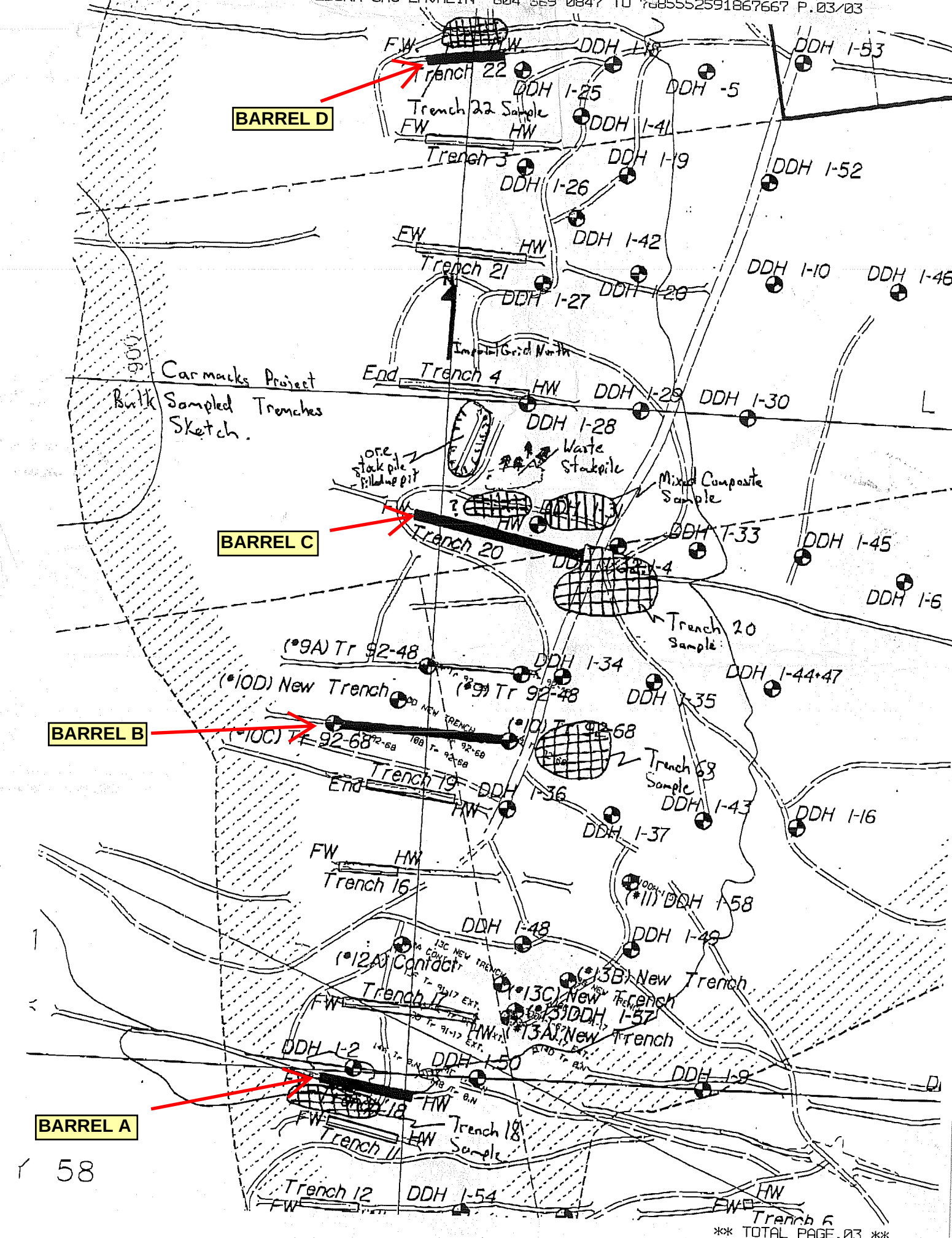
Respectfully submitted,

Access Consulting Group



Robert L. McIntyre, R.E.T., CCEP
President

Attachments: Site Map
Selected Photographs


BARREL D
BARREL C
BARREL B
BARREL A
Trench 22
Trench 22 Sample
Trench 3
Trench 21
Trench 4
Trench 20
Trench 20 Sample
Trench 19
Trench 16
Trench 17
Trench 18
Trench 18 Sample
Trench 11
Trench 12
Trench 6
Trench 63 Sample
Carmacks Project
Bulk Sampled Trenches
Sketch.
Imperial Grid North
Ore stockpile
Waste Stockpile
Mixed Composite Sample
(*9A) Tr 92-48
(*9) Tr 92-48
(*10D) New Trench
(*10C) Tr 92-68
(*10) Tr 92-68
(*11) DDH I-58
(*12A) Contact
(*13B) New Trench
(*13C) New Trench
(*13A) New Trench
DDH I-1
DDH I-2
DDH I-3
DDH I-4
DDH I-5
DDH I-6
DDH I-8
DDH I-9
DDH I-10
DDH I-16
DDH I-19
DDH I-20
DDH I-25
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DDH I-36
DDH I-37
DDH I-41
DDH I-42
DDH I-43
DDH I-44+47
DDH I-45
DDH I-46
DDH I-48
DDH I-49
DDH I-50
DDH I-52
DDH I-53
DDH I-54
DDH I-57
FW
HW
End

KILBORN SNC-LAVALIN

KILBORN ENGINEERING PACIFIC LTD.
Suite 400, 1380 Burrard Street
Vancouver, B.C.
Canada V6Z 2B7

Telephone: (604) 669-8811

FAX (604) 669-0847

TO:	Dan Cornett	**COPY TO:**	
COMPANY:	Access Mining Consultants Ltd.		
FAX NO.:	(867)667-6680	**COPY TO:**	
FROM:	Dave Keller		
DATE:	May 1, 1997		
SUBJECT:	Location of Bulk Sample Material		
PROJECT #:	8555-25		

NUMBER OF PAGES SENT: 3 (INCLUDING TRANSMITTAL PAGE)

MESSAGE:

Dan,

Please find attached a photocopy of a potion of the Geological Mapping Plan, Figure 1-1.1 from the report. I have sketched the approximate locations of the areas were bulk sample material from each trench was mixed and placed in piles. Material in piles in these areas can be used to make a composite for all four trenches.

I have also marked the area where the material composited from all four trenches was mixed and piled. If any material is left here it can used. I recall that we used most of this material and there is probably little material left.

I have used the following to denote the:

Trench bulk sample material area 

Composited bulk sample material for all four trenches 

The content of this communication is confidential. If you are not the intended recipient, please notify us immediately. Be advised that the unauthorized use or disclosure of this communication or of its content, meaning, purpose, or the mere disclosure of its existence, is unlawful.

KILBORN
SNC-LAVALIN

FAX
(604) 669-0847

I am fairly sure of the bulk sample material location for trench 91-20. There is a possibility that the material may be located behind the composited bulk sample material. This location is indicated by a "?" in the sketch.

Please contact me if you have any questions.

Dave Keller

The content of this communication is confidential. If you are not the intended recipient, please notify us immediately. Be advised that the unauthorized use or disclosure of this communication or of its content, meaning, purpose, or the mere disclosure of its existence, is unlawful.



Trench 91-18
(Site of Barrel A)



Trench 91-18
Composite p; 6
(Site of Barrel A)



Barrel A
Trench 91-18



Barrel A
Trench 91-18
Composite p; 6



Barrel A
Trench 91-18
Composite p; 6



Trench 91-18
(Site of Barrel B)



Trench 92-68
(Site of Barrel B)



Trench 92-68
(Site of Barrel B)



Trench 91-20
(Site of Barrel C)



Barrel C
Trench 92-20



Barrel D
Trench 91-22



Barrel D
Trench 91-22



Barrel D
Trench 91-22

APPENDIX II

Historic Geochemical Testing and Test Protocols

March 26, 2010
Project No. 07-1413-0077/9100
Doc. No. 105

Golder Associates

1.0 HISTORIC GEOCHEMICAL TESTING

Geochemical testing of waste rock and ore samples began in the mid 1990's and has been supplemented with additional testing as the project has evolved. Table II-1 and II-2 list the various test program that have taken place over the years, the tests conducted and the number and types of test per test program.

Table II-1: Summary of Historic and Current Geological and Geochemical Investigations of Waste Rock

Geochemical Test Protocol	Hallam Knight Piesold 1995	ACG Consulting Group 2006	Golder Associates Ltd. 2007	Golder Associates Ltd. 2008
Petrography	n/a	27	n/a	n/a
Acid Base-Accounting (ABA)	23	27	7	8
Whole Rock	23	27	7	8
24 hour Leach Tests	6	27	7	8
Tessier Extraction	1	n/a	n/a	n/a
Kinetic Test	n/a	n/a	6	n/a

Table II-2: Summary of Historic Geological and Geochemical Investigations of Ore and Spent Ore

Studies	Hallam Knight Piesold Ltd. 1995	Beattie Consulting Ltd. 1994	Beattie Consulting Ltd. 1996	Beattie Consulting Ltd. 1998	Beattie Consulting Ltd. 2001	Alexco Resource Corp. 2006	Golder Associates Ltd. 2008
	Raw Ore	Metallurgical Leach/Neutralized Leached Ore					
Test Material	Core and Trench Samples	Core and Bulk Surface Samples	Core and Pilot Heap Leach Plant Trench Samples	Trench Samples (Kilborn)	Trench Samples (Kilborn)	Unspecified Material (Source Process Research Ass.)	Trench Samples (ACG); Rinsed and Neutralization (PRA)
Geochemical Test Protocol	10 ABA, 3 BC LEP	None	Mineralogy Prior to Test	ICP Prior to Test	None	2 ABA, 4 Petrography	Petrography, ABA, Whole Rock, 24 hour Leach Test, Kinetic Test (Humidity Cell)

1.1 TESTS PROTOCOLS

1.2 Whole Rock Analysis

The chemical composition of each of the samples was determined by whole rock analysis using 1) lithium metaborate fusion and nitric acid digestion for major element concentrations and 2) multi-acid digestion for trace element analyses. Whole rock analysis of major rock-forming elements provides total elemental weight percent compositions as oxides (*e.g.,* Na_2O, CaO, SiO_2, etc.) and is used to determine the general characteristics of different lithologies. Multi-acid digestion provides elemental concentrations of trace metals as well as major elements. Multi-acid digestion of samples prior to ICP analysis is aggressive, however, the process may leave trace amounts of solids undissolved and therefore not analyzed. Thus, lithium metaborate fusion analytical results are considered to be more representative of the actual concentration of major elements as compared to major element results from multi-acid digestion.

1.3 Shake Flask Extraction (SFE)

The SFE test uses 250 g of minus 9.52 mm (3/8 inch) crushed material is mixed with 750 ml of deionized water (3:1 water to rock ratio). The water and rock mixture is then agitated on a shaker table for 24 hours. The resulting leachate is filtered and analyzed for; pH, conductivity, acidity, alkalinity, sulphate, and low-level metals (by ICP-MS).

1.4 Acid Base-Accounting (ABA)

ABA tests were performed to evaluate the ARD potential of the waste rock and neutralized spent ore material. ABA testing is a screening level tool that is used to estimate the amount of acid generating and acid neutralizing material in a sample. It is designed to provide the following:

- The maximum acid generation potential of a material assuming all of the sulphide sulphur can be attributed to pyrite and is allowed to oxidize; and
- The maximum acid neutralization potential of the material assuming all acid buffering capacity of a sample, as fast acting carbonate neutralizing potential, is allowed to react.

The ABA analyses are conducted using the modified Sobek method. Paste pH is the pH measured for a paste consisting of water and crushed rock. Total sulphur (S_T) concentration is analyzed by pyrolysis and infrared spectroscopy (using a LECO furnace), and acid soluble sulphate sulphur (S_{SO4}) is measured by ICP analysis after reaction with HCl. Sulphide sulphur (S_{S-2}) is calculated by difference using S_T and S_{SO4} ($S_{S-2} = S_T - S_{SO4}$). S_{S-2} content is then used to calculate the acid generating potential (AP). Bulk NP is measured by titrating the sample with a strong acid and measuring the amount of strong base required to return the solution to a specified pH.

1.5 Mineralogy

The neutralized spent ore samples were analysed for their mineralogy using the Rietveld method of quantitative X-Ray Diffraction (XRD) analysis (see Attachment II). The samples were reduced <10 µm by grinding under ethanol in a vibratory McCrone Micronising Mill for 7 minutes. Step-scan X-ray powder-diffraction data were collected over a range 3-80°2θ with CoKα radiation on a standard Siemens (Bruker) D5000 Bragg-Brentano diffractometer equipped with an Fe monochromator foil, 0.6 mm (0.3°) divergence slit, incident- and diffracted-beam Soller slits and a Vantec-1 strip detector. The long fine-focus Co X-ray tube was operated at 35 kV and 40 mA, using a take-off angle of 6°.

The X-ray diffractograms were analyzed using the International Centre for Diffraction Database PDF-4 using Search-Match software by Siemens (Bruker). X-ray powder-diffraction data were refined with Rietveld program Topas 3 (Bruker AXS).

1.6 Kinetic Test

Humidity cell tests use a standard test format. A 1 kg sample of 80% minus 6.35 mm (¼ inch) material is placed in a humidity cell vessel and flushed with 740 mL of demineralised water (cycle 1). The leachate is recovered, filtered, and preserved for analysis. Weekly cycles follow in which dry air is passed over and through the sample for three days, followed by moist air passed over and through the sample for three days, followed by flushing of the sample with 500 mL of demineralised water on the seventh day. The weekly cycle is repeated for a minimum of 20 weeks or until the leachate achieves a steady state chemical composition.

Weekly samples for this study are analyzed for pH, conductivity, acidity, alkalinity, and sulphate up to cycle 44 and every two cycles thereafter. A full range of anions and cations that include the weekly parameters plus 35 major and trace element concentrations were collected for cycles, 1, 2, 3, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 32, 36, and 40 and every 8 cycles (*i.e.*, cycle 48, 58 etc.) thereafter. A grain size analysis of the samples is also conducted to estimate the reactive surface area of the test material in the cell.

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APPENDIX III

XRD Mineralogy

QUANTITATIVE PHASE ANALYSIS OF TWO POWDER SAMPLES USING THE RIETVELD METHOD AND X-RAY POWDER DIFFRACTION DATA.

(Project : 0715 Carmack – P.O. 41720)

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CEMI
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Mati Raudsepp, Ph.D.
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The University of British Columbia
Vancouver, BC V6T 1Z4

July 18, 2008

EXPERIMENTAL METHOD

The two samples **"T1"** and "**B1**" were reduced into fine powder to the optimum grain-size range for X-ray analysis (<10μm) grinding under ethanol in a vibratory McCrone Micronising Mill for 7 minutes. Step-scan X-ray powder-diffraction data were collected over a range 3-80°2θ with CoKα radiation on a standard Siemens (Bruker) D5000 Bragg-Brentano diffractometer equipped with an Fe monochromator foil, 0.6 mm (0.3°) divergence slit, incident- and diffracted-beam Soller slits and a Vantec-1 strip detector. The long fine-focus Co X-ray tube was operated at 35 kV and 40 mA, using a take-off angle of 6°.

RESULTS AND DISCUSSION

The X-ray diffractograms were analyzed using the International Centre for Diffraction Database PDF-4 using Search-Match software by Siemens (Bruker). X-ray powder-diffraction data were refined with Rietveld program Topas 3 (Bruker AXS).

The results of quantitative phase analysis by Rietveld refinement are given in Table 1. These amounts represent the relative amounts of crystalline phases normalized to 100%. The Rietveld refinement plots for the samples are shown in Figures 1-2.

The patterns of both samples show a hump between 5-9º2θ that likely corresponds to a disordered/nanoscale smectite group mineral or mixed chlorite-smectite; an empirical montmorillonite structure model has been fitted as an approximation.

Table 1. Results of quantitative phase analysis (wt.%)

Mineral	**Ideal formula**	**T1**	**B1**
Quartz	SiO_2	9.9	7.5
Biotite	$K(Mg,Fe^{2+})_3AlSi_3O_{10}(OH)_2$	5.4	7.0
Muscovite	$KAl_2AlSi_3O_{10}(OH)_2$	1.4	
Actinolite	$Ca_2(Mg,Fe^{2+})_5Si_8O_{22}(OH)_2$	6.1	5.7
K-feldspar	$KAlSi_3O_8$	6.2	5.1
Plagioclase	$NaAlSi_3O_8 – CaAl_2Si_2O_8$	56.8	52.1
Gypsum	$CaSO_4 \cdot 2H_2O$		0.9
Jarosite	$K_2Fe_6^{3+}(SO_4)_4(OH)_{12}$	1.7	2.1
Calcite	$CaCO_3$	0.6	
Montmorillonite model	$(Na,Ca)_{0.3}(Al,Mg)_2Si_4O_{10}(OH)_2 \cdot nH_2O$	12.0	19.7
Total		100.0	100.0

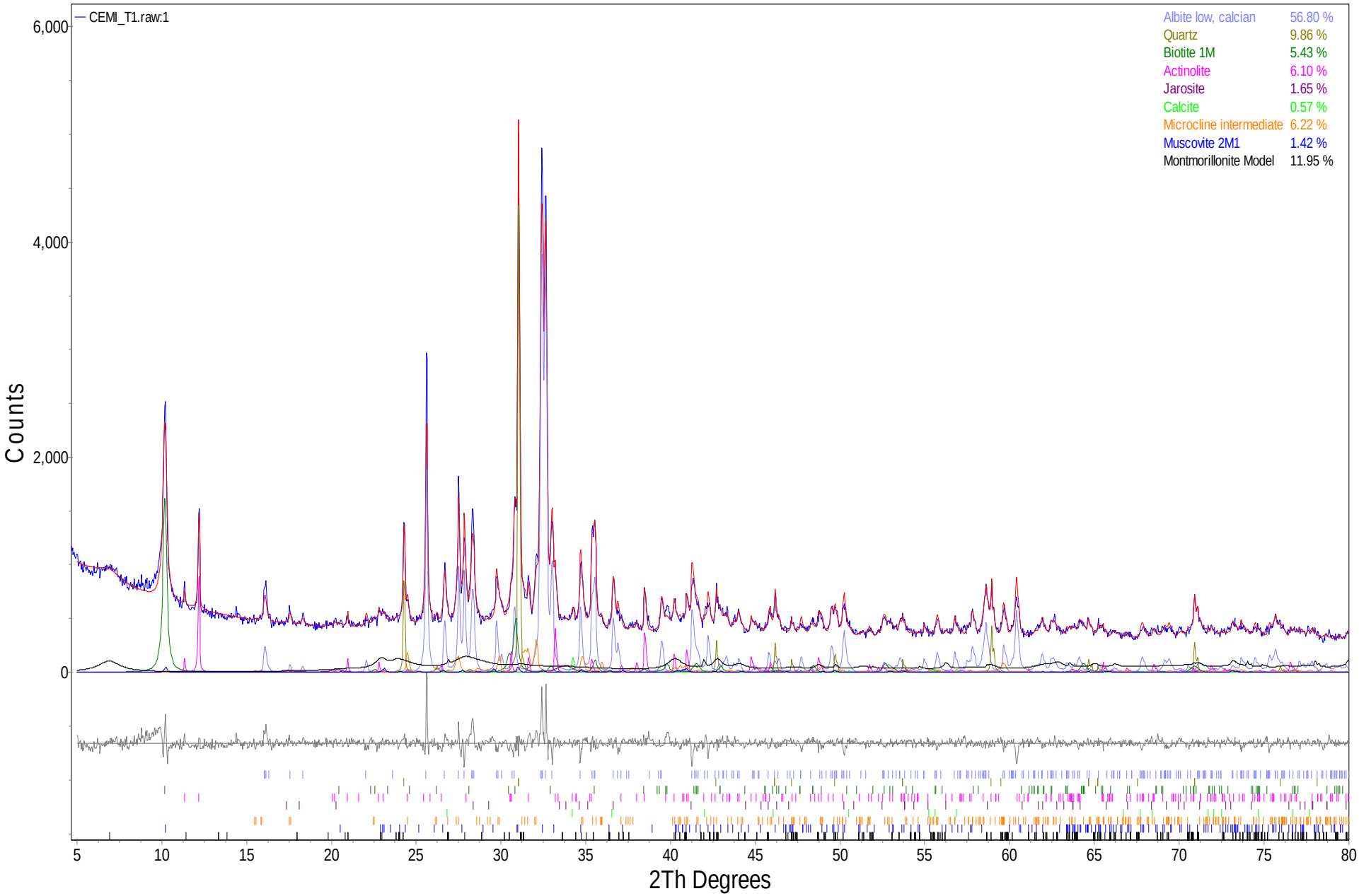


Figure 1. Rietveld refinement plot of sample **CEMI "T1"** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below – difference between observed and calculated intensities; vertical bars, positions of all Bragg reflections). Coloured lines are individual diffraction patterns of all phases.

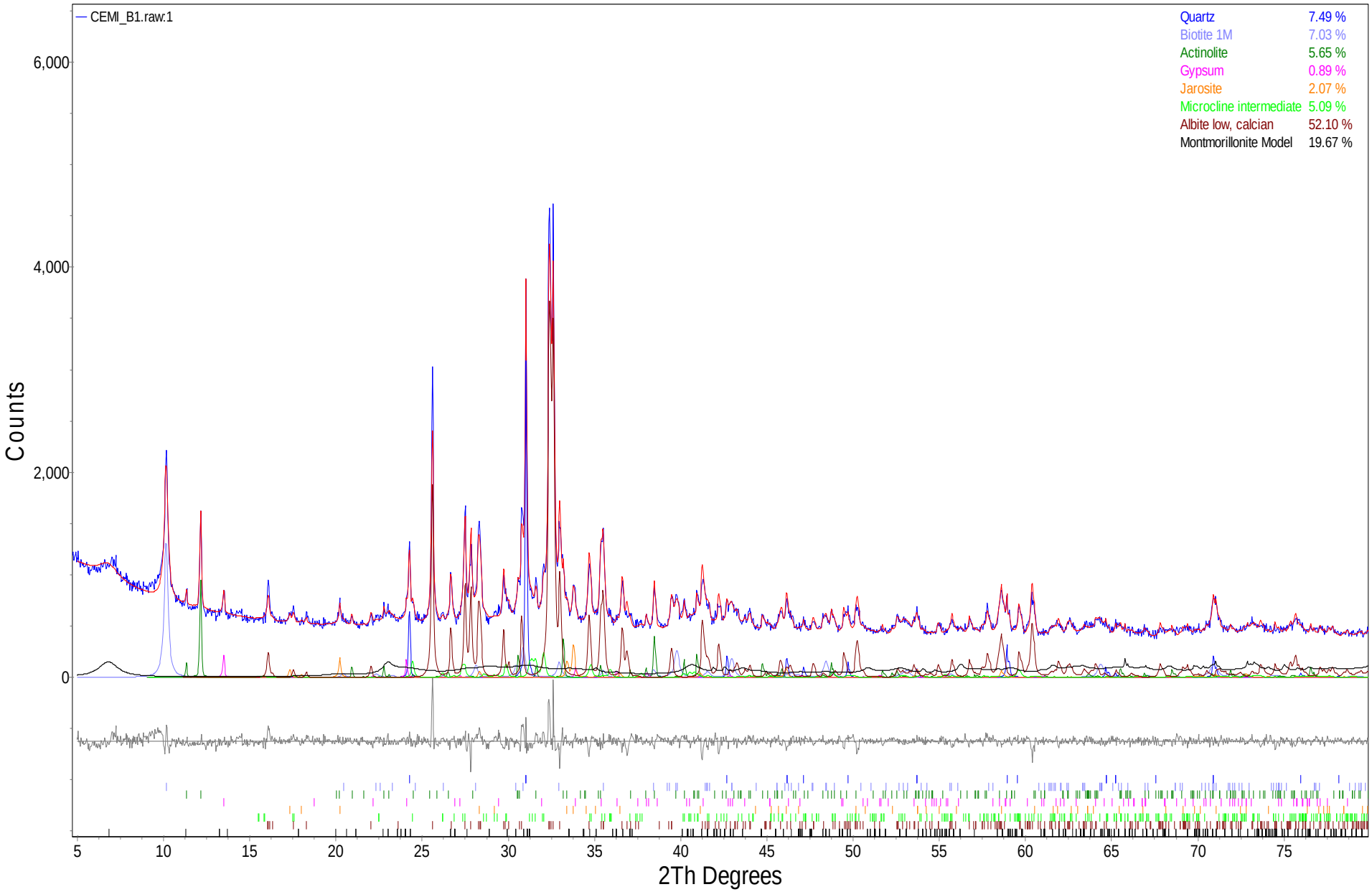


Figure 2. Rietveld refinement plot of sample **CEMI "B1"** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below – difference between observed and calculated intensities; vertical bars, positions of all Bragg reflections). Coloured lines are individual diffraction patterns of all phases.

APPENDIX IV

2008 Static and Kinetic Testing Results

March 26, 2010
Project No. 07-1413-0077/9100
Doc. No. 105

Golder Associates

TABLE IV.1
X-Ray Diffraction Mineralogy
2008 Spent Ore Samples
Carmacks Copper Project, YT

Mineral	Ideal formula	T1	B1
Quartz	SiO_2	9.9	7.5
Biotite	$K(Mg,Fe^{2+})_3AlSi_3O_{10}(OH)_2$	5.4	7
Muscovite	$KAl_2AlSi_3O_{10}(OH)_2$	1.4	
Actinolite	$Ca_2(Mg,Fe^{2+})_5Si_8O_{22}(OH)_2$	6.1	5.7
K-feldspar	$KAlSi_3O_8$	6.2	5.1
Plagioclase	$NaAlSi_3O_8 – CaAl_2Si_2O_8$	56.8	52.1
Gypsum	$CaSO_4 \cdot 2H_2O$		0.9
Jarosite	$K_2Fe_6^{3+}(SO_4)_4(OH)_{12}$	1.7	2.1
Calcite	$CaCO_3$	0.6	
Montmorillonite model	$(Na,Ca)_{0.3}(Al,Mg)_2Si_4O_{10}(OH)_2 \cdot nH_2O$	12	19.7
Total		100	100

TABLE IV.2
Whole Rock Analysis Results
2008 Samples
Carmacks Copper Project, YT

Sample ID	Rock type	Alteration	Mineralization	SiO2 %	Al2O3 %	Fe2O3 %	CaO %	MgO %	Na2O %	K2O %	TiO2 %	P2O5 %	MnO %	BaO %	Cr2O3 %	LOI %	Total %	C %	S %
Supplemental Waste Rock																			
GA-01-08 50.5-52	Granodiorite	fresh	none	63.08	17.32	4.07	4.49	1.21	5.13	1.25	0.39	0.16	0.07	0.19	0.03	1.98	99.36	0.03	<0.01
GA-01-08 95-96	Granodiorite	fresh	none	63.12	16.8	3.65	4.46	1.07	4.71	1.88	0.34	0.15	0.07	0.41	0.03	2.97	99.65	0.08	<0.01
GA-02-08 55.5-57	Granodiorite	veining (qz-k-spar, clay-calcite), minor clay alt	none	60.3	18.92	3.93	4.77	1.27	5.35	1.81	0.4	0.19	0.08	0.17	0.02	2.71	99.92	0.07	<0.01
GA-02-08 75-76.5	Granodiorite	veining (qz-k-spar, clay-calcite), minor clay alt	none	56.71	19.46	4.91	5.55	1.71	6.14	1.22	0.51	0.26	0.09	0.09	0.02	2.83	99.52	0.11	<0.01
GA-02-08 95-96.5	Granodiorite	veining (qz-k-spar, clay-calcite), minor clay alt	none	63.46	17.44	3.84	4.5	1.16	4.87	1.71	0.38	0.15	0.07	0.3	0.03	1.19	99.12	0.01	<0.01
GA-03-08 50-51.5	Granodiorite	veining (k-spar/calcite/quartz)	none	63.08	17.3	3.77	4.41	1.17	4.63	2.32	0.39	0.16	0.08	0.26	0.03	1.43	99.03	0.04	<0.01
GA-03-08 98.5-100	Granodiorite	veining (k-spar/calcite/quartz)	none	57.11	19.42	5.1	5.51	1.55	5.77	1.31	0.54	0.24	0.1	0.16	0.02	2.66	99.48	0.12	<0.01
GA-02-08 31-32.5	mixed Gniess/Granodiorite	amphibolite	Chalcopyrite (1-2%)	52.94	16.69	9.26	6.13	3.55	3.32	2.82	0.73	0.28	0.11	0.18	0.02	3.56	99.59	<0.01	0.18
Spent Ore																			
B 1 (-1/2 inch)	Neutralized Spent Ore	-	-	54.56	17.73	7.47	4.46	2.52	4.68	2.2	0.85	0.33	0.07	0.15	0.02	4.79	99.81	0.01	0.55
T 1 (-1/2 inch)	Neutralized Spent Ore	-	-	58.36	18.08	5.19	4.5	2.07	4.95	2.01	0.87	0.12	0.05	0.17	0.02	3.07	99.46	0.12	0.12
Col-6 (0700601)	Neutralized Spent Ore	-	-	59.93	15.78	6.5	4.05	1.95	3.89	2.26	0.76	0.3	0.05	0.15	0.01	4.16	99.8	0.07	0.37

Notes:
< = less than detection limit

TABLE IV.3
Trace Element Analysis Results
2008 Samples
Carmacks Copper Project, YT

Sample ID	Rock type	Alteration	Mineralization	Ag ppm	Al %	As ppm	Ba ppm	Be ppm	Bi ppm	Ca %	Cd ppm	Ce ppm	Co ppm	Cr ppm	Cs ppm	Cu ppm	Fe %	Ga ppm	Ge ppm	Hf ppm	Hg ppm	In ppm	K %	La ppm	Li ppm	Mg %	Mn ppm	Mo ppm
Supplemental Waste Rock																												
GA-01-08 50.5-52	Granodiorite	fresh	none	0.2	0.81	<5	138	<0.5	<5	0.81	1	-	4	145	-	<1	2.21	-	-	-	<1	-	0.16	<10	-	0.52	360	<2
GA-01-08 95-96	Granodiorite	fresh	none	<0.2	1.07	<5	141	<0.5	<5	1.34	1	-	7	155	-	<1	2.12	-	-	-	<1	-	0.09	<10	-	0.48	351	<2
GA-02-08 55.5-57	Granodiorite	veining (qz-k-spar, clay-calcite), minor clay alt	none	0.2	1	<5	178	<0.5	<5	0.87	1	-	6	136	-	<1	2.3	-	-	-	<1	-	0.32	<10	-	0.62	422	<2
GA-02-08 75-76.5	Granodiorite	veining (qz-k-spar, clay-calcite), minor clay alt	none	0.2	1.07	<5	72	0.5	<5	1.49	1	-	7	94	-	<1	2.25	-	-	-	<1	-	0.1	<10	-	0.62	396	<2
GA-02-08 95-96.5	Granodiorite	veining (qz-k-spar, clay-calcite), minor clay alt	none	0.2	0.82	<5	178	<0.5	7	0.71	1	-	6	148	-	<1	2.09	-	-	-	<1	-	0.23	<10	-	0.47	355	<2
GA-03-08 50-51.5	Granodiorite	veining (k-spar/calcite/quartz)	none	0.4	0.88	<5	103	<0.5	<5	0.87	1	-	5	139	-	<1	2.09	-	-	-	<1	-	0.19	<10	-	0.49	396	<2
GA-03-08 98.5-100	Granodiorite	veining (k-spar/calcite/quartz)	none	24.1	1.06	<5	111	0.5	<5	1.26	1	-	7	98	-	86	2.71	-	-	-	<1	-	0.15	<10	-	0.68	503	<2
GA-02-08 31-32.5	mixed Gniess/Granodiorite	amphibolite	Chalcopyrite (1-2%)	0.3	1.49	<5	74	<0.5	6	1.17	1	-	23	90	-	296	4.31	-	-	-	1	-	0.33	<10	-	1.02	396	9
Spent Ore																												
B 1 (-1/2 inch)	Neutralized Spent Ore	-	-	3.9	1.61	3.5	470	<1	3.4	0.71	0.4	13	10	61	1.6	866.9	4.1	11	0.1	0.1	0.2	0.14	0.9	8	5.1	1.03	306	175.5
T 1 (-1/2 inch)	Neutralized Spent Ore	-	-	3.4	1.04	2.7	571	<1	1.9	0.59	0.2	11	7.1	57	1.4	647.2	2.62	6	0.1	0.1	0.2	0.06	0.59	6	3.5	0.71	234	90.1
Col-6 (0700601)	Neutralized Spent Ore	-	-	5.5	1.93	3.2	660	<1	5.3	0.72	1.1	16	11.9	58	2.1	721	4.28	12	0.2	0.1	0.8	0.11	1.05	10	5.8	1.04	337	390.4

Sample ID	Rock type	Alteration	Mineralization	Na %	Nb ppm	Ni ppm	P %	Pb ppm	Rb ppm	Re ppb	S %	Sb ppm	Sc ppm	Se ppm	Sn ppm	Sr ppm	Ta ppm	Te ppm	Th ppm	Ti %	Tl ppm	U ppm	V ppm	W ppm	Y ppm	Zn ppm	Zr ppm
Supplemental Waste Rock																											
GA-01-08 50.5-52	Granodiorite	fresh	none	0.07	-	6	772	<2	-	-	<0.01	7	3	-	-	19	-	-	<5	0.11	<10	<10	54	<10	-	33	2
GA-01-08 95-96	Granodiorite	fresh	none	0.07	-	4	714	2	-	-	<0.01	7	3	-	-	42	-	-	<5	0.11	<10	<10	51	<10	-	32	2
GA-02-08 55.5-57	Granodiorite	veining (qz-k-spar, clay-calcite), minor clay alt	none	0.07	-	5	827	<2	-	-	<0.01	<5	2	-	-	32	-	-	6	0.14	<10	<10	53	<10	-	47	2
GA-02-08 75-76.5	Granodiorite	veining (qz-k-spar, clay-calcite), minor clay alt	none	0.09	-	4	1127	<2	-	-	<0.01	<5	4	-	-	41	-	-	<5	0.12	<10	<10	56	<10	-	37	3
GA-02-08 95-96.5	Granodiorite	veining (qz-k-spar, clay-calcite), minor clay alt	none	0.09	-	3	719	<2	-	-	<0.01	<5	3	-	-	34	-	-	<5	0.12	<10	<10	50	<10	-	34	2
GA-03-08 50-51.5	Granodiorite	veining (k-spar/calcite/quartz)	none	0.08	-	3	750	<2	-	-	<0.01	<5	3	-	-	31	-	-	6	0.11	<10	<10	49	<10	-	37	2
GA-03-08 98.5-100	Granodiorite	veining (k-spar/calcite/quartz)	none	0.08	-	3	1056	<2	-	-	<0.01	<5	4	-	-	58	-	-	5	0.13	<10	<10	64	<10	-	60	3
GA-02-08 31-32.5	mixed Gniess/Granodiorite	amphibolite	Chalcopyrite (1-2%)	0.09	-	14	1248	7	-	-	0.18	<5	9	-	-	11	-	-	5	0.16	<10	<10	120	<10	-	39	3
Spent Ore																											
B 1 (-1/2 inch)	Neutralized Spent Ore	-	-	0.07	0.2	6.8	0.136	4.3	60.2	39	0.57	0.1	6.9	1.1	2.1	47	<0.1	0.7	2	0.191	0.3	0.5	122	6.8	4.3	58	2.2
T 1 (-1/2 inch)	Neutralized Spent Ore	-	-	0.07	0.2	5.4	0.037	4.5	46.6	26	0.1	<0.1	5.3	<0.5	1.8	42	<0.1	0.6	1	0.175	0.3	0.5	90	5.4	4.2	38	2
Col-6 (0700601)	Neutralized Spent Ore	-	-	0.13	0.3	7.5	0.115	6.3	68	246	0.42	0.1	7.5	2.7	2	43	<0.1	1.1	2.4	0.229	0.4	0.7	133	17.7	5.2	70	2.6

Notes:
< = less than detection limit
Non-detect values assumed to be equal to one half of the detection limit in calculations of average, median and standard deviation, where applicable.

CCME (CEQG) (freshwater aquatic life)* (mg/L)				**6.5 - 9.0**							**0.005 - 0.1**		**0.005**				**0.000026**	**0.073**	**0.025 - 0.15**			**0.001**		**0.0001**
Metal Mining Effluent Regulations (MMER) [5] (mg/L)**				6.0 - 9.5									0.5						0.5					
Sample ID	**Rock type**	**Alteration**	**Mineralization**	**pH s.u.**	**REDOX mV**	**Conductivity uS/cm**	**Acidity (pH 8.3) mg/L as CaCO3**	**Alkalinity mg/L as CaCO3**	**Hardness mg/L as CaCO3**	**Sulphate (mg/L)**	**Aluminum [2] (mg/L)**	**Antimony (mg/L)**	**Arsenic (mg/L)**	**Barium (mg/L)**	**Magnesium (mg/L)**	**Manganese (mg/L)**	**Mercury (mg/L)**	**Molybdenum (mg/L)**	**Nickel [4] (mg/L)**	**Phosphorus (mg/L)**	**Potassium (mg/L)**	**Selenium (mg/L)**	**Silicon (mg/L)**	**Silver (mg/L)**
Supplemental Waste Rock																								
GA-01-08 50.5-52	Granodiorite	fresh	none	7.81	367	65	3.2	43.7	37.5	4	**0.174**	0.00005	0.0001	0.0905	0.6	0.00563	0.00002	0.00054	0.00016	0.005	1.2	0.00011	1.72	<0.000005
GA-01-08 95-96	Granodiorite	fresh	none	8.02	353	77	3.2	51.3	45.8	4	**0.146**	0.00006	0.00005	0.0888	0.92	0.00439	0.00002	0.00121	0.00011	0.005	1.42	0.0001	2.41	<0.000005
GA-02-08 55.5-57	Granodiorite	veining (qz-k-spar, clay-calcite), minor clay alt	none	8.03	355	74	3.2	48.5	42.1	4	**0.159**	0.00004	0.00002	0.0567	1.07	0.00788	<0.00001	0.00075	0.00012	0.003	1.6	0.00004	1.89	<0.000005
GA-02-08 75-76.5	Granodiorite	veining (qz-k-spar, clay-calcite), minor clay alt	none	8.06	353	83	3.1	54.7	49.2	4	**0.153**	0.00003	0.00006	0.0652	1.29	0.00519	<0.00001	0.00118	0.00013	0.004	0.93	<0.00004	2.12	<0.000005
GA-02-08 95-96.5	Granodiorite	veining (qz-k-spar, clay-calcite), minor clay alt	none	7.92	353	46	3.4	30.4	24.4	3	**0.159**	0.00002	0.00013	0.0509	0.67	0.00481	0.00002	0.00125	0.00011	0.006	1.3	<0.00004	1.68	<0.000005
GA-03-08 50-51.5	Granodiorite	veining (k-spar/calcite/quartz)	none	7.97	357	68	3.3	47.5	41	3	**0.172**	0.00002	0.00006	0.0527	0.97	0.00657	0.00001	0.00067	0.0002	0.004	1.28	<0.00004	1.93	<0.000005
GA-03-08 98.5-100	Granodiorite	veining (k-spar/calcite/quartz)	none	8.02	355	79	3.1	51.7	46	3	**0.138**	0.00003	0.00004	0.0548	1.15	0.00555	0.00004	0.00166	0.00011	0.005	1.11	<0.00004	1.97	0.000013
GA-02-08 31-32.5	mixed Gniess/Granodiorite	amphibolite	Chalcopyrite (1-2%)	7.43	373	144	4.2	8.1	76.5	79	0.0082	0.00003	<0.00002	0.008	2.91	0.0181	0.00002	0.00989	0.00043	0.008	2.87	**0.00129**	2.96	<0.000005
Spent Ore																								
B 1 (-1/2 inch)	Neutralized Spent Ore	-	-	**5.96**	487	2359	8.0	2.2	1590	1463	**0.195**	<0.0001	0.0011	0.0103	3.09	0.151	<0.00001	0.0053	0.0053	0.021	4.41	**0.002**	19.9	<0.00003
T 1 (-1/2 inch)	Neutralized Spent Ore	-	-	8.09	417	266	2.6	87.2	54.7	38	0.0498	0.0004	0.00194	0.107	<0.05	0.00039	0.00001	**0.185**	0.00024	0.575	1.84	**0.00855**	34.6	0.000041
Col-6 (0700601)	Neutralized Spent Ore	-	-	7.67	398	2197	5.8	52.7	693	1339	0.002	0.0004	0.0014	0.0277	0.4	0.0005	<0.00005	**0.996**	0.0012	0.247	4.48	**0.0119**	35	<0.00003

CCME (CEQG) (freshwater aquatic life)* (mg/L)							**0.000005 - 0.000338**		**0.001/0.0089**		**0.002 - 0.004**	**0.3**	**0.001 - 0.007**					**0.0008**					**0.03**	
Metal Mining Effluent Regulations (MMER) [5] (mg/L)**											0.3		0.2										0.5	
Sample ID	**Rock type**	**Alteration**	**Mineralization**	**Beryllium (mg/L)**	**Bismuth (mg/L)**	**Boron (mg/L)**	**Cadmium [4,7] (mg/L)**	**Calcium (mg/L)**	**Chromium [3] (mg/L)**	**Cobalt (mg/L)**	**Copper [4] (mg/L)**	**Iron (mg/L)**	**Lead [4] (mg/L)**	**Lithium (mg/L)**	**Sodium (mg/L)**	**Strontium (mg/L)**	**Sulphur (mg/L)**	**Thallium (mg/L)**	**Tin (mg/L)**	**Titanium (mg/L)**	**Uranium (mg/L)**	**Vanadium (mg/L)**	**Zinc (mg/L)**	**Zirconium (mg/L)**
Supplemental Waste Rock																								
GA-01-08 50.5-52	Granodiorite	fresh	none	<0.00001	<0.000005	<0.05	<0.000005	14	<0.0001	0.000008	0.00014	0.006	0.000011	<0.0005	2.17	0.0369	<3	<0.000002	<0.00001	<0.0005	<0.000002	0.0011	0.0007	<0.0001
GA-01-08 95-96	Granodiorite	fresh	none	<0.00001	<0.000005	<0.05	<0.000005	16.9	<0.0001	<0.000005	0.00074	0.004	0.000069	<0.0005	2.4	0.0634	<3	<0.000002	<0.00001	0.0006	0.000007	0.0022	0.001	<0.0001
GA-02-08 55.5-57	Granodiorite	veining (qz-k-spar, clay-calcite), minor clay alt	none	<0.00001	<0.000005	<0.05	<0.000005	15.1	<0.0001	0.000006	0.00154	0.004	0.00005	<0.0005	2.41	0.0459	<3	<0.000002	<0.00001	<0.0005	0.000005	0.0021	0.0008	<0.0001
GA-02-08 75-76.5	Granodiorite	veining (qz-k-spar, clay-calcite), minor clay alt	none	<0.00001	<0.000005	<0.05	<0.000005	17.6	0.0002	0.000006	0.00015	0.002	0.000007	<0.0005	3.32	0.0772	<3	<0.000002	<0.00001	<0.0005	0.000004	0.0021	0.0004	<0.0001
GA-02-08 95-96.5	Granodiorite	veining (qz-k-spar, clay-calcite), minor clay alt	none	<0.00001	<0.000005	<0.05	<0.000005	8.69	<0.0001	0.000009	0.00044	0.008	0.00001	<0.0005	2.03	0.0598	<3	<0.000002	<0.00001	<0.0005	<0.000002	0.0016	0.0003	<0.0001
GA-03-08 50-51.5	Granodiorite	veining (k-spar/calcite/quartz)	none	<0.00001	<0.000005	<0.05	<0.000005	14.8	<0.0001	0.000013	0.00126	0.005	0.00007	<0.0005	2.32	0.0737	<3	0.000003	<0.00001	<0.0005	0.000009	0.0016	0.0009	<0.0001
GA-03-08 98.5-100	Granodiorite	veining (k-spar/calcite/quartz)	none	<0.00001	<0.000005	<0.05	<0.000005	16 5	<0.0001	0.000008	0.00119	0.006	0.000048	<0.0005	2.72	0.0668	<3	0.000004	<0.00001	0.0012	0.000007	0.0022	0.0007	<0.0001
GA-02-08 31-32.5	mixed Gniess/Granodiorite	amphibolite	Chalcopyrite (1-2%)	<0.00001	<0.000005	<0.05	<0.000005	25.9	<0.0001	0.000238	0.00187	0.005	0.00007	0.001	2.75	0.0401	26	0.000002	<0.00001	<0.0005	<0.000002	0.0003	0.0011	<0.0001
Spent Ore																								
B 1 (-1/2 inch)	Neutralized Spent Ore	-	-	<0.00005	<0.00003	0.031	**0.00061**	631	0.0007	0.00288	**0.213**	0.047	0.00004	<0.003	15.7	0.455	552	0.00013	<0.00005	0.01	<0.00001	0.002	**0.0836**	<0.0005
T 1 (-1/2 inch)	Neutralized Spent Ore	-	-	<0.00001	0.000008	0.006	**0.000153**	21.9	0.0001	0.000014	**0.00339**	0.046	0.000066	<0.0005	35.8	0.101	17	0.000005	0.00002	0.0054	0.000006	0.0016	0.0006	<0.0001
Col-6 (0700601)	Neutralized Spent Ore	-	-	<0.00005	<0.00003	<0.3	**0.00046**	277	<0.0005	<0.00003	**0.0041**	0.01	<0.00003	<0.003	256	0.349	441	0.00003	<0.00005	<0.003	<0.00001	<0.001	0.0006	<0.0005

Notes:

1. CEQG freshwater guidelines and criteria are based on **total** metal concentrations, except for aluminum (dissolved aluminum criterion).
2. Freshwater aquatic life criterion for aluminum depends on pH, [Ca2+] and DOC. In this table, only the pH criterion has been applied to highlight exceedances.
3. Freshwater aquatic life criteria for chromium depends on the valence of chromium ion. In the above table, the Cr(VI) criterion of 0.001 mg/L is shown.
4. Freshwater aquatic life criterion or guideline is hardness dependant.
5. Maximum authorized monthly mean concentration (based on **total** concentration).
6. < = less than the analytical detection limit.
7. Cadmium guideline = 10^(0.86*log(hardness)-3.2)

* December 2003

** June 6, 2002

Non-detect values assumed to be equal to one half the detection limit in calculations of average, median and standard deviation, where applicable.

TABLE IV.5
Acid Base Accounting Results
2008 Samples
Carmacks Copper Project, YT

Sample ID	Rock type	Alteration	Mineralization	Paste pH	S(T) %	S(SO4) %	S(S-2) %	AP	NP	TIC %	CaCO3 NP	Net NP	NPR	CaCO3 Net NP	CaNPR
Suplemental Waste Rock															
GA-01-08 50.5-52	Granodiorite	fresh	none	8.33	<0.01	<0.01	<0.01	<0.3	8.4	0.03	2.5	8.4	28.0	2.5	8.33
GA-01-08 95-96	Granodiorite	fresh	none	8.24	<0.01	<0.01	<0.01	<0.3	12.3	0.08	6.7	12.3	41.0	6.7	22.22
GA-02-08 55.5-57	Granodiorite	veining (qz-k-spar, clay-calcite), minor clay alt	none	8.10	<0.01	<0.01	<0.01	<0.3	13.0	0.07	5.8	13.0	43.3	5.8	19.44
GA-02-08 75-76.5	Granodiorite	veining (qz-k-spar, clay-calcite), minor clay alt	none	8.13	<0.01	<0.01	<0.01	<0.3	16.1	0.11	9.2	16.1	53.7	9.2	30.56
GA-02-08 95-96.5	Granodiorite	veining (qz-k-spar, clay-calcite), minor clay alt	none	8.39	<0.01	<0.01	<0.01	<0.3	7.3	0.01	0.8	7.3	24.3	0.8	2.78
GA-03-08 50-51.5	Granodiorite	veining (k-spar/calcite/quartz)	none	8.33	<0.01	<0.01	<0.01	<0.3	9.9	0.04	3.3	9.9	33.0	3.3	11.11
GA-03-08 98.5-100	Granodiorite	veining (k-spar/calcite/quartz)	none	8.18	<0.01	<0.01	<0.01	<0.3	16.5	0.12	10.0	16.5	55.0	10.0	33.33
GA-02-08 31-32.5	mixed Gniess/Granodiorite	amphibolite	Chalcopyrite (1-2%)	6.81	0.18	0.03	0.15	4.7	11.6	<0.01	<0.8	6.9	2.5	3.9	0.17
Spent Ore															
B 1 (-1/2 inch)	Neutralized Spent Ore	-	-	5.91	0.55	0.42	0.13	4.1	6.3	0.01	0.8	2.2	1.6	-3.2	0.21
T 1 (-1/2 inch)	Neutralized Spent Ore	-	-	7.85	0.12	0.07	0.05	1.6	10.8	0.08	6.7	9.2	6.9	5.1	4.27
Col-6 (0700601)	Neutralized Spent Ore	-	-	7.89	0.38	0.3	0.08	2.5	8.8	0.04	3.3	6.3	3.5	0.8	1.33

Notes:
< = less than detection limit
* S(S2-) sulphide sulphur calculated as S(T)total suphur - S(SO4)sulphate sulphur
Where S(SO4) is reported as <0.01%, it is assumed to be zero for the AP calculation.
TIC = Total inorganic carbon, used in calculation of CaNP
AP = Acid potential in kg CaCO3 equivalent per tonne of rock. AP is determined from calculated sulphide sulphur content: S(T) - S(SO4), assuming total conversion of sulphide to sulphate.
Bulk NP = Neutralization potential in kg CaCO3 equivalent per tonne of rock.
CaNP = Carbonate mineral neutralization potential in kg CaCO3 equivalent per tonne of rock
NET NP = Net neutralization potential in kg CaCO3 equivalent per tonne of rock. Calculated as the difference between NP and AP.
NPR = Neutralization potential ratio: NP/AP
CaNPR = Neutralization potential ratio calculated using CaNP: CaNP/AP
Non-detect values assumed to be equal to one half of the detection limit in calculations of average, median and standard deviation, where applicable.

TABLE IV.6
Kinetic Test Results Neutralized Spent Ore Sample T1
Cormacks Copper Project, YT

HC 7
Sample = T1 (-1/2")

Date	Cycle No.	Volume mL Input	Volume mL Output	pH	Cond. umhos/cm	Acidity (pH 4.5) mgCaCO3/L	Acidity (pH 8.3) mgCaCO3/L	Alkalinity mgCaCO3/L	Sulphate mg/L	Hardness CaCO3 mg/L	Al mg/L	Sb mg/L	As mg/L	Ba mg/L	Be mg/L	Bi mg/L	B mg/L	Cd mg/L	Ca mg/L	Cr mg/L	Co mg/L	Cu mg/L	Fe mg/L	Pb mg/L	Li mg/L	Mg mg/L	Mn mg/L	Hg ug/L	Mo mg/L	Ni mg/L	P mg/L	K mg/L	Se mg/L	Si mg/L	Ag mg/L	Na mg/L	Sr mg/L	S mg/L	Tl mg/L	Sn mg/L	Ti mg/L	U mg/L	V mg/L	Zn mg/L	Zr mg/L	Major Anions	Major Cations	Diff	Diff (%)
31-Mar-08	1	500	300	8.14	957	#N/A	2.2	83.3	328	160	0.0374	0.00066	0.0051	0.072	<0.00001	<0.000005	0.01	0.00049	63.9	0.0004	2.5E-05	0.0036	0.036	0.00032	<0.0005	0.06	0.0003	0.02	0.806	0.0005	0.996	3.5	0.018	55.8	3.2E-05	137	0.241	135	9E-06	0.00003	0.006	1E-05	0.0024	0.0013	<0.0001	8.50	9.24	0.74	4.2%
07-Apr-08	2	500	485	7.74	927	#N/A	6.7	67.8	186	63.9	0.0164	0.00051	0.004	0.0598	<0.00001	<0.000005	0.009	0.00038	25.6	<0.0001	0.00012	0.0036	0.017	0.00006	<0.0005	<0.05	0.0004	<0.01	0.899	0.0059	0.967	2.35	0.0205	44	6.4E-05	76.2	0.108	49	0.00001	0.00002	0.004	1E-05	0.0021	0.0007	<0.0001	5.23	4.65	-0.58	-5.9%
14-Apr-08	3	500	490	8.22	322	#N/A	1.3	91.0	60	39.6	0.0226	0.00065	0.0058	0.0598	<0.00001	0.000007	<0.005	0.0003	15.9	0.0002	0.00001	0.0023	0.027	7.6E-05	<0.0005	<0.05	0.0001	<0.01	0.795	0.0002	1.41	1.97	0.0279	49	7.3E-05	48.9	0.0724	21	6E-06	0.00002	0.0046	4E-06	0.0023	0.0037	<0.0001	3.07	2.97	-0.10	-1.7%
21-Apr-08	4	500	480	8.17	238	#N/A	2.1	78.8	35	34.4	0.0315	0.00058	0.0054	0.0617	<0.00001	0.000005	<0.05	0.00033	13.8	<0.0001	1.4E-05	0.0026	0.025	4.2E-05	<0.0005	<0.05	0.0001	<0.01	0.617	0.0003	1.33	1.93	0.028	47.8	3.6E-05	40.7	0.0631	14	3E-06	0.00002	0.004	6E-06	0.0022	0.0002	<0.0001	2.31	2.51	0.20	4.2%
28-Apr-08	5	500	480	8.22	209	#N/A	1.4	73.6	24																																								
05-May-08	6	500	460	8.15	164	#N/A	1.6	55.6	22	37.1	0.0333	0.00041	0.0035	0.0696	<0.00001	0.00001	<0.05	6.4E-05	14.9	<0.0001	9E-06	0.0029	0.03	0.00026	<0.0005	<0.05	0.0005	<0.01	0.347	0.0002	0.797	1.78	0.0213	38.4	3.4E-05	20.3	0.0656	8	5E-06	0.00001	0.0028	3E-05	0.0018	0.0025	<0.0001	1.57	1.67	0.10	3.1%
12-May-08	7	500	490	8.22	176	#N/A	1.4	61.8	20																																								
19-May-08	8	500	470	8.17	140	#N/A	1.1	48.3	21	34.9	0.0162	0.00033	0.0024	0.0658	<0.00001	0.000005	<0.05	5.8E-05	14	<0.0001	<0.000005	0.0032	0.014	0.00041	<0.0005	<0.05	0.0002	<0.01	0.212	0.0002	0.513	1.45	0.0128	29.8	2.2E-05	10.5	0.0664	5	<0.000002	<0.00001	0.0016	7E-06	0.0014	0.0034	<0.0001	1.40	1.19	-0.21	-8.1%
26-May-08	9	500	480	7.99	135	#N/A	3.2	51.9	19																																							
02-Jun-08	10	500	470	8.12	122	#N/A	1.3	49.2	17	53.7	0.0204	0.00037	0.0026	0.0886	<0.00001	<0.000005	<0.05	2.6E-05	21.5	<0.0001	7E-06	0.0024	0.019	3.1E-05	<0.0005	<0.05	0.0002	<0.01	0.219	0.0002	0.588	1.86	0.0143	37.2	2.6E-05	8.43	0.0928	6	2E-06	0.00001	0.0018	<0.00000	0.001	0.0004	<0.0001	1.34	1.49	0.15	5.3%
09-Jun-08	11	500	480	7.97	93	#N/A	2.1	41.3	12																																							
16-Jun-08	12	500	475	7.94	79	#N/A	2.5	38.3	11	41.1	0.0099	0.00025	0.0016	0.0859	<0.00001	<0.000005	<0.05	3.7E-05	16.4	<0.0001	7E-06	0.0012	0.012	2.2E-05	<0.0005	<0.05	0.0002	<0.01	0.156	0.0001	0.366	1.44	0.0086	27.5	2.2E-05	3.47	0.0693	4	3E-06	0.00001	0.0005	9E-06	0.0013	0.001	<0.0001	1.00	1.01	0.01	0.5%
23-Jun-08	13	500	480	7.96	79	#N/A	3.5	45.5	13																																							
30-Jun-08	14	500	480	7.98	95	#N/A	2.8	35.6	11	43.1	0.0382	0.00032	0.0019	0.0925	<0.00001	<0.000005	<0.05	6.9E-05	17.3	<0.0001	8E-06	0.0015	0.014	7.6E-05	<0.0005	<0.05	0.0001	<0.01	0.215	0.0002	0.351	1.64	0.012	31.7	2.4E-05	2.49	0.0798	4	3E-06	0.00001	0.0012	<0.00000	0.0011	0.0007	<0.0001	0.94	1.01	0.07	3.7%
07-Jul-08	15	500	480	8.00	123	#N/A	2.4	40.9	8																																							
14-Jul-08	16	500	480	7.90	81	#N/A	2.4	32.5	9	38.8	0.0136	0.00023	0.0016	0.0794	<0.00001	0.000005	<0.05	3.8E-05	15.5	<0.0001	<0.000005	0.0018	0.015	0.00011	<0.0005	<0.05	0.0002	<0.01	0.158	5E-05	0.349	1.42	0.0091	21.5	1.9E-05	1.61	0.0663	<3	3E-06	0.00002	0.0013	9E-06	0.0008	0.0012	<0.0001	0.84	0.88	0.04	2.5%
21-Jul-08	17	500	475	8.02	107	#N/A	2.3	44.5	8																																							
28-Jul-08	18	500	475	8.01	92	#N/A	1.8	36.9	7	43.1	0.0168	0.00024	0.0018	0.0953	<0.00001	<0.000005	<0.05	5.8E-05	17.2	<0.0001	7E-06	0.0013	0.016	2.4E-05	<0.0005	<0.05	0.0003	<0.01	0.144	0.0002	0.379	1.49	0.008	26.9	2.8E-05	1.15	0.0686	<3	2E-06	<0.00001	0.0014	2E-05	0.0004	0.0004	<0.0001	0.88	0.95	0.06	3.4%
04-Aug-08	19	500	490	8.07	115	#N/A	1.8	53.6	8																																							
11-Aug-08	20	500	485	7.96	88	#N/A	2.2	38.5	8	46.4	0.0221	0.00023	0.0017	0.0915	<0.00001	0.000008	<0.05	2.5E-05	18.6	<0.0001	5E-06	0.0026	0.027	0.00012	<0.0005	<0.05	0.0005	<0.01	0.118	0.0003	0.414	1.61	0.0087	31.7	0.00005	1.09	0.0771	3	<0.000002	<0.00001	0.0026	8E-06	0.0009	0.0016	<0.0001	0.94	1.02	0.08	4.1%
18-Aug-08	21	500	420	8.03	120	#N/A	2.0	54.2	9																																							
25-Aug-08	22	500	495	7.83	58	#N/A	2.3	29.5	4	31.6	0.0132	0.00017	0.0014	0.0701	<0.00001	0.000007	<0.05	7.5E-05	12.7	<0.0001	<0.000005	0.0011	0.01	9.6E-05	<0.0005	<0.05	0.0001	<0.01	0.0847	0.0002	0.295	1.14	0.0059	17.7	2.5E-05	0.53	0.0544	<3	<0.000002	<0.00001	0.0011	<0.00000	0.0008	0.0003	<0.0001	0.67	0.69	0.01	1.0%
01-Sep-08	23	500	485	7.87	62	#N/A	2.1	34.7	4																																							
08-Sep-08	24	500	460	7.98	89	#N/A	2.4	51.9	3	46.3	0.0173	0.00029	0.0022	0.0963	<0.00001	0.000007	<0.05	7.1E-05	18.6	<0.0001	5E-06	0.0018	0.018	9.8E-05	<0.0005	<0.05	0.0001	<0.01	0.151	0.0001	0.445	1.77	0.012	32.1	3.1E-05	0.78	0.0837	<3	3E-06	0.00002	0.0014	6E-06	0.001	0.0004	<0.0001	1.10	1.01	-0.09	-4.4%
15-Sep-08	25	500	465	7.83	60	#N/A	2.0	26.3	3																																							
22-Sep-08	26	500	425	8.02	82	#N/A	1.8	42.6	3	47.1	0.0216	0.00024	0.0019	0.0895	<0.00001	0.000009	<0.05	5.6E-05	18.9	<0.0001	6E-06	0.0019	0.023	5.1E-05	<0.0005	<0.05	0.0001	<0.01	0.123	0.0002	0.426	1.86	0.0087	30.6	4.4E-05	0.7	0.0815	<3	3E-06	0.00002	0.0029	7E-06	0.0011	0.0006	<0.0001	0.91	1.02	0.11	5.6%
29-Sep-08	27	500	460	8.07	108	#N/A	1.9	50.7	3																																							
06-Oct-08	28	500	450	7.99	86	#N/A	2.2	45.5	2	46.1	0.0145	0.00024	0.002	0.0932	<0.00001	0.00001	<0.05	4.4E-05	18.5	<0.0001	6E-06	0.0021	0.021	4.9E-05	<0.0005	<0.05	0.0002	<0.01	0.111	0.0001	0.43	1.8	0.0088	34.7	5.9E-05	0.62	0.084	<3	3E-06	<0.00001	0.0021	8E-06	0.0009	0.0003	<0.0001	0.95	1.00	0.04	2.3%
13-Oct-08	29	500	445	8.00	85	#N/A	2.4	44.5	2																																							
20-Oct-08	30	500	430	7.94	88	#N/A	2.8	42.5	3																																							
27-Oct-08	31	500	435	7.92	81	#N/A	2.7	44.7	3																																							
03-Nov-08	32	500	450	7.71	78	#N/A	1.9	46.5	4	44.6	0.0407	0.00025	0.002	0.0928	<0.00001	0.000011	<0.05	2.3E-05	17.9	0.0001	0.00064	0.0029	0.04	5.8E-05	<0.0005	<0.05	0.0004	<0.01	0.0856	0.0253	0.425	1.98	0.0084	38.4	6.1E-05	0.49	0.0797	<3	5E-06	0.00001	0.003	4E-06	0.0009	0.0006	<0.0001	1.01	0.97	-0.05	-2.5%
10-Nov-08	33	500	440	7.91	99	#N/A	3.7	50.5	3																																							
17-Nov-08	34	500	435	7.98	84	#N/A	2.7	52.4	3																																							
24-Nov-08	35	500	440	7.53	31	#N/A	2.3	17.8	2																																							
01-Dec-08	36	500	450	7.78	59	#N/A	2.4	34.7	2	29.1	0.0239	0.00012	0.001	0.0676	<0.00001	0.000006	<0.05	2.5E-05	11.7	<0.0001	<0.000005	0.0029	0.02	0.00014	<0.0005	<0.05	0.0001	<0.01	0.0492	0.0001	0.224	1.22	0.0045	18.5	3.4E-05	0.29	0.0533	<3	3E-06	0.00003	0.0019	6E-06	0.0008	0.0003	<0.0001	0.73	0.63	-0.11	-7.9%
08-Dec-08	37	500	465	7.93	74	#N/A	2.2	42.4	2																																							
15-Dec-08	38	500	455	7.84	98	#N/A	3.7	57.1	<1																																							
22-Dec-08	39	500	460	7.69	93	#N/A	5.5	53.1	3																																							
29-Dec-08	40	500	440	7.64	75	#N/A	8.6	49.2	3	41.4	0.0434	0.00025	0.0021	0.0916	<0.00001	0.000015	<0.05	4.2E-05	16.6	<0.0001	0.00039	0.0028	0.042	6.8E-05	<0.0005	<0.05	0.0005	<0.01	0.071	0.0141	0.373	1.95	0.0077	33.6	8.3E-05	0.37	0.0732	<3	4E-06	0.00002	0.0045	6E-06	0.0011	0.0003	<0.0001	1.05	0.89	-0.15	-7.9%
05-Jan-09	41	500	430	7.80	84	#N/A	5.0	51.0	2																																							
12-Jan-09	42	500	425	7.76	71	#N/A	4.8	45.2	3																																							
19-Jan-09	43	500	420	7.89	75	#N/A	3.1	42.1	2																																							
26-Jan-09	44	500	400	7.75	75	#N/A	4.2	43.5	3																																							
02-Feb-09	45	500	440																																												
09-Feb-09	46	500	450	7.83	86	#N/A	4.2	49.2	2																																							
16-Feb-09	47	500	450																																												
23-Feb-09	48	500	460	7.98	86	#N/A	3.7	50.6	2	41.5	0.0263	0.00026	0.0022	0.0929	<0.00001	0.00001	<0.05	0.00002	16.6	<0.0001	0.00002	0.0033	0.035	9.1E-05	<0.0005	<0.05	0.0003	<0.01	0.0725	0.0011	0.323	1.81	0.0062	35.6	5.7E-05	0.3	0.0787	<3	3E-06	<0.00001	0.0027	6E-06	0.0012	0.0005	<0.0001	1.05	0.89	-0.16	-8.5%
02-Mar-09	49	500	425																																												
09-Mar-09	50	500	470	7.75	106	#N/A	6.2	60.7	4																																							
16-Mar-09	51	500	450																																												
23-Mar-09	52	500	495	7.78	99	#N/A	5.5	57.3	2																																							
30-Mar-09	53	500	440																																												
06-Apr-09	54	500	485	7.55	93	#N/A	6.7	50.4	4																																							
13-Apr-09	55	500	445																																												
20-Apr-09	56	500	450	7.74	93	#N/A	5.6	53.5	3	46.1	0.0419	0.00028	0.0025	0.109	<0.00001	0.000029	<0.05	1.9E-05	18.5	<0.0001	3.9E-05	0.0029	0.04	0.0001	<0.0005	<0.05	0.0002	<0.01	0.0628	0.0002	0.344	1.92	0.0054	35.3	7.6E-05	0.29	0.0827	<3	5E-06	0.00002	0.0059	5E-06	0.0016	0.0007	<0.0001	1.13	0.98	-0.15	-7.0%
27-Apr-09	57	500	420																																												
04-May-09	58	500	435	7.77	107	#N/A	5.7	59.9	<1																																							
11-May-09	59	500	425																																												
18-May-09	60	500	425	7.77	97	#N/A	5.3	54.4	<1																																							
25-May-09	61	500	405																																												
01-Jun-09	62	500	430	7.73	74	#N/A	7.8	52.5	4																																							
08-Jun-09	63	500	435																																												
15-Jun-09	64	500	405	7.89	64	#N/A	3.5	41.9	2	35.7	0.0336	0.00019	0.0027	0.0896	<0.00001	0.000021	<0.05	6E-06	14.3	<0.0001	6.4E-05	0.0035	0.041	0.00011	<0.0005	<0.05	0.0005	<0.01	0.0498	0.0003	0.266	1.4	0.0038	32.4	8.2E-05	0.32	0.0647	<3	3E-06	<0.00001	0.0046	6E-06	0.0011	0.0005	<0.0001	0.88	0.76	-0.12	-7.0%
22-Jun-09	65	500	445																																												
29-Jun-09	66	500	500	7.58	57	#N/A	4.9	41.5	1																																							
06-Jul-09	67	500	435																																												
13-Jul-09	68	500	420	7.76	69	#N/A	3.9	46.3	<1																																							
20-Jul-09	69	500	435																																												
27-Jul-09	70	500	430	7.84	91	#N/A	7.8	54.8	4																																							
03-Aug-09	71	500	430																																												
10-Aug-09	72	500	445	7.84	76	#N/A	5.8	45.2	1	37.1	0.0333	0.00025	0.0021	0.102	<0.00001	0.000023	<0.05	1.9E-05	14.9	<0.0001	2.6E-05	0.003	0.049	0.00011	<0.0005	<0.05	0.0007	<0.01	0.0599	0.0004	0.268	1.56	0.0048	35.4	7.2E-05	0.24	0.068	<3	5E-06	<0.00001	0.0045	3E-06	0.001	0.0005	<0.0001	0.92	0.79	-0.13	-7.6%
17-Aug-09	73	500	420																																												
24-Aug-09	74	500	455	8.00	76	#N/A	2.6	46.6	<1																																							
31-Aug-09	75	500	420																																												
07-Sep-09	76	500	420	7.75	84	#N/A	7.3	51.7	1																																							
14-Sep-09	77	500	370																																												
21-Sep-09	78	500	465	7.81	65	#N/A	4.6	44.2	2																																							
28-Sep-09	79	500	405																																												
05-Oct-09	80	500	420	7.81	68	#N/A	5.3	44.1	3	43.5	0.0693	0.00021	0.0016	0.109	<0.00001	0.000048	<0.05	3.7E-05	17.2	<0.0001	1.8E-05	0.0061	0.113	0.00039	<0.0005	0.16	0.0009	<0.01	0.0482	0.0002	0.265	1.55	0.0039	33.4	0.00013	0.34	0.0678	<3	4E-06	0.00005	0.0091	8E-06	0.0009	0.0038	<0.0001	0.94	0.91	-0.03	-1.7%
12-Oct-09	81	500	435																																												
19-Oct-09	82	500	425	7.82	75	#N/A	4.2	45.9	2																																							
26-Oct-09	83	500	420																																												
02-Nov-09	84	500	425	7.83	84	#N/A	4.4	48.1	1																																							
09-Nov-09	85	500	405																																												
16-Nov-09	86	500	440	7.90	82	#N/A	5.9	50.4	4																																							
23-Nov-09	87	500	375																																												
30-Nov-09	88	500	390	7.83	85	#N/A	4.2	48.2	5	39.1	0.0986	0.00022	0.0013	0.14	<0.00001	0.000173	<0.05	<0.000005	15.7	0.0001	2.4E-05	0.0085	0.242	0.00068	<0.0005	<0.05	0.0005	<0.01	0.032	0.0003	0.211	1.74	0.003	34.3	0.00043	0.28	0.0749	<3	4E-06	0.00007	0.0239	5E-06	0.0015	0.0015	<0.0001	1.07	0.84	-0.23	-12.0%
07-Dec-09	89	500	390																																												
14-Dec-09	90	500	385	7.89	77	#N/A	3.0	43.8	1																																							
21-Dec-09	91	500	380																																												
28-Dec-09	92	500	380	7.82	84	#N/A	3.7	45.5	1																																							
04-Jan-10	93	500	390																																												
11-Jan-10	94	500	460	7.91	105	#N/A	6.7	58.2	3																																							
18-Jan-10	95	500	450																																												
25-Jan-10	96	500	450	7.85	85	#N/A	4.3	55.5	1	46	0.0736	0.00023	0.0016	0.142	<0.00001	0.00005	<0.05	2.1E-05	18.4	<0.0001	2.4E-05	0.0099	0.122	0.00019	<0.0005	<0.05	0.0007	<0.01	0.0366	0.0004	0.236	1.92	0.0036	41.9	0.00014	0.22	0.09	<3	5E-06	0.00002	0.0094	2E-05	0.0014	0.0008	<0.0001	1.13	0.98	-0.15	-7.3%
01-Feb-10	97	500	450																																												
08-Feb-10	98	500	440	7.73	100	#N/A	6.2	59.2	<1																																							
15-Feb-10	99	500	465																																												
22-Feb-10	100	500	460	7.82	76	#N/A	4.5	49.9																																							

HC 8
Sample = B1 (-1/2")

Date	Cycle	Volume mL		pH	Cond.	Acidity	Acidity	Alkalinity	Sulphate	Hardness	Al	Sb	As	Ba	Be	Bi	B	Cd	Ca	Cr	Co	Cu	Fe	Pb	Li	Mg	Mn	Hg	Mo	Ni	P	K	Se	Si	Ag	Na	Sr	S	Ti	Sn	Ti	U	V	Zn	Zr	Major	Major	Diff	Diff
	No.	Input	Output		umhos/cm	(pH 4.5) mgCaCO3/L	(pH 8.3) mgCaCO3/L	mgCaCO3/L	mg/L	CaCO3 mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Anions	Cations		(%)
31-Mar-08	1	500	320	5.01	2477	#N/A	14.2	1.1	1533	1370	0.461	0.0001	0.0048	0.0089	<0.00005	<0.00003	0.034	0.00083	538	<0.0005	0.0054	0.281	0.121	0.0003	0.006	6.63	0.295	0.05	0.0078	0.0097	0.035	8.2	0.0029	24.2	<0.00003	73.9	0.469	584	0.00019	<0.00005	0.01	1E-05	<0.001	0.105	<0.0005	31.96	30.81	-1.15	-1.8%
07-Apr-08	2	500	495	7.58	1256	#N/A	8.0	48.1	1308	1140	0.276	3E-05	0.0019	0.0078	0.00003	<0.000005	0.031	0.00065	448	<0.0001	0.0046	0.248	0.096	0.0008	0.0038	4.77	0.23	<0.01	0.00557	0.0078	0.025	7.18	0.0015	21.8	2.6E-05	25.4	0.383	404	0.00017	<0.00001	0.0009	1E-05	<0.0002	0.0677	<0.0001	28.21	24.04	-4.18	-8.0%
14-Apr-08	3	500	500	5.10	1839	#N/A	8.6	0.4	1142	1120	0.229	3E-05	0.0023	0.0066	0.00003	<0.000005	0.023	0.000666	442	0.0004	0.0043	0.237	0.092	6.5E-05	0.0044	4.6	0.229	<0.01	0.00387	0.0071	0.025	8.71	0.0013	22.6	4.4E-05	14.2	0.351	397	0.0002	<0.00001	<0.0005	2E-05	<0.0002	0.061	<0.0001	23.80	23.27	-0.52	-1.1%
21-Apr-08	4	500	430	5.77	1104	#N/A	6.7	1.5	643	715	0.141	2E-05	0.0007	0.0058	0.00002	<0.000005	<0.05	0.000397	282	0.0001	0.0027	0.158	0.072	0.0002	0.0033	2.53	0.137	<0.01	0.00227	0.0042	0.018	6.71	0.0009	14.2	2.8E-05	7.59	0.201	237	0.00012	<0.00001	<0.0005	2E-05	<0.0002	0.0322	<0.0001	13.43	14.78	1.36	4.8%
28-Apr-08	5	500	435	5.37	1181	#N/A	7.2	0.5	680																																									
05-May-08	6	500	420	5.56	884	#N/A	5.9	0.9	490	452	0.0866	<0.00002	0.0005	0.0048	0.00002	<0.000005	<0.05	0.000336	177	<0.0001	0.0025	0.141	0.067	1.9E-05	0.003	2.36	0.125	<0.01	0.00193	0.004	0.01	5.24	0.0008	10.5	3.5E-05	4.36	0.138	160	0.00011	<0.00001	<0.0005	3E-05	<0.0002	0.028	<0.0001	10.23	9.35	-0.88	-4.5%
12-May-08	7	500	430	5.82	672	#N/A	5.1	1.1	313																																								
19-May-08	8	500	445	5.56	862	#N/A	5.4	0.8	453	462	0.085	<0.00002	0.0006	0.0039	0.00002	<0.000005	<0.05	0.00037	180	<0.0001	0.003	0.148	0.067	5.4E-05	0.0033	2.9	0.144	<0.01	0.00154	0.0044	0.009	5.55	0.0007	10.9	2.6E-05	2.65	0.126	163	9.8E-05	0.00002	<0.0005	3E-05	<0.0002	0.03	<0.0001	9.45	9.48	0.03	0.1%
26-May-08	9	500	450	5.60	943	#N/A	6.5	0.5	642																																								
02-Jun-08	10	500	430	5.59	650	#N/A	4.6	0.6	420	479	0.0623	<0.00002	0.0005	0.0038	0.00001	<0.000005	<0.05	0.000307	189	<0.0001	0.0024	0.114	0.036	8.5E-05	0.0024	2.12	0.109	<0.01	0.00147	0.0046	0.012	4.86	0.0005	10.7	1.9E-05	1.28	0.113	159	8.6E-05	<0.00001	<0.0005	3E-06	<0.0002	0.0215	<0.0001	8.76	9.79	1.02	5.5%
09-Jun-08	11	500	460	5.59	678	#N/A	5.0	0.7	453																																								
16-Jun-08	12	500	445	5.49	711	#N/A	6.8	0.6	469	528	0.074	<0.00002	0.0004	0.0031	0.00003	<0.000005	<0.05	0.000401	207	<0.0001	0.0035	0.154	0.015	0.00035	0.0036	2.52	0.135	0.01	0.00169	0.0043	0.01	6.47	0.0006	16.5	3.3E-05	1.16	0.125	180	0.00012	0.00001	<0.0005	6E-06	<0.0002	0.0282	<0.0001	9.78	10.75	0.97	4.7%
23-Jun-08	13	500	435	5.88	405	#N/A	5.9	1.2	282																																								
30-Jun-08	14	500	430	5.94	634	#N/A	5.4	1.1	390	385	0.0419	<0.00002	0.0004	0.0038	0.00001	<0.000005	<0.05	0.000266	151	0.0001	0.003	0.111	0.012	0.00003	0.0028	1.61	0.0901	<0.01	0.00174	0.0029	0.009	4.62	0.0005	10.8	0.00005	0.81	0.0932	123	9.4E-05	<0.00001	0.0005	6E-06	<0.0002	0.0179	<0.0001	8.15	7.82	-0.33	-2.0%
07-Jul-08	15	500	435	5.79	787	#N/A	5.1	0.8	381																																								
14-Jul-08	16	500	435	5.72	704	#N/A	5.5	0.9	371	378	0.0461	<0.00002	0.0004	0.0034	0.00002	<0.000005	<0.05	0.000305	148	<0.0001	0.0042	0.143	0.009	5.5E-05	0.0033	1.88	0.102	<0.01	0.0018	0.0034	0.01	5.26	0.0005	11.5	0.00004	0.85	0.0825	130	9.4E-05	<0.00001	0.0005	1E-05	<0.0002	0.0206	<0.0001	7.75	7.71	-0.04	-0.2%
21-Jul-08	17	500	455	5.64	738	#N/A	5.2	0.7	407																																								
28-Jul-08	18	500	435	5.58	768	#N/A	4.5	1.7	391	426	0.0512	<0.00002	0.0004	0.0059	0.00002	5E-06	<0.05	0.000357	168	<0.0001	0.0042	0.154	0.011	0.00035	0.0031	1.7	0.0884	<0.01	0.00201	0.0033	0.011	5.28	0.0003	11.4	3.3E-05	0.67	0.0892	148	9.5E-05	0.00002	0.001	4E-05	<0.0002	0.0238	<0.0001	8.18	8.69	0.51	3.0%
04-Aug-08	19	500	460	5.71	607	#N/A	4.0	3.2	291																																								
11-Aug-08	20	500	440	5.60	716	#N/A	4.7	0.4	418	459	0.0488	<0.00002	0.0002	0.006	0.00001	<0.000005	<0.05	0.000261	181	<0.0001	0.0037	0.159	0.011	0.00011	0.0029	1.54	0.0779	<0.01	0.00152	0.0028	0.008	4.81	0.0003	11.3	3.7E-05	0.67	0.0883	160	8.3E-05	0.00002	0.0005	7E-06	<0.0002	0.0273	<0.0001	8.72	9.31	0.59	3.3%
18-Aug-08	21	500	440	5.59	688	#N/A	4.9	3.3	374																																								
25-Aug-08	22	500	450	5.65	559	#N/A	4.3	0.4	306	350	0.0269	<0.00002	0.0003	0.0041	<0.00001	<0.000005	<0.05	0.000212	138	<0.0001	0.0026	0.102	0.006	7.7E-05	0.0025	1.01	0.0548	<0.01	0.00147	0.0019	0.009	4.03	0.0003	10.5	2.4E-05	0.46	0.071	117	7.2E-05	<0.00001	0.0005	<0.00000	<0.0002	0.0139	<0.0001	6.38	7.09	0.71	5.3%
01-Sep-08	23	500	430	5.59	619	#N/A	4.8	0.5	354																																								
08-Sep-08	24	500	455	5.74	430	#N/A	4.4	2.7	227	248	0.0204	<0.00002	0.0002	0.0047	<0.00001	<0.000005	<0.05	0.000163	97.9	<0.0001	0.002	0.0939	0.006	8.8E-05	0.0022	0.76	0.0397	<0.01	0.00148	0.0015	0.008	3.35	0.0003	10.6	2.7E-05	0.4	0.0514	83	6.6E-05	<0.00001	<0.0005	3E-06	<0.0002	0.0116	<0.0001	4.78	5.05	0.27	2.7%
15-Sep-08	25	500	445	5.80	463	#N/A	3.8	0.9	222																																								
22-Sep-08	26	500	500	5.82	367	#N/A	3.6	0.7	199	222	0.0174	<0.00002	0.0001	0.0057	<0.00001	<0.000005	<0.05	0.000114	87.7	<0.0001	0.0014	0.0642	0.004	4.7E-05	0.002	0.67	0.0327	<0.01	0.00154	0.0013	0.009	3.02	0.0003	13.3	2.4E-05	0.37	0.0444	77	5.7E-05	0.00001	0.0007	4E-06	<0.0002	0.0086	<0.0001	4.16	4.52	0.37	4.2%
29-Sep-08	27	500	465	5.97	303	#N/A	3.5	0.9	140																																								
06-Oct-08	28	500	450	5.90	274	#N/A	3.1	0.8	138	141	0.0107	<0.00002	0.0002	0.0048	<0.00001	<0.000005	<0.05	0.000076	55.8	<0.0001	0.0011	0.054	0.004	3.8E-05	0.0017	0.51	0.0238	<0.01	0.00145	0.0008	0.006	2.32	0.0003	10.5	0.00002	0.34	0.034	50	5.1E-05	<0.00001	<0.0005	7E-06	<0.0002	0.0061	<0.0001	2.89	2.90	0.01	0.2%
13-Oct-08	29	500	450	5.97	277	#N/A	3.9	1.1	130																																								
20-Oct-08	30	500	450	5.93	238	#N/A	3.2	1.1	117																																								
27-Oct-08	31	500	455	5.84	282	#N/A	4.0	1.1	139																																								
03-Nov-08	32	500	455	5.80	195	#N/A	2.9	<0.1	95	95.3	0.0083	<0.00002	0.0001	0.0057	<0.00001	<0.000005	<0.05	0.000052	37.6	<0.0001	0.0007	0.0345	0.004	2.1E-05	0.0012	0.35	0.0164	<0.01	0.00183	0.0006	0.009	1.82	0.0002	7.85	2.2E-05	0.26	0.0236	34	3.8E-05	<0.00001	<0.0005	4E-06	<0.0002	0.0044	<0.0001	1.98	1.96	-0.02	-0.4%
10-Nov-08	33	500	460	6.03	197	#N/A	3.4	1.6	82																																								
17-Nov-08	34	500	480	5.93	229	#N/A	4.3	0.6	124																																								
24-Nov-08	35	500	520	5.69	252	#N/A	4.8	0.8	120																																								
01-Dec-08	36	500	500	5.92	152	#N/A	3.7	1.1	63	62.2	0.0069	<0.00002	9E-05	0.0038	<0.00001	<0.000005	<0.05	0.000039	24.5	<0.0001	0.0005	0.0275	0.004	3.9E-05	0.0012	0.26	0.0122	<0.01	0.00191	0.0005	0.01	1.76	0.0002	11.9	2.1E-05	0.23	0.0166	22	3.6E-05	<0.00001	<0.0005	7E-06	<0.0002	0.0033	<0.0001	1.33	1.30	-0.03	-1.3%
08-Dec-08	37	500	500	6.21	100	#N/A	3.8	1.0	43																																								
15-Dec-08	38	500	505	6.23	119	#N/A	6.1	1.2	48																																								
22-Dec-08	39	500	480	6.60	106	#N/A	6.2	1.7	42																																								
29-Dec-08	40	500	450	7.21	79	#N/A	7.9	2.8	39	33.4	0.0069	<0.00002	0.0001	0.0044	<0.00001	<0.000005	<0.05	0.000023	13.1	<0.0001	0.0006	0.0213	0.004	0.00014	0.0014	0.16	0.0076	<0.01	0.00336	0.0111	0.014	1.75	0.0003	14.5	1.3E-05	0.22	0.0096	12	3.3E-05	0.00005	<0.0005	<0.00000	<0.0002	0.0021	<0.0001	0.87	0.72	-0.15	-9.3%
05-Jan-09	41	500	420	5.73	79	#N/A	6.4	0.5	34																																								
12-Jan-09	42	500	430	6.24	51	#N/A	4.7	1.4	22																																								
19-Jan-09	43	500	425	5.93	63	#N/A	4.0	1.0	24																																								
26-Jan-09	44	500	420	6.46	72	#N/A	5.4	1.7	28																																								
02-Feb-09	45	500	440																																														
09-Feb-09	46	500	445	7.09	53	#N/A	5.5	2.6	19																																								
16-Feb-09	47	500	430																																														
23-Feb-09	48	500	510	6.79	54	#N/A	5.6	1.9	19	18.3	0.0058	<0.00002	0.0018	0.0049	<0.00001	<0.000005	<0.05	0.00003	7.09	<0.0001	0.0003	0.0229	0.004	8.2E-05	0.0008	0.14	0.0063	0.01	0.00452	0.0006	0.021	1.14	0.0003	12.1	1.1E-05	0.18	0.0065	6	2.5E-05	<0.00001	<0.0005	2E-06	0.0002	0.0027	<0.0001	0.43	0.40	-0.03	-3.8%
02-Mar-09	49	500	460																																													
09-Mar-09	50	500	425	5.56	54	#N/A	6.0	1.1	20																																								
16-Mar-09	51	500	505																																														
23-Mar-09	52	500	495	5.56	33	#N/A	5.1	1.1	11																																								
30-Mar-09	53	500	505																																														
06-Apr-09	54	500	505	5.80	29	#N/A	5.2	1.1	12																																								
13-Apr-09	55	500	495																																														
20-Apr-09	56	500	490	5.56	32	#N/A	5.0	1.0	12	11	0.0046	<0.00002	0.0002	0.0037	<0.00001	<0.000005	<0.05	0.000017	4.23	<0.0001	0.0002	0.0251	0.004	5.5E-05	0.0006	0.1	0.0048	0.01	0.00607	0.0002	0.023	0.87	0.0003	10.1	9E-06	0.18	0.0041	4	1.7E-05	<0.00001	<0.0005	<0.00000	0.0003	0.002	<0.0001	0.27	0.25	-0.02	-3.9%
27-Apr-09	57	500	510																																													
04-May-09	58	500	490	5.68	36	#N/A	4.6	0.9	9																																								
11-May-09	59	500	460																																													
18-May-09	60	500	510	5.91	55	#N/A	5.8	1.6	17																																								
25-May-09	61	500	510																																													
01-Jun-09	62	500	500	5.97	29	#N/A	5.8	1.4	15																																								
08-Jun-09	63	500	500																																													
15-Jun-09	64	500	455	5.97	15	#N/A	3.5	1.9	6	5.5	0.0157	<0.00002	0.001	0.0032	<0.00001	<0.000005	<0.05	0.000011	2.12	<0.0001	0.0002	0.0175	0.017	3.4E-05	<0.0005	0.06	0.0027	<0.01	0.00766	0.0016	0.021	0.54	0.0003	5.66	1.9E-05	0.16	0.0028	<3	0.00001	<0.00001	0.0009	2E-06	<0.0002	0.0015	<0.0001	0.16	0.13	-0.03	-10.8%
22-Jun-09	65	500	480																																													
29-Jun-09	66	500	510	6.08	23	#N/A	4.6	1.2	10																																								
06-Jul-09	67	500	455																																														
13-Jul-09	68	500	420	6.01	18	#N/A	3.7	1.3	4																																								
20-Jul-09	69	500	435																																														
27-Jul-09	70	500	445	5.64	11	#N/A	5.0	0.1	4																																								
03-Aug-09	71	500	415																																														
10-Aug-09	72	500	440	5.97	11	#N/A	4.9	1.1	4	4.1	0.0108	<0.00002	0.0002	0.0024	<0.00001	1.2E-05	<0.05	0.000018	1.54	<0.0001	9E-05	0.0175	0.035	6.5E-05	0.0006	0.05	0.0023	<0.01	0.0179	0.0002	0.041	0.61	0.0005	9.32	0.00001	0.15	0.0015	<3	1.1E-05	0.00002	<0.0005	3E-06	<0.0002	0.0026	<0.0001	0.10	0.10	0.00	-0.9%
17-Aug-09	73	500	440																																													
24-Aug-09	74	500	415	5.94	11	#N/A	4.3	1.3	<1																																								
31-Aug-09	75	500	430																																														
07-Sep-09	76	500	475	6.12	9	#N/A	4.8	1.4	2																																								
14-Sep-09	77	500	415																																														
21-Sep-09	78	500	400	6.16	14	#N/A	5.1	7.0	4																																								
28-Sep-09	79	500	410																																														
05-Oct-09	80	500	495	5.89	15	#N/A	6.7	1.4	6	5.4	0.326	2E-05	0.0005	0.0104	0.00002	0.00021	<0.05	0.000028	1.97	0.0003	0.0002	0.0351	0.559	0.00076	0.0008	0.12	0.0039	<0.01	0.0321	0.0005	0.091	0.95	0.0008	21.2	0.00011	0.26	0.003	<3	1.8E-05	0.00021	0.0199	2E-05	0.0014	0.0029	<0.0001	0.15	0.14	-0.01	-2.8%
12-Oct-09	81	500	465																																													
19-Oct-09	82	500	435	6.39	6	#N/A	3.3	1.4	2																																								
26-Oct-09	83	500	455																																														
02-Nov-09	84	500	465	6.42	5	#N/A	4.3	1.6	2																																								
09-Nov-09	85	500	440																																														
16-Nov-09	86	500	495	6.89	12	#N/A	9.2	3.3	5																																								
23-Nov-09	87	500	440																																														
30-Nov-09	88	500	435	6.08	8	#N/A	4.7	1.4	3	2.4	0.025	<0.00002	0.0008	0.003	<0.00001	2.8E-05	<0.05	<0.000005	0.94	<0.0001	7E-05	0.0056	0.072	8.9E-05	<0.0005	<0.05	0.0016	<0.01	0.0193	0.0003	0.048	0.52	0.0004	8.44	5.3E-05	0.15	0.0012	<3	6E-06	0.00002	0.0017	3E-06	0.0003	0.0017	<0.0001	0.09	0.07	-0.02	-14.6%
07-Dec-09	89	500	440																																													
14-Dec-09	90	500	440	5.98	10	#N/A	5.7	1.3	4																																								
21-Dec-09	91	500	460																																														
28-Dec-09	92	500	430	6.11	11	#N/A	4.3	1.0	2																																								
04-Jan-10	93	500	420																																														
11-Jan-10	94	500	445	6.00	14	#N/A	7.2	1.5	6																																								
18-Jan-10	95	500	440																																														
25-Jan-10	96	500	435	6.01	5	#N/A	5.0	1.2	3	3.5	0.0344	<0.00002	0.0003	0.0034	<0.00001	4.8E-05	<0.05	0.000019	1.29	<0.0001	9E-05	0.0206	0.123	7.4E-05	0.0006	0.06	0.0027	<0.01	0.0284	0.0002	0.058	0.68	0.0006	12.8	2.7E-05	0.17	0.0016	<3	0.00001	<0.00001	0.002	<0.00000	0.0004	0.0015	<0.0001	0.09	0.09	0.00	1.7%
01-Feb-10	97	500	430																																													
08-Feb-10	98	500	430	5.48	10	#N/A	6.8	1.3	2																																								
15-Feb-10	99	500	465																																														
22-Feb-10	100	500	445	5.66	20	#N/A	5.4	1.3																																								

TABLE IV.8
Kinetic Test Results Neutralized Spent Ore Sample Col-6
Cormacks Copper Project, YT

HC 9
Sample = Col-6 (0700601)

Date	Cycle No.	Volume mL Input	Volume mL Output	pH	Cond. umhos/cm	Acidity (pH 4.5) mgCaCO3/L	Acidity (pH 8.3) mgCaCO3/L	Alkalinity mgCaCO3/L	Sulphate mg/L	Hardness CaCO3 mg/L	Al mg/L	Sb mg/L	As mg/L	Ba mg/L	Be mg/L	Bi mg/L	B mg/L	Cd mg/L	Ca mg/L	Cr mg/L	Co mg/L	Cu mg/L	Fe mg/L	Pb mg/L	Li mg/L	Mg mg/L	Mn mg/L	Hg ug/L	Mo mg/L	Ni mg/L	P mg/L	K mg/L	Se mg/L	Si mg/L	Ag mg/L	Na mg/L	Sr mg/L	S mg/L	Tl mg/L	Sn mg/L	Ti mg/L	U mg/L	V mg/L	Zn mg/L	Zr mg/L	Major Anions	Major Cations	Diff	Diff (%)
09-Feb-09	1	750	565	7.36	4159	#N/A	14.5	56.0	2531	691	0.035	0.0008	0.0025	0.0187	<0.00005	<0.00003	<0.3	0.00114	276	<0.0005	0.00006	0.0106	0.023	0.00008	<0.003	0.71	0.0007	0.07	2.57	0.0019	0.45	7.53	0.02	35.3	<0.00003	811	0.374	915	0.00004	0.00007	0.004	2E-05	0.002	0.0006	<0.0005	53.85	49.28	-4.57	-4.4%
16-Feb-09	2	500	460	7.78	2122	#N/A	3.5	44.2	1076	383	0.021	0.0008	0.0034	0.0148	<0.00005	<0.00003	<0.3	0.00106	153	<0.0005	0.00005	0.0059	0.013	0.00007	<0.003	0.32	0.0007	<0.05	2.17	0.0031	0.413	3.97	0.021	26.4	0.00008	338	0.205	396	0.00007	<0.00005	<0.003	0.0001	0.004	0.0011	<0.0005	23.30	22.46	-0.84	-1.8%
23-Feb-09	3	500	470	7.69	1771	#N/A	5.5	39.2	788	445	0.008	0.0004	0.0026	0.0178	<0.00005	<0.00003	<0.3	0.00052	178	<0.0005	0.00005	0.0038	0.007	<0.00003	<0.003	0.32	<0.0003	<0.05	1.78	0.0004	0.299	4.1	0.0149	27.7	0.00005	236	0.216	291	0.00002	<0.00005	<0.003	<0.00001	0.004	0.0008	<0.0005	17.20	19.27	2.07	5.7%
02-Mar-09	4	500	450	7.58	1466	#N/A	5.4	39.5	675	426	0.015	0.0002	0.0014	0.0156	<0.00005	<0.00003	<0.3	0.00047	170	<0.0005	<0.00003	0.0039	0.014	0.00011	<0.003	0.27	<0.0003	<0.05	1.42	0.0027	0.278	3.68	0.0153	29.8	0.00003	156	0.206	256	<0.00001	<0.00005	<0.003	6E-05	0.003	0.0013	<0.0005	14.85	15.38	0.53	1.7%
09-Mar-09	5	500	450	7.52	1455	#N/A	7.3	46.6	678																																								
16-Mar-09	6	500	500	7.46	1154	#N/A	7.3	48.5	664	496	0.0053	0.00047	0.00144	0.0193	<0.00001	<0.000005	<0.05	0.00033	198	<0.0001	1.5E-05	0.0026	0.005	0.00001	<0.0005	0.27	0.0001	<0.01	1.15	0.0002	0.303	3.74	0.0178	44.6	5E-06	66	0.218	221	0.000014	<0.00001	0.0006	6E-06	0.0017	0.0006	<0.0001	14.80	12.87	-1.94	-7.0%
23-Mar-09	7	500	510	7.49	845	#N/A	6.2	41.8	373																																							
30-Mar-09	8	500	515	7.49	797	#N/A	6.8	49.1	320	314	0.006	0.00048	0.00168	0.0222	0.00002	<0.000005	<0.05	0.0002	126	<0.0001	0.00011	0.0029	0.007	2.8E-05	<0.0005	0.16	0.001	0.01	0.835	0.0005	0.305	2.59	0.0179	41.9	<0.000005	21.5	0.144	112	0.000016	<0.00001	<0.0005	1E-05	0.0017	0.0003	<0.0001	7.65	7.30	-0.35	-2.3%
06-Apr-09	9	500	490	7.55	540	#N/A	6.2	40.3	224																																							
13-Apr-09	10	500	460	7.50	535	#N/A	6.8	45.0	214	234	0.0063	0.00038	0.00189	0.0226	0.00002	<0.000005	<0.05	0.00021	93.3	<0.0001	9.5E-05	0.0023	0.008	1.4E-05	<0.0005	0.12	0.0005	<0.01	0.666	0.0006	0.302	2.18	0.0154	34	0.00001	11.1	0.108	78	0.000015	<0.00001	<0.0005	2E-05	0.0017	0.0005	<0.0001	5.36	5.20	-0.15	-1.5%
20-Apr-09	11	500	515	7.55	435	#N/A	6.0	46.9	172																																							
27-Apr-09	12	500	505	7.69	370	#N/A	5.2	45.8	118	160	0.007	0.0004	0.0017	0.0259	<0.00005	<0.00003	<0.3	0.00027	64	<0.0005	<0.00003	0.0021	0.006	<0.00003	<0.003	0.07	<0.0003	<0.05	0.601	0.0002	0.323	1.94	0.0175	35.8	<0.00003	5.97	0.0819	46	<0.00001	<0.00005	<0.003	<0.00001	0.002	<0.0005	<0.0005	3.37	3.51	0.13	2.0%
04-May-09	13	500	500																																												
11-May-09	14	500	495	7.51	269	#N/A	7.0	45.5	87																																							
18-May-09	15	500	515																																												
25-May-09	16	500	510	7.67	195	#N/A	6.0	42.8	46	85.3	0.008	0.00036	0.00198	0.0215	<0.00001	<0.000005	<0.05	8.3E-05	34.1	<0.0001	5.5E-05	0.0022	0.009	8.9E-05	<0.0005	<0.05	0.0005	<0.01	0.373	0.0005	0.334	1.43	0.0192	34.5	2.2E-05	2.59	0.048	19	0.000012	<0.00001	<0.0005	5E-06	0.0019	0.0004	<0.0001	1.81	1.85	0.04	1.0%
01-Jun-09	17	500	520																																											
08-Jun-09	18	500	500	7.72	182	#N/A	6.2	50.1	38																																							
15-Jun-09	19	500	505																																												
22-Jun-09	20	500	500	7.73	128	#N/A	6.4	49.7	30	71.3	0.0174	0.00049	0.00221	0.0235	<0.00001	<0.000005	<0.05	0.00013	28.6	<0.0001	1.1E-05	0.0033	0.018	1.7E-05	<0.0005	<0.05	0.0011	<0.01	0.365	0.0002	0.45	1.52	0.0198	45.8	7.3E-05	1.97	0.0396	11	0.000006	<0.00001	0.0013	1E-05	0.0026	0.0004	<0.0001	1.62	1.55	-0.07	-2.1%
29-Jun-09	21	500	520																																											
06-Jul-09	22	500	325	7.78	112	#N/A	4.3	40.2	13																																							
13-Jul-09	23	500	495																																												
20-Jul-09	24	500	505	7.69	126	#N/A	6.3	49.4	18																																							
27-Jul-09	25	500	495																																												
03-Aug-09	26	500	520	7.89	94	#N/A	3.3	39.0	15																																							
10-Aug-09	27	500	495																																												
17-Aug-09	28	500	515	7.71	98	#N/A	4.9	38.6	10	46.8	0.0147	0.00033	0.00242	0.0191	<0.00001	<0.000005	<0.05	0.00004	18.7	<0.0001	7E-06	0.002	0.013	1.3E-05	<0.0005	<0.05	8E-05	<0.01	0.209	0.0001	0.358	1.2	0.0153	28.6	0.0001	0.77	0.0282	4	0.000013	<0.00001	0.0008	4E-06	0.0025	0.0031	<0.0001	0.98	1.00	0.02	0.8%
24-Aug-09	29	500	485																																											
31-Aug-09	30	500	505	7.79	85	#N/A	4.3	35.8	8																																							
07-Sep-09	31	500	490																																												
14-Sep-09	32	500	520	7.75	88	#N/A	4.3	35.0	9																																							
21-Sep-09	33	500	505																																												
28-Sep-09	34	500	500	7.78	103	#N/A	4.5	41.1	17																																							
05-Oct-09	35	500	490																																												
12-Oct-09	36	500	425	7.75	79	#N/A	3.7	34.3	13	38.8	0.0112	0.00018	0.00115	0.0168	<0.00001	<0.000005	<0.05	3.9E-05	15.5	<0.0001	<0.000005	0.0011	0.012	0.00018	<0.0005	<0.05	0.0002	<0.01	0.122	0.0001	0.179	0.86	0.0067	17.5	3.1E-05	0.44	0.0269	4	0.000004	0.0001	0.0009	9E-06	0.0015	0.0004	<0.0001	0.96	0.81	-0.14	-8.0%
19-Oct-09	37	500	425																																											
26-Oct-09	38	500	455	7.80	118	#N/A	3.4	45.6	17																																							
02-Nov-09	39	500	485																																												
09-Nov-09	40	500	500	7.66	90	#N/A	5.8	42.0	5																																							
16-Nov-09	41	500	440																																												
23-Nov-09	42	500	425	7.69	91	#N/A	6.0	37.6	11																																							
30-Nov-09	43	500	430																																												
07-Dec-09	44	500	445	7.61	78	#N/A	4.6	37.8	4	35.8	0.0235	0.00018	0.00109	0.0161	<0.00001	0.000014	<0.05	1.9E-05	14.4	<0.0001	6E-06	0.0022	0.034	0.00014	<0.0005	<0.05	0.0003	<0.01	0.105	0.0003	0.187	0.81	0.0049	16.8	0.0001	0.47	0.0248	<3	0.000002	0.00002	0.0015	3E-05	0.0013	0.0014	<0.0001	0.84	0.76	-0.08	-5.0%
14-Dec-09	45	500	435																																											
21-Dec-09	46	500	450	7.93	77	#N/A	2.9	41.9	9																																							
28-Dec-09	47	500	430																																												
04-Jan-10	48	500	445	7.70	89	#N/A	4.7	37.7	7																																							
11-Jan-10	49	500	405																																												
18-Jan-10	50	500	485	7.77	91	#N/A	5.7	35.6	9																																							
25-Jan-10	51	500	455																																												
01-Feb-10	52	500	490	7.80	75	#N/A	4.1	43.6	7	45.8	0.0102	0.00025	0.00171	0.0202	<0.00001	0.000006	<0.05	6.1E-05	18.3	<0.0001	<0.000005	0.0026	0.017	9.2E-05	<0.0005	<0.05	0.0005	<0.01	0.144	0.0001	0.319	1.18	0.0088	33.3	0.0001	0.39	0.0302	<3	0.000004	0.00005	0.001	9E-05	0.0021	0.0006	<0.0001	1.02	0.96	-0.06	-2.9%
08-Feb-10	53	500	470																																											
15-Feb-10	54	500	470	7.64	69	#N/A	4.0	35.4	1																																							
22-Feb-10	55	500	485																																												

APPENDIX V

2007 Waste Rock Static Results

March 26, 2010
Project No. 07-1413-0077/9100
Doc. No. 105

Golder Associates

TABLE V.1
Whole Rock Analysis Results
2007 Samples
Carmacks Copper Project, YT

Average Amounts of Chemical Elements* (%)					**66.88**	**15.66**	**1.33**	**3.56**	**1.57**	**3.84**	**3.07**	**0.57**	**0.21**	**0.07**						
Sample ID	**Rock type**	**Alteration**	**Mineralization**	**Location**	**SiO2**	**Al2O3**	**Fe2O3**	**CaO**	**MgO**	**Na2O**	**K2O**	**TiO2**	**P2O5**	**MnO**	**BaO**	**Cr2O3**	**LOI**	**Total**	**C**	**S**
					%	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**
C228435	foliated granodiorite	Unaltered	Weak (0.620 % Cu)	Hanging wall	51.65	16.95	8.71	4.85	4.41	5.39	2.23	0.65	0.34	0.16	0.21	0.01	2.74	98.29	0.05	0.05
C228666	granodiorite	Chlorite/epidote	None	Hanging wall	53.1	20.1	7.05	6.63	2.42	6.65	0.98	0.68	0.3	0.11	0.13	0.01	1.36	99.52	0.12	0.02
C229560	granodiorite	Hematite	None	Hanging wall	58.41	20.14	4.01	5.18	1.52	6.85	1.55	0.51	0.11	0.07	0.16	0.02	1.05	99.56	0.01	0.01
C229587	granodiorite	Potassium feldspar	Weak (0.50 % Cu)	Hanging wall	54.05	20.13	5.42	4.68	2.78	6.65	1.7	0.55	0.23	0.08	0.15	0.01	2.18	98.6	0.02	0.02
C490366	granodiorite	Unaltered	None	Interbed	54.03	20.5	5.5	6.64	2.01	6.85	0.94	0.6	0.18	0.09	0.11	0.02	1.85	99.31	0.03	0.26
C490395	mixed gneiss/ granodiorite	Gypsum	Weak (0.365 % Cu)	Footwall	46.82	17.86	9.29	9.79	4.56	4.91	0.96	0.94	0.14	0.13	0.07	0.02	2.74	98.22	0.02	0.88
C490422	mixed gneiss/ granodiorite	Gypsum	Weak (0.150 % Cu)	Footwall	47.16	16.79	13.09	7.58	5.01	3.95	1.83	1.11	0.13	0.13	0.1	0.01	2	98.88	0.02	0.38

Notes:
< = less than detection limit
* For Granodiorites (Price, 1997)

TABLE V.2
Trace Element Analysis Results
2007 Samples
Carmacks Copper Project, YT

Sample ID	Rock type	Alteration	Mineralization	Location	Ag ppm	Al %	As ppm	Ba ppm	Be ppm	Bi ppm	Ca %	Cd ppm	Co ppm	Cr ppm	Cu ppm	Fe %	Hg ppm	K %	La ppm	Mg %	Mn ppm
C228435	foliated granodiorite	Unaltered	Weak (0.620 % Cu)	Hanging wall	2.1	2.14	<5	89	0.8	<5	1.7	<1	17	40	8268	3.66	1	0.12	<10	1.49	595
C228666	granodiorite	Chlorite/epidote	None	Hanging wall	<0.2	1.18	<5	516	0.5	<5	1.46	<1	11	77	45	2.92	2	0.26	<10	0.78	397
C229560	granodiorite	Hematite	None	Hanging wall	<0.2	0.85	<5	106	<0.5	<5	0.9	<1	6	82	158	1.61	<1	0.12	<10	0.46	247
C229587	granodiorite	Potassium feldspar	Weak (0.50 % Cu)	Hanging wall	1.4	1.53	<5	343	0.6	<5	0.78	<1	13	57	6299	2.77	1	0.45	<10	1.14	368
C490366	granodiorite	Unaltered	None	Interbed	<0.2	0.95	<5	165	<0.5	<5	1.42	<1	7	83	24	2.09	1	0.1	<10	0.6	293
C490395	mixed gneiss/ granodiorite	Gypsum	Weak (0.365 % Cu)	Footwall	0.6	1.03	<5	128	<0.5	<5	2.03	<1	9	77	2520	2.24	1	0.19	<10	0.76	285
C490422	mixed gneiss/ granodiorite	Gypsum	Weak (0.150 % Cu)	Footwall	<0.2	2.53	<5	81	0.7	<5	2.25	<1	21	44	2630	5.21	2	0.32	<10	1.76	528

Sample ID	Rock type	Alteration	Mineralization	Location	Mo ppm	Na %	Ni ppm	P ppm	Pb ppm	S %	Sb ppm	Sc ppm	Sr ppm	Th ppm	Ti %	Tl ppm	U ppm	V ppm	W ppm	Zn ppm	Zr ppm
C228435	foliated granodiorite	Unaltered	Weak (0.620 % Cu)	Hanging wall	15	0.1	9	2697	10	0.03	<5	8	58	<5	0.21	13	15	102	<10	70	6
C228666	granodiorite	Chlorite/epidote	None	Hanging wall	<2	0.09	3	1880	2	0.01	<5	4	44	<5	0.16	15	12	82	<10	54	3
C229560	granodiorite	Hematite	None	Hanging wall	2	0.09	3	991	3	<0.01	<5	3	30	<5	0.11	<10	<10	44	<10	27	3
C229587	granodiorite	Potassium feldspar	Weak (0.50 % Cu)	Hanging wall	6	0.07	11	2013	6	<0.01	<5	5	42	<5	0.18	10	13	81	<10	64	5
C490366	granodiorite	Unaltered	None	Interbed	2	0.09	3	1300	4	0.25	<5	3	132	<5	0.13	10	<10	53	<10	37	2
C490395	mixed gneiss/ granodiorite	Gypsum	Weak (0.365 % Cu)	Footwall	62	0.13	7	1225	3	0.8	<5	5	60	<5	0.14	<10	10	77	<10	29	3
C490422	mixed gneiss/ granodiorite	Gypsum	Weak (0.150 % Cu)	Footwall	42	0.16	9	1266	5	0.36	<5	12	66	<5	0.31	<10	16	183	<10	50	5

Notes:
< = less than detection limit
Non-detect values assumed to be equal to one half of the detection limit in calculations of average, median and standard deviation, where applicable.

TABLE V.3
Shake Flask Extraction Results
2007 Samples
Carmacks Copper Project, YT

CCME (CEQG) (freshwater aquatic life)* (mg/L)					6.5 - 9.0							0.005 - 0.1		0.005				0.000026	0.073	0.025 - 0.15			0.001		0.0001
Metal Mining Effluent Regulations (MMER)[5]** (mg/L)					6.0 - 9.5									0.5						0.5					
Sample ID	**Rock type**	**Alteration**	**Mineralization**	**Location**	**pH s.u.**	**REDOX mV**	**Conductivity uS/cm**	**Acidity (pH 8.3) mg/L as CaCO3**	**Alkalinity mg/L as CaCO3**	**Hardness mg/L as CaCO3**	**Sulphate (mg/L)**	**Aluminum[2] (mg/L)**	**Antimony (mg/L)**	**Arsenic (mg/L)**	**Barium (mg/L)**	**Magnesium (mg/L)**	**Manganese (mg/L)**	**Mercury (mg/L)**	**Molybdenum (mg/L)**	**Nickel[4] (mg/L)**	**Phosphorus (mg/L)**	**Potassium (mg/L)**	**Selenium (mg/L)**	**Silicon (mg/L)**	**Silver (mg/L)**
C228435	foliated granodiorite	Unaltered	Weak (0.620 % Cu)	Hanging wall	7.41	406	93	2.9	3.2	17.8	5	0.051	<0.00005	0.0002	0.0363	1.69	0.00899	<0.00005	**0.101**	<0.0005	<0.1	2.41	**0.0032**	3.47	0.00001
C228666	granodiorite	Chlorite/epidote	None	Hanging wall	7.84	393	156	2.6	72.6	74	5	0.0798	0.00015	0.0002	0.288	2.44	0.0105	<0.00005	0.00586	<0.0005	<0.1	2.79	<0.0005	1.97	<0.00001
C229560	granodiorite	Hematite	None	Hanging wall	7.55	387	84	2.6	37.7	28.3	1	0.0992	0.00005	0.0002	0.0221	0.84	0.00417	<0.00005	0.00833	<0.0005	<0.1	1.49	<0.0005	2.39	<0.00001
C229587	granodiorite	Potassium feldspar	Weak (0.50 % Cu)	Hanging wall	7.13	391	49	3.2	18.0	10.9	4	0.0337	<0.00005	0.0005	0.0534	0.53	0.00514	<0.00005	0.0175	<0.0005	<0.1	2.83	0.0007	3.87	<0.00001
C490366	granodiorite	Unaltered	None	Interbed	7.5	412	1648	3.8	31.3	1100	1017	0.0509	<0.00005	0.0004	0.0497	1.01	0.0184	<0.00005	0.00045	0.0015	<0.1	4.28	0.0008	0.93	<0.00001
C490395	mixed gneiss/ granodiorite	Gypsum	Weak (0.365 % Cu)	Footwall	7.17	399	2052	3.7	14.6	1490	1320	0.0378	0.00005	0.0004	0.0941	1.27	0.0176	<0.00005	0.0031	0.0018	<0.1	5.7	**0.0011**	0.92	<0.00001
C490422	mixed gneiss/ granodiorite	Gypsum	Weak (0.150 % Cu)	Footwall	7.49	375	850	3.4	28.9	513	427	0.0586	<0.0005	0.0003	0.0266	3.75	0.164	<0.00005	0.000711	<0.0005	<0.1	4.16	0.0009	1.35	<0.00001

CCME (CEQG) (freshwater aquatic life)* (mg/L)								0.000005 - 0.000338		0.001/0.0089		0.002 - 0.004	0.3	0.001 - 0.007					0.0008					0.03	
Metal Mining Effluent Regulations (MMER)[5]** (mg/L)												0.3		0.2										0.5	
Sample ID	**Rock type**	**Alteration**	**Mineralization**	**Location**	**Beryllium (mg/L)**	**Bismuth (mg/L)**	**Boron (mg/L)**	**Cadmium[4, 7] (mg/L)**	**Calcium (mg/L)**	**Chromium[3] (mg/L)**	**Cobalt (mg/L)**	**Copper[4] (mg/L)**	**Iron (mg/L)**	**Lead[4] (mg/L)**	**Lithium (mg/L)**	**Sodium (mg/L)**	**Strontium (mg/L)**	**Sulphur (mg/L)**	**Thallium (mg/L)**	**Tin (mg/L)**	**Titanium (mg/L)**	**Uranium (mg/L)**	**Vanadium (mg/L)**	**Zinc (mg/L)**	**Zirconium (mg/L)**
C228435	foliated granodiorite	Unaltered	Weak (0.620 % Cu)	Hanging wall	<0.00005	<0.00005	<0.008	**0.00018**	4.36	<0.0002	0.00003	0.00102	0.006	0.00002	0.001	10.1	0.119	1.9	<0.00005	<0.00005	<0.0005	<0.00001	0.00102	<0.0005	<0.005
C228666	granodiorite	Chlorite/epidote	None	Hanging wall	<0.00005	<0.00005	<0.008	0.00001	25.6	<0.0002	<0.00002	0.0003	<0.005	<0.00002	0.0017	4.53	0.153	2	<0.00005	<0.00005	<0.0005	<0.00001	0.00209	<0.0005	<0.005
C229560	granodiorite	Hematite	None	Hanging wall	<0.00005	<0.00005	<0.008	0.00001	9.96	0.0003	<0.00002	<0.0001	0.009	0.00004	0.0007	6.86	0.0437	0.7	<0.00005	<0.00005	<0.0005	<0.00001	0.00178	<0.0005	<0.005
C229587	granodiorite	Potassium feldspar	Weak (0.50 % Cu)	Hanging wall	<0.00005	<0.00005	<0.008	**0.00003**	3.5	<0.0002	0.00003	**0.0136**	0.011	<0.00002	0.0008	4.73	0.0298	1.6	<0.00005	<0.00005	0.0009	<0.00001	0.00151	<0.0005	<0.005
C490366	granodiorite	Unaltered	None	Interbed	<0.00005	<0.00005	0.016	<0.00001	439	<0.0002	<0.00002	<0.0005	<0.005	0.00003	0.0008	9.62	2.01	336	<0.00005	<0.00005	0.0028	0.00004	0.00052	0.001	<0.005
C490395	mixed gneiss/ granodiorite	Gypsum	Weak (0.365 % Cu)	Footwall	<0.00005	<0.00005	0.008	0.00004	595	<0.0002	<0.00002	0.0003	<0.005	<0.00002	0.0017	5.85	1.44	495	<0.00005	<0.00005	0.0037	0.00003	0.00068	<0.0005	<0.005
C490422	mixed gneiss/ granodiorite	Gypsum	Weak (0.150 % Cu)	Footwall	<0.00005	<0.00005	0.063	0.00002	199	<0.0002	<0.00002	<0.0001	<0.005	<0.00002	0.0043	14.4	1.01	159	<0.00005	0.00006	0.0011	0.00012	0.00144	<0.0005	<0.005

Notes:
1. CEQG freshwater guidelines and criteria are based on **total** metal concentrations, except for aluminum (dissolved aluminum criterion).
2. Freshwater aquatic life criterion for aluminum depends on pH, [Ca2+] and DOC. In this table, only the pH criterion has been applied to highlight exceedances.
3. Freshwater aquatic life criteria for chromium depends on the valence of chromium ion. In the above table, the Cr(VI) criterion of 0.001 mg/L is shown.
4. Freshwater aquatic life criterion or guideline is hardness dependant.
5. Maximum authorized monthly mean concentration (based on **total** concentration).
6. < = less than the analytical detection limit.
7. Cadmium guideline = 10^(0.86*log(hardness)-3.2)

* December 2003
** June 6, 2002
Non-detect values assumed to be equal to one half the detection limit in calculations of average, median and standard deviation, where applicable.

TABLE V.4
Acid Base Accounting Results
2007 Samples
Carmacks Copper Project, YT

Sample ID	Rock type	Alteration	Mineralization	Location	Paste pH	S(T) %	S(SO4) %	S(S-2) %	AP	NP	TIC %	CaCO3 NP	Net NP	NPR	CaNPR	ARD Potential	CaCO3 ARD Potential
C228435	foliated granodiorite	Unaltered	Weak (0.620 % Cu)	Hanging wall	9.18	0.05	<0.01	0.05	1.6	18.8	0.03	2.5	17.2	12.0	1.60	None	Possible
C228666	granodiorite	Chlorite/epidote	None	Hanging wall	9.28	0.02	<0.01	0.02	0.6	19.3	0.1	8.3	18.7	30.9	13.33	None	None
C229560	granodiorite	Hematite	None	Hanging wall	9.37	0.01	<0.01	0.01	0.3	8.5	<0.01	<0.8	8.2	27.2	1.28	None	Possible
C229587	granodiorite	Potassium feldspar	Weak (0.50 % Cu)	Hanging wall	9.33	0.02	<0.01	0.02	0.6	12.8	<0.01	<0.8	12.2	20.5	0.64	None	Likely
C490366	granodiorite	Unaltered	None	Interbed	8.69	0.26	0.24	0.02	0.6	9.5	0.02	1.7	8.9	15.2	2.67	None	Low
C490395	mixed gneiss/ granodiorite	Gypsum	Weak (0.365 % Cu)	Footwall	8.92	0.88	0.57	0.31	9.7	9.5	<0.01	<0.8	-0.2	1.0	0.04	Likely	Likely
C490422	mixed gneiss/ granodiorite	Gypsum	Weak (0.150 % Cu)	Footwall	8.57	0.38	0.08	0.30	9.4	13.5	<0.01	<0.8	4.1	1.4	0.04	Possible	Likely

Notes:
< = less than detection limit
* S(S2-) sulphide sulphur calculated as S(T)total suphur - S(SO4)sulphate sulphur
Where S(SO4) is reported as <0.01%, it is assumed to be zero for the AP calculation.
TIC = Total inorganic carbon, used in calculation of CaNP
AP = Acid potential in kg CaCO3 equivalent per tonne of rock. AP is determined from calculated sulphide sulphur content: S(T) - S(SO4), assuming total conversion of sulphide to sulphate.
Bulk NP = Neutralization potential in kg CaCO3 equivalent per tonne of rock.
CaNP = Carbonate mineral neutralization potential in kg CaCO3 equivalent per tonne of rock
NET NP = Net neutralization potential in kg CaCO3 equivalent per tonne of rock. Calculated as the difference between NP and AP.
NPR = Neutralization potential ratio: NP/AP
CaNPR = Neutralization potential ratio calculated using CaNP: CaNP/AP
Non-detect values assumed to be equal to one half of the detection limit in calculations of average, median and standard deviation, where applicable.

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Western Copper Corporation

2009 ANNUAL QUARTZ MINING LICENCE REPORT

SUBMITTED TO YUKON GOVERNMENT, ENERGY MINES AND RESOURCES

YUKON QUARTZ MINING LICENCE QML-0007

Appendix G

Thermal Analysis for the Waste Rock Storage Area (September 2009)

September 28, 2009

Project No. 07-1413-0077/1100
Doc. No. 117

Mr. Jonathan Clegg
Western Copper Corporation
2050 – 1111 West Georgia Street
Vancouver, BC
V6E 4M3

THERMAL ANALYSIS FOR THE WASTE ROCK STORAGE AREA - CARMACKS COPPER MINE, YUKON

Dear Mr. Clegg,

1.0 INTRODUCTION

In support of the preliminary design for the waste rock storage area (WRSA) at the Carmacks Copper project in Yukon, preliminary thermal models were developed to assess the changes that may occur to the ground temperatures in the foundation beneath the WRSA as the waste rock is placed. The analysis will assist in an evaluation of the stability of the waste rock storage area. Previous slope stability analysis conducted for the site (Golder, 2008b) indicated that stability issues could arise if the entire upper silty sand layer below the WRSA was to thaw. It was noted that if only the active layer thawed, the stability of the WRSA would remain satisfactory for the initial waste rock lift and subsequent lifts as the overall WRSA is developed.

This letter describes the thermal models and presents the results of the modeling that should be interpreted in conjunction with the stability analysis.

2.0 THERMAL MODEL

The model uses sequential and iterative analyses that together provide elements to understand the patterns of the thermal regime that are expected to develop in the foundation of the WRSA. The models are however simplifications of the field condition and several assumptions were made in terms of initial field conditions, material properties, and evolution of climate and ground temperatures. The models are suitable for a feasibility stage, however more detailed work would be required as part of the final design of the waste rock dump.

The thermal analysis was prepared using the two-dimensional finite element code TEMPW, by Geoslope International Ltd. The geometry of the WRSA, ground topography and subsurface stratifications were based on previous report by Golder (2008b).

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2.1 Material Properties

The results of the drilling at the site as presented on the borehole logs at the WRSA show that the foundation zone below the proposed WRSA consists of silty sand overlying clay and bedrock (Golder 2008b). Thermal properties of the materials were estimated using the methods presented in Andersland and Ladanyi (2004), as well as based on past experiences with similar materials. Table 1 presents summarizes the material properties used in the models.

Table 1: Material Properties Used in the Model

Material	Moisture Content	Degree Saturation	Void Ratio	Porosity	Specific Gravity	Dry Density	Volumetric Water Content	Thermal Conductivity		Volumetric Heat Capacity		Reference / Comment
								Frozen	Unfrozen	Frozen	Unfrozen	
	%	%		%		kg/m^3		(W/m ^{o}C)		(MJ/m^3 ^{o}C)		
Waste Rock	3.8	20	0.54	0.35	2.9	1900	0.07	1.4	1.3	1.5	1.6	Thermal properties estimated according to Andersland and Landanyi (2004)
Silty Sand-Saturated	10	100	0.27	0.21	2.7	2100	0.21	2.5	1.7	2.0	2.4	Adjusted from Golder (2008a)
Clay - Saturated	25.5	100	0.69	0.41	2.7	1600	0.41	2.6	1.5	2.1	2.8	Thermal properties estimated according to Andersland and Landanyi (2004)
Bedrock	0.2	100	-	-	3.0	2700	0.005	2.9	2.9	2.4	2.4	Estimated

2.2 Ground Surface Temperature Function

Ground surface temperature typically differs from air temperature because of snow cover during the winter and the thermal properties of the surface material during the summer. As a result, ground surface temperature is typically warmer than average air temperature making it necessary to define a ground surface temperature function to be used as upper boundary condition in the models.

The average annual air temperature obtained for the Carmacks station (Carmacks YK), from the National Climate Data and Information Archive of Environment Canada has increased from -3.5^{o}C between 1960 and 1991 to about -2.2^{o}C between 1991 and 2005. This station is located at lower elevation and about 34 km south of the site, implying that site temperatures may be slightly cooler than those measured at the Carmacks station, but the warming trend is likely to occur at the site as well.

This is noted as the average air temperature measured at the nearest weather station (Williams Creek) from 1992 to 1996 indicated that the site during that period appears to be warmer in the winter months than Carmacks. Data from 1997 to 2007 is discontinuous and inconsistent and that information cannot be used to compile the climate dataset required for the thermal models. Therefore, the analysis was completed using the more comprehensive temperature data from Carmacks.

For the present study, the ground temperature function was generated based on a correction factor (N value) that is applied to the average air temperature. Average N values of 0.9 and 1.4 that are within the range reported for granular materials during winter and summer times, respectively (Andersland and Ladanyi, 2004), were used in the models. The use of N factors is a common practice to assess the surface temperature, which can also be computed using specialized thermal models, but this type of model requires a complete set of detailed climate data in a daily basis format that is not available at this time. The result of the evaluation indicates that for the base case, the ground temperature function averages -1.8 ^{o}C per year to represent the colder average annual air temperature of -3.5 ^{o}C.

General predictions of temperature increase in northern regions vary from 4.5^{o}C to 6.7^{o}C over a period of 100 years. Thus for this effort and to consider variations in the ground surface temperature and possible climate change in the short term, a 1°C warmer ground temperature function was also created that brought the average ground surface temperature to -0.8^{o}C.

The thermistors installed on site indicate that the foundation is frozen down to 35 m in depth. For the ground to remain frozen, the actual on site average ground surface temperature must be below 0 ^{o}C. The ground surface temperature functions modelled indicates that the ground surface temperature would remain below 0 ^{o}C so the model supports the current site conditions.

Table 2 and Figure 1 summarize the ground surface temperature functions used in the models compared to the two different sets of air temperature. The warmer annual ground temperature function averaging -0.8^{o}C can be considered to correlate with the warmer average annual air temperature of -2.2^{o}C.

Table 2: Mean Monthly Air Temperature and Ground Temperature

Month	Mean Monthly Ground Temperature		Mean Monthly Air Temperature	
	Ground Temperature (Base Case)	Ground Temperature (Warmer Case)	Carmacks Air Temperature (1963-1990)	Carmacks Air Temperature (1991-2005)
Jan	-25.7	-24.7	-27.3	-23.9
Feb	-16.4	-15.4	-19.1	-15.7
Mar	-10.4	-9.4	-10.2	-9.9
Apr	-4.0	-3.0	-0.3	-0.9
May	6.5	7.5	7.3	8.1
Jun	18.1	19.1	13.0	14.3
Jul	20.7	21.7	15.1	15.7
Aug	17.5	18.5	12.6	13.4
Sep	9.7	10.7	6.6	6.8
Oct	-1.5	-0.5	-1.5	-1.7
Nov	-13.2	-12.2	-13.8	-12.5
Dec	-22.2	-21.2	-24.6	-21.3
Mean Annual	-1.8	-0.8	-3.5	-2.2

2.3 Model Scenarios and Assumptions

The waste rock storage area was modelled to reflect the initial lift of waste rock as this is the key to the stability of the waste rock storage area at the start of the mine operation. This model develops the storage area to elevation 780 m during the first year of operation. To simulate the progressive increase of the dump height and volume of material placed during the year, the model considered three construction stages that continued for 4 months each, and raised the dump to the elevations of 753 m, 766.5 m, and 780 m. After the dump reaches 780 m, the models continued to cover a period of 10 years to evaluate changes in the foundation temperature in the short term (assumes no more waste rock is placed on the WRSA).

The dump is planned to be progressively raised to its ultimate elevation of about 850 m, but additional lifts of waste rock are not expected to affect the pattern of foundation temperature in the portion at the WRSA toe. Large variation in the foundation temperature occurs mainly associated with freeze and thaw cycles in the active zone that is reported to be about 3 meters deep. Once the first lift of waste rock is placed and the foundation is maintained away from the active zone, temperature variation on the surface of the waste rock will have little impact on the foundation temperature. As the waste rock dump becomes higher, the foundation is moved farther and farther from the active zone and little variation in the foundation temperature is expected as a result of variation in temperatures in the uppermost lift of waste rock.

To confirm the assumption that additional lifts of waste rock will not play a role in the foundation temperature, a second model sequence was run to simulate the placement of the second lift of waste to elevation of 800 m, which represents the second year of operation of the WRSA at the eastern limit of this facility. The model was then run for 10 years, similar to the first case. The temperature profiles computed in the two sets of models for a portion adjacent to the toe of the dump are plotted for comparison.

Additional lifts of waste rock above elevation 800 m have not been incorporated in this study, but can be used in future modelling to confirm and assess the overall performance of the WRSA in the long term. More detailed information about climate and soil / material thermal properties would be required to perform this type of study.

As part of the investigation monitored by Golder (Golder 2008b) boreholes BH-18-07, BH-29-07 and BH-12-07 drilled in the WRSA contain thermistor strings. Thermistor data indicates the active layer in the area is approximately 3 m deep. Based on this information, the initial condition of the models was set to match an average thawed zone of 3 m in the original ground during July. It was assumed in the models that waste rock is initially deposited on thawed ground (Model Stage 1) as this would represent a more adverse condition for stability.

A general heat flux of 0.035 W/m^2 was applied to the bedrock as lower boundary conditions for the models to simulate the geothermal flux. The ground temperature functions presented in Table 2 and Figure 1 were applied to the models as upper boundary conditions.

Waste rock was assumed to be deposited at different temperatures reflecting the time of year during each model stage. The temperature depended on the start date of each stage. In the second case, an upper bound condition, the waste rock is assumed to be 'warm'. The waste rock was then modelled with the rock at different temperatures during deposition / placement for models during model stages 1 to 5. This condition was to assess model sensitivity to the initial waste rock temperature.

The model scenarios are summarized in Table 3, and the sensitivity scenarios to evaluate the impact of additional lifts of waste rock in the foundation temperature are summarized in Table 4.

Table 3: Model Scenarios

Model Scenario	Ground Temperature	Waste Rock Deposition Temperature (°C)		
		Model Stage 1 July-October (EL.753 m)	Model Stage 2 November-March (EL.766.5 m)	Model Stage 3 April-July (EL.780 m)
1	Base Case Function	10	-3	-5
2	1.0 °C Warmer Function	10	-3	-5
3	Base Case Function	15	4	2
4	1.0 °C Warmer Function	15	4	2

Table 4: Model Scenarios – Sensitivity to Additional Lifts of Waste Rock up to 800 m (2nd Year of Operation).

Model Scenario	Ground Temperature	Waste Rock Deposition Temperature (°C)	
		Model Stage 4 (Year 2) July-January (EL.790 m)	Model Stage 5 (Year 2) January-July (EL.800.0 m)
5	Base Case Function	10	-4
6	1.0 °C Warmer Function	15	3

2.4 1-D Model Calibration

This component of the model was developed to assess the suitability of the thermal properties and ground surface temperature function used in the models. Predicted and measured temperatures were compared based on thermistor data from the borehole BH-12-07. The data from the temperatures measured on September 18, 2007 in the borehole was used as reference starting point and a model case with no waste rock was run for a period of 2 years using the base case ground temperature function. The results are shown in Figure 2, and indicate similar trends and variations of the measured temperatures to the values that were predicted by the model.

It is noted that an accurate match of predicted and measured temperatures is hard to be achieved due to the fact that the model uses estimated material properties and ground surface temperature function. Future calibrations would require more detailed information on the foundation soils thermal properties and generation of a ground temperature function based on actual on-site climate data. Nevertheless, the results of the calibration model are considered sufficient for the purpose of this analysis.

3.0 MODEL RESULTS

The geometry of the WRSA used in the model is presented in Figure 3 and shows the foundation stratigraphy and the 5 model stages considered. The model was run for a period of 10 years for the six scenarios.

Temperature variation with time along section “A” shown in Figure 3 for Scenarios 1 to 4 (maximum dump elevation of 780 m), is plotted in Figures 4 and 5. The results of scenarios 5 and 6, which considered sensitivity of temperature foundation to additional lifts of waste rock up to elevation 800 m, are presented in Figure 6. For all scenarios modelled, the results indicate that the foundation is initially thawed near the base of the WRSA in the active layer at start up. However, the temperatures decrease with time and fall below 0°C in approximately 5 years, with freezing conditions prevailing in the upper foundation after that. The waste rock for both rock placement temperatures and ground temperature conditions remains below 0^0C as the general temperatures at the project site ‘cool’ the waste rock below the short term stable ground temperature. It is noted that the temperatures in the waste rock gradually stabilize at a temperature similar to the temperatures of the ground below the waste rock storage area.

The model results incorporating placement of additional waste rock during the second year of operation up to 800 m elevation are very similar to those obtained when the model considered only the geometry from the first year of operation up to 780 m elevation. This indicates that the next lift of waste rock does not change the freezing or ground temperatures in the toe region of the WRSA. It is therefore anticipated that the ground at the toe of the WRSA will freeze and remain frozen for at least 10 years, even with the potential warming effect of climate change.

4.0 CONCLUSION

A simplified thermal analysis was developed for the Waste Rock Storage Area at the Western Copper Carmacks Project using the proposed geometry of the WRSA at the end of the first and second year of operation. The models present a period of 10 years and considered different scenarios that involved different ground surface temperature functions and two waste rock deposition temperature scenarios. On site thermistors indicate that currently the foundation is frozen below the active zone down to at least 35 m in depth which is the maximum depth of thermistors.

The purpose of the thermal models was to assess the change of temperatures in the foundation of the WRSA for the operating period of the facility. Stability analysis that had been developed previously indicated that the WRSA slope would have stability issues if the foundation soils were to thaw. The results of the thermal modeling indicates that the upper foundation soils (down to 3 m depth – *i.e.,* the active layer) below the WRSA would be thawed as in the case today at the beginning of construction. However, the models indicate a trend for temperatures to progressively decrease as the waste rock dump is developed, allowing the foundation to freeze completely in about 5 years.

The models indicated a trend for the frozen conditions to prevail in the foundation 10 years after the construction of the initial lift of the WRSA. Maintenance of freezing conditions in the foundation in the long term will depend on actual evolution of ground temperature associated with possible climate change.

The average annual temperature at Carmacks is reported to have increased from about -3.5^{o}C between 1960 and 1990 to about -2.2 ^{o}C between 1991 and 2005, approaching the limit temperatures for existence of continuous permafrost zone. The site thermistors indicate that foundation temperature to approximately 35 m in depth is approximately -0.4^{o}C, with little variation compared to foundation temperatures below the active zone.

The present modelling exercise was developed to provide an overall understanding of the thermal regime that would potentially be established in the foundation of the WRSA. Several assumptions have been made related to local climate data, initial foundation temperatures, ground surface temperatures, and thermal properties of foundation materials. The assumptions made are considered appropriate for the current project phase. Additional thermal models that include measured thermal properties of the foundation material and a calibrated ground temperature function would be required in detailed design.

We trust that this is satisfactory for your present needs.

Yours very truly,

GOLDER ASSOCIATES LTD.

ORIGINAL SIGNED

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John A. Hull, P.Eng.
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JFC/FFJ/JAH/ja/rs

CC: Javier Ubilla

Attachments: Figures 1 to 6

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REFERENCES

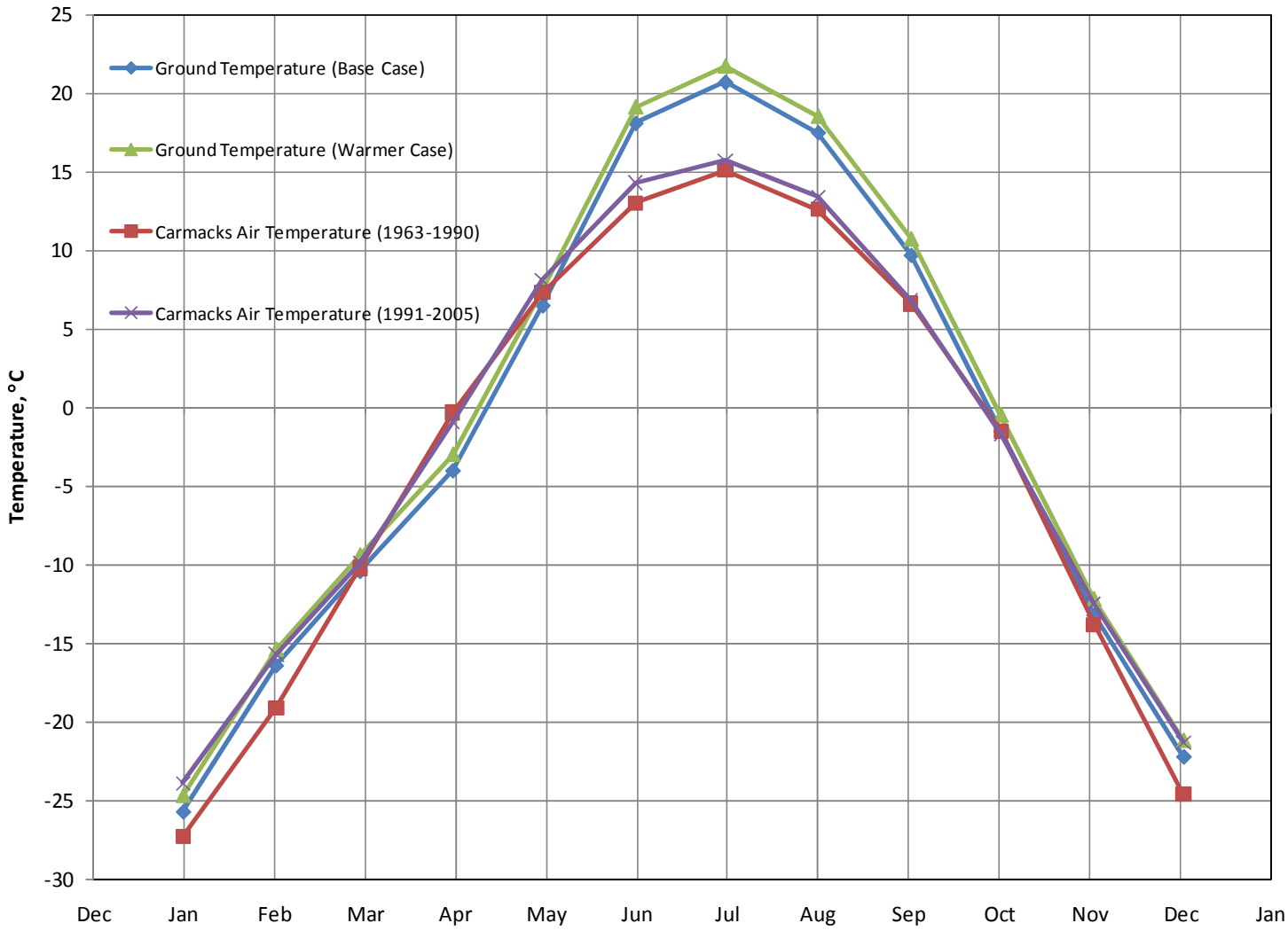
Andersland, O. and Ladanyi, B. 2004. Frozen Ground Engineering. John Wiley & Sons.

GEOSLOPE 2008. Stability Modeling with SLOPE/W 2007. An Engineering Methodology. Third Edition. GEOSLOPE International Ltd., Calgary, March 2008.

Golder 2008a. Final Report on: Preliminary Design Report, Heap Leach Facility, Carmacks Copper Project. Golder Associates Ltd., January 2008.

Golder 2008b. Report on: Preliminary Design, Waste Rock Storage Area, Carmacks Copper Project, Western Copper Corporation, Yukon. Golder Associates Ltd., April 2008.

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PROJECT
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CARMACKS COPPER PROJECT
YUKON TERRITORY

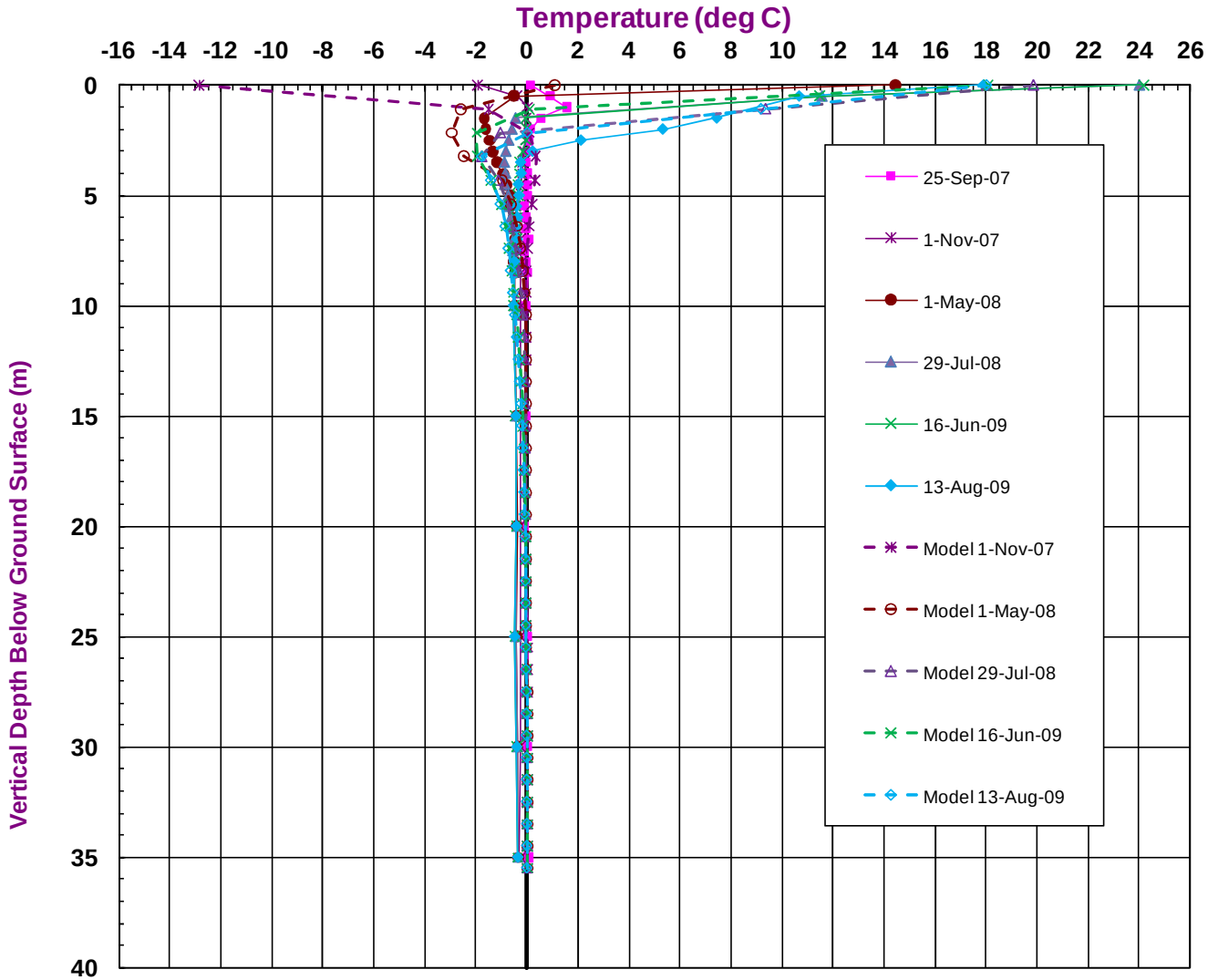
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MEAN MONTHLY AIR AND ESTIMATED GROUND TEMPERAURE

Golder Associates

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FIGURE 1

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YUKON TERRITORY

TITLE

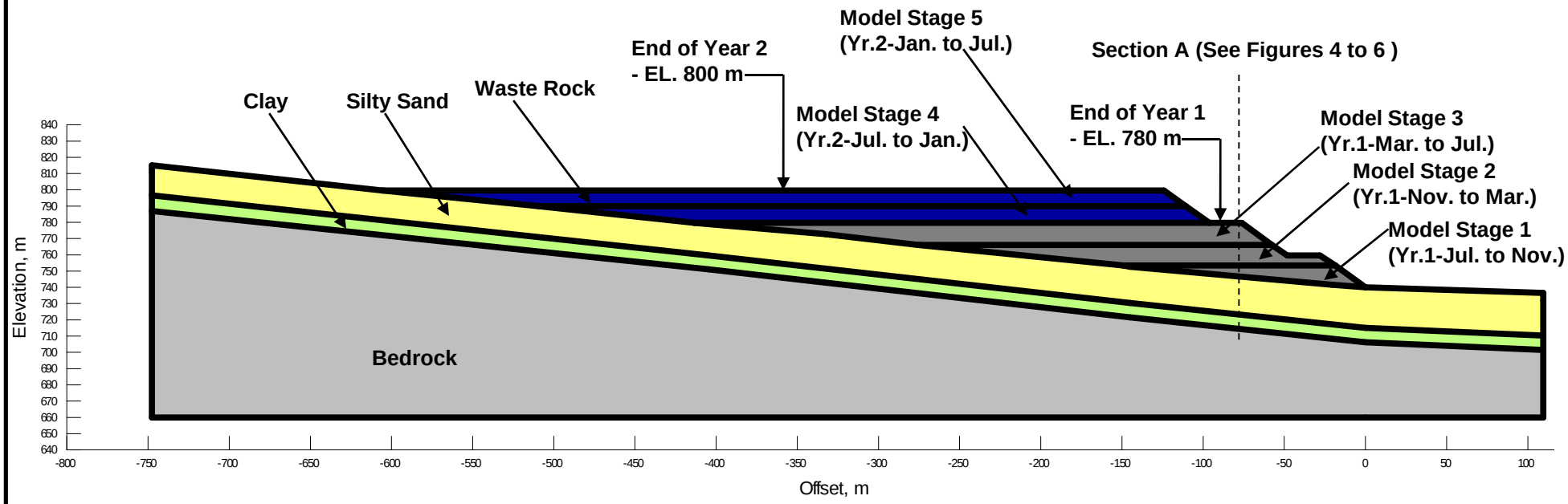
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BH-12-07 THERMISTOR DATA

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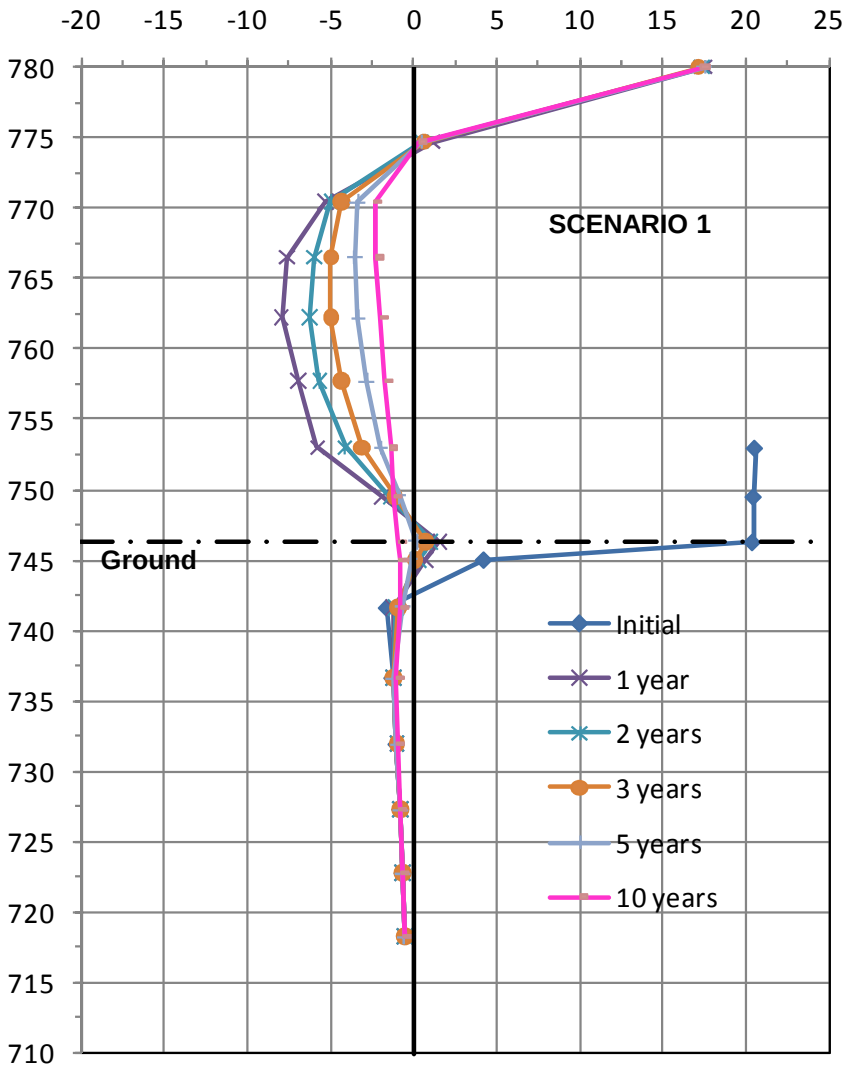
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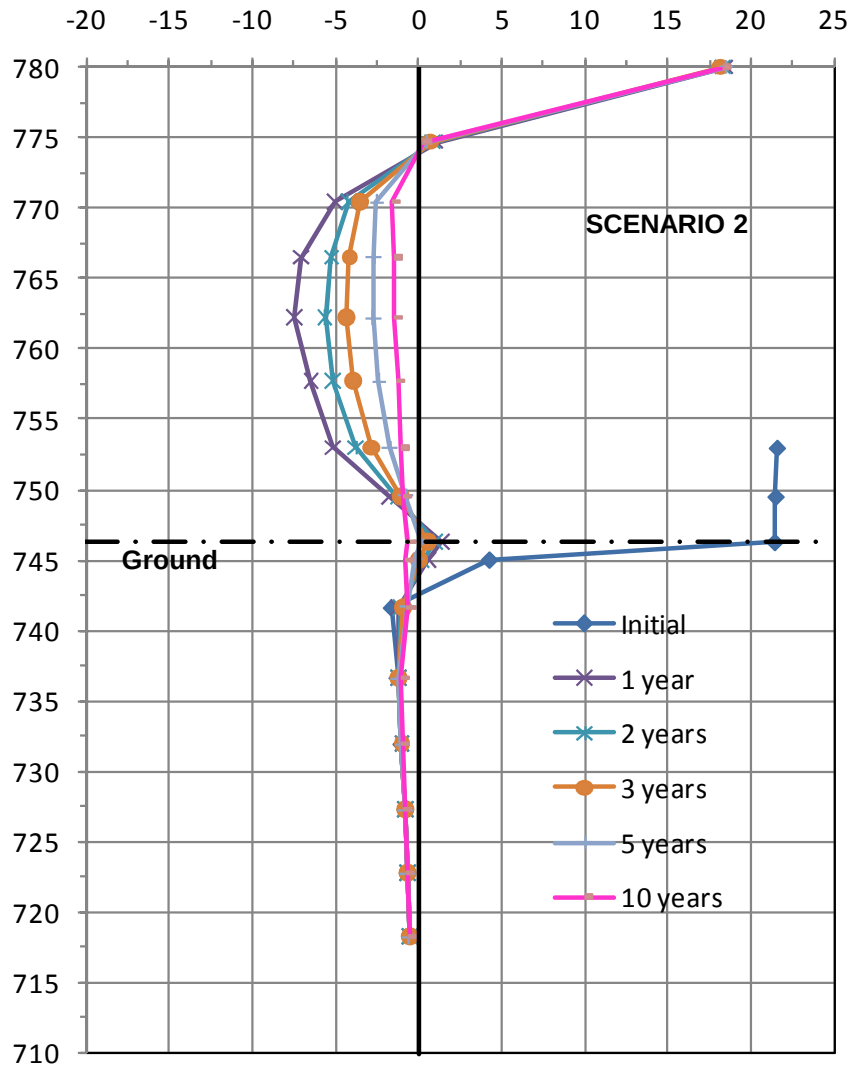
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TITLE	WRSA THERMAL ANALYSIS MODEL SECTION				
Golder Associates	PROJECT No. 07-1413-0077			FILE No.	
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	CADD	JFC	01SEP09	FIGURE 3	
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PROJECT
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CARMACKS COPPER PROJECT
YUKON TERRITORY

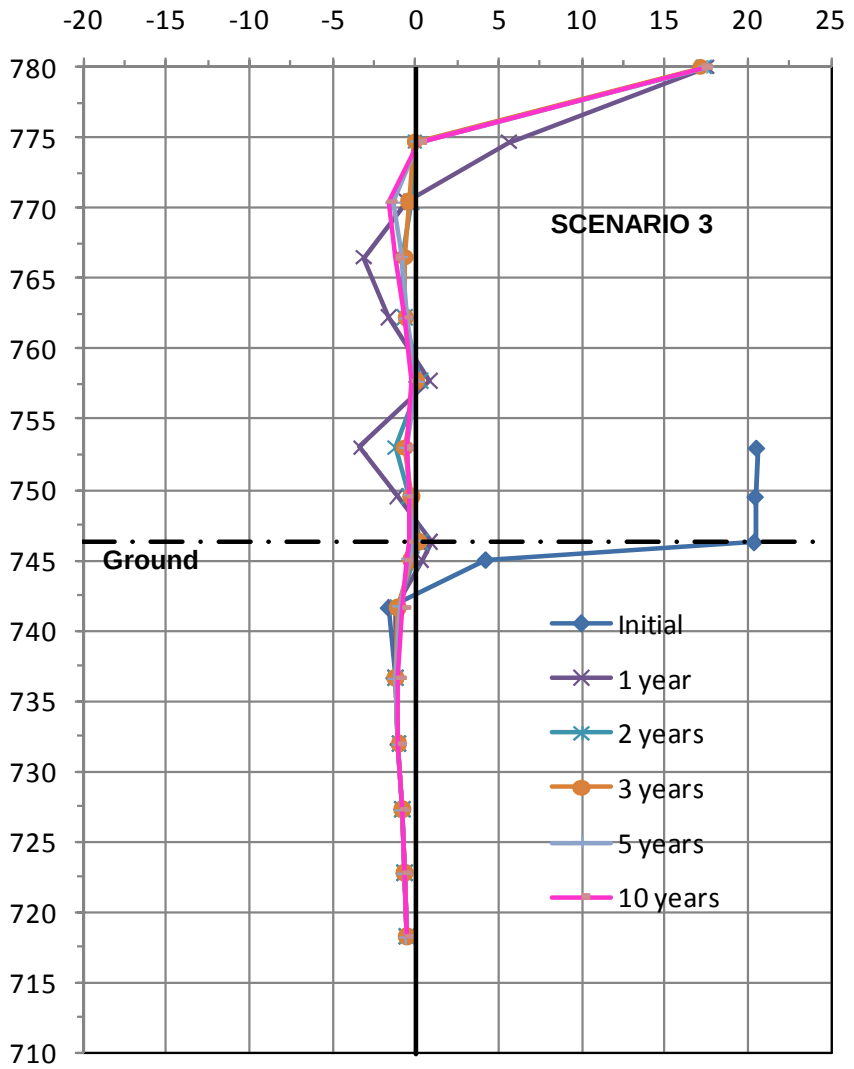
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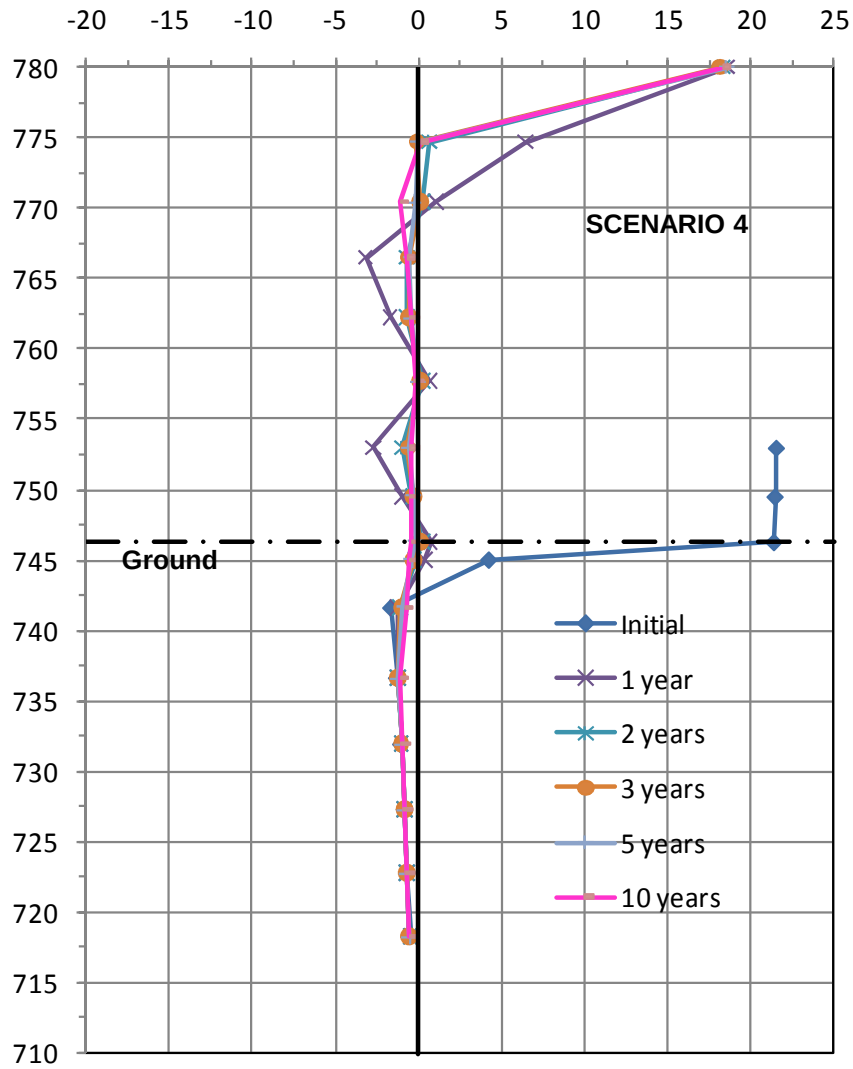
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FIGURE 4

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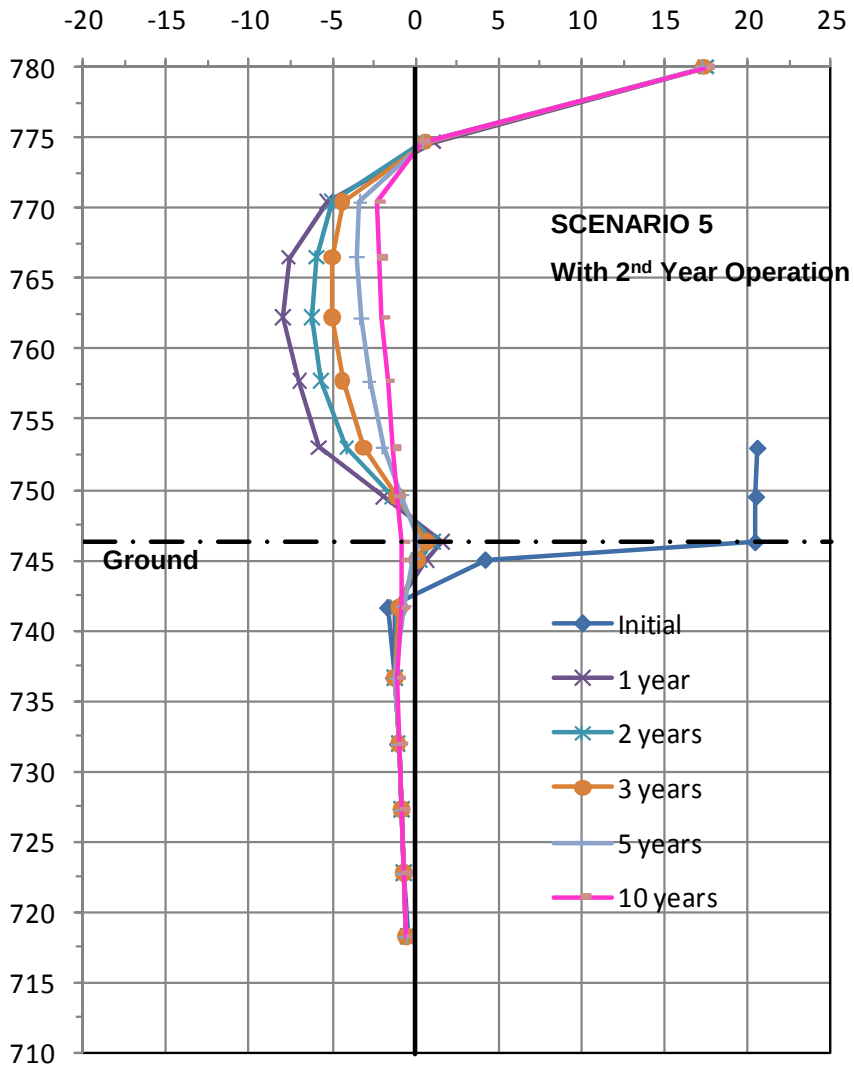
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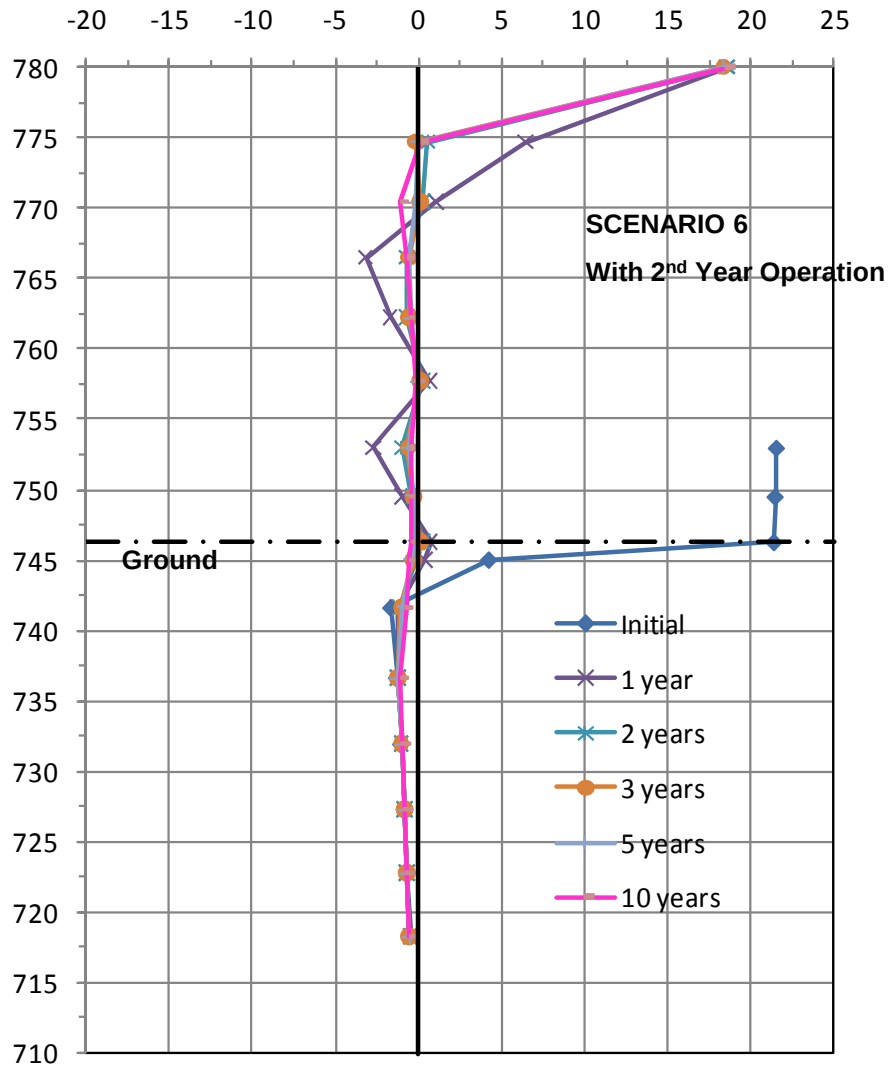
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FIGURE 5

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PROJECT
WESTERN COPPER CORPORATION
CARMACKS COPPER PROJECT
YUKON TERRITORY

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WRSA THERMAL ANALYSIS MODEL RESULTS SCENARIOS 5 AND 6

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FIGURE 6

Western Copper Corporation

2009 ANNUAL QUARTZ MINING LICENCE REPORT

SUBMITTED TO YUKON GOVERNMENT, ENERGY MINES AND RESOURCES

YUKON QUARTZ MINING LICENCE QML-0007

Appendix H

Engineer's Annual Physical Inspection Report (September 2009)

October 2, 2009

Document No. 07-1413-0077
Doc. No. 124

Mr. Jonathan Clegg, P.Eng.
V.P. Engineering
Western Copper Corporation
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ANNUAL INSPECTION – AUGUST 13, 2009
CARMACKS COPPER PROJECT
CARMACKS, YUKON

Dear Mr. Clegg:

Golder Associates Ltd. (Golder) inspected the Carmacks Copper project site of Western Copper Corporation on August 13, 2009. The inspection of the proposed future copper mine project site was completed as part of the requirement of the Quartz Mining License (QML – 0007) for an annual inspection. The inspection was to evaluate the stability of the heap leach facility, the open pit mine area, the waste rock storage area, the processing facilities, any ore preparation facilities and any water diversion structures and/or other related operations or facilities. The inspection was limited in that there are no structures on site except the mine exploration camp. An inspection was however, completed of the entire project area.

1.0 SUMMARY OF INSPECTION REPORT

The inspection by Golder was completed by Mr. John Hull along with Scott Casselman – a representative of Western Copper Corporation. The inspection was focused on the existing site conditions and the limited site infrastructure. The project is in the advanced exploration stage and final permitting for the proposed future mine. The only infrastructure on site at present is the exploration camp and a series of access roads to the proposed open pit mine area. The access roads were developed to provide access for site exploration.

The inspection of the camp area indicated the camp is well maintained and there is no erosion of sediments from the pad area into the surrounding natural area. The slope behind or west of the camp is stable and is not impacting or causing any safety issues with the camp structures or operations. There is minor slumping of small sections of the slope, but these are not impacting camp safety nor would they represent an issue to workers on the project.

The inspection included the area proposed for the heap leach facility, the associated events pond structure and the heap leach sediment pond area. This portion of the site also includes the area planned for the process plant west of the heap leach embankment and the events pond. None of these structures have been developed and site preparation in these areas has been limited to the clearing of trees and organic soils (complete in 1997-1998) and development of a series of access roads which cross the area. Since the initial clearing, re-growth has been occurring. Within the area there are several small sediment catch basins. The inspection indicated that there has been some erosion of sediments along the access roads and that the sediment basins are full of trapped sediment. Photographs of these areas are presented in Appendix A. The erosion and sediment control measures completed during September 2008 will be inspected and maintained this year. This work was completed in September 2009 as documented in the Golder technical memorandum dated September 30, 2009, document number 123.

The area where the open pit would be developed was inspected. The excavation slopes of the trenches developed as part of the effort to obtain bulk samples are in reasonable condition and there was no observed slumping of the excavation slopes or failures of these slopes. There was also no erosion area noted around the areas. Several of the closed drill pads were inspected and there did not appear to be any erosion noted from these areas that required attention.

The area of the proposed waste rock storage area and the present access road crossing at North Williams Creek were inspected. The waste rock storage area is still tree covered and the drill pads in the area of the proposed waste storage area did not have any signs of sediment movement into the surrounding area. The small sediment catch basins at the drill pads still have capacity to manage more sediment, if required.

The process plant and the crusher / truck shop areas were also inspected. The process plant site is partially cleared and the crusher / truck shop site is still tree covered. There was no apparent erosion along any of the access roads in these two areas or at the weather station located just to the west of the crusher / truck shop area.

The new camp site was inspected and it is still tree covered. The site adjacent to the camp where the new water wells were installed was also inspected and there is no apparent movement of sediment off the work pads around the wells.

The general site development has not started yet so there are no permanent water diversion structures in place. There are however, water management diversion structures (i.e. ditches and sediment catch basins) in place that are appropriate for the exploration stage of the operation Minor erosion was observed along some of the site access roads and in the cleared area of the future events pond. Mitigation of these areas was completed in September 2009 and is considered adequate at this time.

2.0 SUMMARY AND COMMENTS

The Carmacks Copper project site is still in the advanced exploration stage and as such the only infrastructure on site is the exploration camp. None of the facilities that would be developed for the mining operation have been constructed. Thus, there are no maintenance issues with the proposed / planned features.

Geochemical testing of the rinsed spent ore and neutralized spent ore to determine rinsing criteria is on going. In addition, geochemical tests have been completed on the waste rock that would be placed in the waste rock storage area. The full summary of the results of the testing will be presented under separate cover, but a summary of the testing indicates the whole rock major element composition of the waste rock and spent ore samples show that the bulk chemistries are slightly elevated in concentrations of iron, calcium, sodium and magnesium. The trace element chemistries from supplemental waste rock samples (testing in 2008) were enriched in silver, chromium, copper and molybdenum. The trace element chemistries of the 2007 waste rock samples tested show enrichment in copper and molybdenum. The trace element chemistries of the neutralized spent ore samples are enriched in silver, cadmium, chromium, copper and molybdenum.

The results of the static test work for the 2008 waste rock samples from the shallow footwall beneath the ore zone are consistent with the results observed for equivalent rock types tested during the 2007 test work and suggest that the waste rock has low acid generating and metals leaching potential. In addition, results of the humidity cell testing completed in 2007 which maintained a neutral pH during the test and showed no evidence of the onset of pyrite oxidation or acid generation, suggesting that over the long term the waste rock mined from the shallow footwall will, like other waste rock from the deposit, satisfy the MMER authorized levels.

Kinetic testing for the two spent ore samples begun in March 2008 and for the spent ore sample begun in February 2009 are currently on-going. Results of the kinetic tests to date show that the leachate derived from the neutralized spent ore samples are neutral to alkaline and within MMER guideline limits, while the pH of the leachate from the rinsed ore sample is slightly acidic and less than or equal to the minimum MMER guideline. MMER metals concentrations in the humidity cell leachate are all below the MMER - Maximum Monthly Mean concentration (the minimum guideline) and appear to be declining over time.

The testing will be completed by the end of 2009 and the results along with recommendations for additional testing will be presented in a complete geochemistry report.

3.0 RECOMMENDED ACTIONS

The inspection of the proposed mine site for the Carmacks Copper was completed on August 13, 2009 and indicated that as the site development has not been started yet, there is limited infrastructure to inspect or to require maintenance or further investigations. The required maintenance to manage some minor erosion items in the area of the events pond and the future heap leach sediment pond was completed successfully in mid September 2009. There is no further maintenance work required this year.

We trust that this is satisfactory for your present needs.

Yours very truly,

GOLDER ASSOCIATES LTD.

ORIGINAL SIGNED AND SEALED

John A. Hull, P.Eng. (BC, NWT, NU, YK)
Principal

ORIGINAL SIGNED

John Cunning, P.Eng (BC)
Associate

JAH/JCC/mrb

CC: Fiona Esford
Attachments: Photographs
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Description: Sediment basins full of sediments, near the proposed HLF sediment pond and Events Pond

Date of Photographs: August 13, 2009

Golder Associates	CARMACKS COPPER PROJECT SITE INSPECTION		
Drawn: JU	App'd:	Date: August 13, 2009	Figure: 1
Project No.: 0714130077			Revision No.: 0

FILE LOCATION: O:\Active_2007\1413\07-1413-0077 Carmacks-Field Investigation\7400 Erosion and Sediment Control Measures\2009 Work



Description: Erosion on road in proposed Events Pond area
Date of Photograph: August 13, 2009

Golder Associates		**CARMACKS COPPER PROJECT SITE INSPECTION**	
Drawn: JU	App'd:	Date: August 13, 2009	Figure: **2**
Project No.: 0714130077			Revision No.: 0

FILE LOCATION: O:\Active_2007\1413\07-1413-0077 Carmacks-Field Investigation\7400 Erosion and Sediment Control Measures\2009 Work



Slope Behind Camp Area



Exploration Camp Infrastructure



Camp Area

Date of Photographs: August 13, 2009

Golder Associates		**CARMACKS COPPER PROJECT SITE INSPECTION**	
Drawn: JU	App'd:	Date: August 13, 2009	Figure: **3**
Project No.: 0714130077			Revision No.: 0

FILE LOCATION: O:\Active_2007\1413\07-1413-0077 Carmacks-Field Investigation\7400 Erosion and Sediment Control Measures\2009 Work



Description: Internal Road
Date of Photograph: August 13, 2009

Golder Associates		CARMACKS COPPER PROJECT SITE INSPECTION	
Drawn: JU	App'd:	Date: August 13, 2009	Figure: 4

Project No.: 0714130077 Revision No.: 0

FILE LOCATION: O:\Active_2007\1413\07-1413-0077 Carmacks-Field Investigation\7400 Erosion and Sediment Control Measures\2009 Work



Description: Waste Rock Storage Area
Date of Photograph: August 13, 2009

Golder Associates		**CARMACKS COPPER PROJECT SITE INSPECTION**	
Drawn: JU	App'd:	Date: August 13, 2009	Figure: **5**
Project No.: 0714130077			Revision No.: 0

Western Copper Corporation

2009 ANNUAL QUARTZ MINING LICENCE REPORT

SUBMITTED TO YUKON GOVERNMENT, ENERGY MINES AND RESOURCES

YUKON QUARTZ MINING LICENCE QML-0007

Appendix I

Contingency Plan
(January 2010)



Western Copper
Corporation

Carmacks Copper Mine

Quartz Mining License QML-0007
Contingency Plan

Report Date:
January 18, 2010

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SUMMARY

The Carmacks Copper Mine is a proposed open pit copper mine located 45 km by secondary road (Freegold Road) northwest of the Village of Carmacks, approximately 175 km north of Whitehorse in Yukon. The project is located on Commissioner Land in the Traditional Territories of Little Salmon Carmacks First Nation and Selkirk First Nation. It will produce an average of approximately 14,500 tonnes of copper cathode per year by means of a conventional open pit mining, heap leaching and SX/EW process over a seven-year period. During operation, the mine will employ an average of 150 staff and workers.

In September 2008 the Government of Yukon issued a Decision Document under the Yukon Environment and Socio Economic Assessment Act (YESAA) permitting the development of the mine to proceed subject to obtaining the necessary licences, a Type A Water Use Licence and a Quartz Mining Licence. On April 15, 2009, the Government of Yukon issued Quartz Mining Licence QML-0007 (QML) for the mine.

Among the provisions of the QML is the requirement to produce and submit a Contingency Plan within nine months of the issue of the QML for the approval of the Chief. The Contingency Plan will be revised and updated on a regular basis as specified by the QML.

This initial Contingency Plan was developed as a result of a workshop held over a two day period in October 2009. The Workshop was comprised of a group of seven individuals familiar with the Carmacks Copper project and knowledgeable in the design and operation of similar facilities. The Workshop was conducted using the Systems Failure Modes and Effects Criticality Analysis (SFMECA), an adaptation of the Failure Modes and Effects Analysis (FEMA) involving the study of large systems, rather than small components. In the course of the Workshop each facility was carefully evaluated for the effects and consequences of all of the identified risks or potential failures. For each risk and failure mode a Risk Factor was derived. If the initial Risk Factor was deemed too high then mitigation measure were proposed to reduce the Risk Factor to acceptable levels.

A total of 76 risks or failure modes were evaluated for the various facilities. Of those, 37 were judged to warrant careful consideration and of those nine were deemed to have Risk Factors high enough to warrant the need for possible further mitigation measures. In all cases mitigation measures were proposed which either jointly or individually resulted in a Residual Risk Factor low enough to be accepted as controllable.

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The risks are listed below:

Risk or Failure Mode	Initial Risk Factor	Residual Risk Factor
HLF - Embankment instability	90	3
HLF - Ore instability	90	3
HLF - Deformation leading to failure of liner system	30	9 – 3
HLF - Failure to adequately rinse and neutralize heap at closure	100	3 – 1
Process Plant - Acid Plant upset resulting in release of acid to environment	30	10 – 3
Open Pit - Slope instability	30	3

There are several surveillance measures presently in place or planned to be in place that will assist in the mitigation of risks. These include ground temperature measurements, water monitoring, survey control and a solution management plan. The implementation of any of the mitigation measures will require additional testwork and engineering. This work will be incorporated into the detailed design phase on the mine development.

DRAFT

1.0 INTRODUCTION

The Carmacks Copper Mine is a proposed open pit copper mine located 45 km by secondary road (Freegold Road) northwest of the Village of Carmacks, which is located on the Klondike Highway approximately 175 km north of Whitehorse in Yukon. The project is located on Commissioner Land in the Traditional Territories of Little Salmon Carmacks First nation and Selkirk First Nation. Western Copper Corp., a publicly traded exploration and development company, is the sole owner of the Carmacks Copper property through its wholly owned subsidiary Carmacks Copper Ltd.

The development plan for the mine has been reviewed by the Yukon Environmental and Socioeconomic Assessment Board (YESAB) and a positive YESAA Screening Report was issued in July 2008. In September 2008 the Government of the Yukon issued a Decision Document permitting the development of the mine to proceed subject to obtaining the necessary licences, a Type A Water Use Licence and a Quartz Mining Licence. On April 15, 2009, the Government of Yukon issued Quartz Mining Licence QML-0007 (QML) for the mine. The Water Use Licence application is presently under consideration by the Yukon Water Board.

1.1 MINE DESCRIPTION

The Carmacks Copper mine has total proven and probable reserves of 10.6 million tonnes of ore and will produce an average of approximately 14,500 tonnes of pure copper cathode per year by means of a conventional open pit mining and heap leaching process. This will involve mining about 1.77 million tonnes of ore per year. The peak total material movement (ore plus waste) will be approximately13.3 million tonnes per year. With this plan, the open pit mine will operate for just over six years with copper leaching continuing for a further year. Preproduction stripping requirements will be minimal at about 2 million tonnes of overburden soils and waste rock.

The open pit mine will have capacity to operate year round but with allowance for weather delays, etc. it is planned to operate the equivalent of 335 days per year. Similarly, ore mining will take place for the equivalent of about 220 days per year. Each day will consist of two 12-hour shifts and four operating crews will be required to cover the operation.

Ore mined from the open pit will be hauled by truck and dumped directly into the crusher or stockpiled immediately adjacent to the crusher in a surge pile. The crushed product will first be agglomerated with sulphuric acid and water and then transported by a series of conveyors to a lined valley fill leach pad where it will be placed by means of a radial stacker.

The crushed ore on the leach pad will be irrigated with a dilute 1% sulphuric acid solution to leach copper from the ore. Leaching will continue on a year-round basis. Leach solution will be collected and pumped to the solvent extraction plant, part of the Process Facilities, where the dissolved copper in the solution will be concentrated. This concentrated copper solution passes to the electrowinning plant where the concentrated

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dissolved copper is plated onto stainless steel cathode blanks. Copper cathode is stripped from the blanks and is then transported to market.

The mine site will be developed over a two-summer construction period. During this schedule a peak of about 250 construction personnel will be employed. Total staff employed at the mine during operations would average approximately 150 employees.

The main mine components are as follows:

Open pit;
Waste Rock Storage Area and Sediment Pond;
Heap Leach Facility (HLF) including leach pad and embankment, Events Pond, and Sediment Pond; and
Processing facilities.

The mine infrastructure includes:

Access roads;
Truck/Maintenance Shop;
Administration building;
Laboratory facility;
Operations Camp to accommodate non-local workers;
Gatehouse/First Aid station;
Explosives Storage;
Wastewater Treatment Plant;
Temporary Sludge Holding Cell and
Solid Waste Dump.

Project drawings may be found in Appendix D

Fresh water (up to 1,600 m^3 per day) will be obtained from wells located in the confined aquifer in the bedrock underlying Williams Creek drainage while makeup water from the Sediment Ponds will be used to the extent possible.

The leach pad and process plant are designed to be operated under normal conditions with 100% recycled solutions and with no release of process solutions to the environment. Only during a major upset condition or emergency situation will process solution be released during operations. In such a situation the solution will first be treated in the Water Treatment Plant (conventional lime treatment with high density sludge) and then released under controlled conditions to Williams Creek. Controlled release of treated effluent from the Heap Leach Facility will be required during site closure activities. The treated solution will meet acceptable discharge standards before being released.

Controlled releases of non-contact surface water run-off to Williams Creek will be made from the Heap Leach Facility and Waste Rock Storage Area Sediment Ponds generally during the months of April through October. Such water will be discharged to the environment in full compliance with the discharge performance standards and in a manner that will prevent adverse affects to aquatic resources or surrounding ecology.

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At mine closure the heap will be rinsed and neutralized following which it will be capped with an evapo-transpiration soil cover. Additional contingency measures are planned to passively treat heap effluent at closure if required. Several years of post closure monitoring is planned to ensure that the closed facility is performing as proposed.

1.2 QUARTZ MINING LICENCE REQUIREMENTS

Among the provisions of the QML is the requirement to produce and submit a Contingency Plan for the approval of the Chief. The Contingency Plan is to be updated on a regular basis. Section 11.0 of the QML addresses this:

> ***11.0 Approval and Implementation of the Contingency Plan***
> *11.1 Within 9 months of the effective date of this License, the Licensee shall submit to the Chief for approval a contingency plan that describes possible alternative approaches to decommissioning the Heap Leach Facility and the Mine, including the estimated costs to implement and monitor triggers that would indicate that such contingencies are likely ("Contingency Plan")).*
>
> *11.1.1 The Contingency Plan must include the following:*
>
> *11.1.1.1 a failure modes and effects analysis providing:*
> *11.1.1.1.1 an assessment of the failure modes under operational conditions and post closure,*
> *11.1.1.1.2 an assessment of the likelihood of failure and consequence of failure,*
> *11.1.1.1.3 identification of any significant risks, and*
> *11.1.1.1.4 prioritization of risks which are considered significant enough to warrant further investigation and mitigation;*
>
> *11.1.1.2 identification of potential contingency mitigations or alternative designs to reduce risks identified in the failure modes and effects analysis;*
>
> *11.1.1.3 identification of existing monitoring and surveillance techniques, along with any additional monitoring and surveillance or other investigations recommended, that will provide additional information on the risks identified in the failure modes and effects analysis;*
>
> *11.1.1.4 identification of further investigative work recommended to further develop the contingency mitigations or alternative designs, along with triggers for implementation of such contingencies and costs to implement; and*
>
> *11.1.1.5 any other information the Chief considers necessary.*
>
> *11.2 Upon approval by the Chief, the Contingency Plan will be included in Schedule C and the Licensee will be required to implement:*

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11.2.1 the monitoring and surveillance or other investigations recommended in the contingency plan;

11.2.2 the recommended further investigative work to develop contingency mitigations or alternative designs; and

11.2.3 any other conditions of the approval required by the Chief.

11.3 The Licensee will submit to the Chief for approval an updated version of the Contingency Plan at the same time and in the same manner as the Revised Reclamation and Closure Plan as set out in 10.4 and 10.5.

The object of this document is to address the requirements of this section of the QML. The following sections, therefore, outline the failure mode effects analysis (FMEA) process, the FMEA planning specific to the Carmacks mine, the identification of significant risks and possible alternative plans for decommissioning that resulted from the planning exercise.

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2.0 CONTINGENCY PLANNING

2.1 SYSTEMS FAILURE MODES AND EFFECTS CRITICALITY ANALYSIS

In order to meet the requirements of the QML, a failure FMEA was planned to identify critical areas of the mine design during operational conditions and post mine closure.

The FMEA selected was typical of most risk assessment processes. The methodology was based on that contained in the report by Golder Associates to the Government of Yukon "*Failure Modes and Effects Criticality Analysis Model for Risk Assessment*". Appendix A ("Introduction to the Systems Failure Modes and Effects Criticality Analysis") outlines this methodology which is an adaptation of the FMEA method originally developed to assess the detailed risk associated with parts and components of equipment. This adaptation involves the study of large systems, rather than small components, the identification of existing risk mitigation measures and the estimation and ranking of risk. The Systems Failure Modes and Effects Criticality Analysis (SFMECA) method covers all of the standard risk assessment steps.

In simple terms, the risk assessment starts with the identification of the objectives of the process. In the case of SFMECA process for Carmacks Copper, this objective follows from the directive in the QML, "*an assessment of the failure modes under operational conditions and post closure* ".

With this understanding, the next step is the identification of the hazards or failure modes. This step requires both a detailed knowledge of the system under consideration and the possible failure modes. In the case of the Carmacks Copper mine this requires familiarity with the details of the existing feasibility level design of all components of the mine as well as a detailed understanding of all possible events that would result in a failure based on experience and a thorough knowledge of the industry. The possible failure modes may be a result of any one of a number of hazards, or combination of hazards, such as those inherent in the operations; various historical causes of failures; failure of external supplies such as utilities; environmental threats such as storms and earthquakes; and management systems such as procedures, training, inspections to name just a few.

Each facility is examined carefully for the effects and consequences of all of the identified potential failures. The principal planned control measures are considered in this process. The effects and consequences are considered, not only in terms of their effect on the environment and worker safety but also possible social and community effects, financial and legal consequences. For each failure mode a severity factor is assigned based on the impact in each of these categories. The severity factor is assigned from the following table (Table 1) which is fairly consistent with other risk assessment processes currently being used.

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Table 1 Severity Factor Definitions

Financial Impact	Health and Safety	Natural Environment	Social/Cultural Heritage	Community/Govt./ Reputation/Media	Legal	Severity Factor
> US$500 million	>100 fatalities or very serious irreversible injury to persons.	Very significant impact on highly valued species, habitat or ecosystem.	Irreparable damage to highly valued items of great cultural significance or complete breakdown of social order.	Prolonged International Condemnation	Potential jail terms for executives and/or very high fines for company. Prolonged, multiple litigation.	1000
US$100 million - US$500 million	10 to 100 fatalities, or very serious irreversible injury persons.	Significant impact on highly valued species, habitat, or ecosystem.	Irreparable damage to highly valued items of cultural significance or breakdown of social order.	International multi-NGO and media condemnation.	Very significant fines and prosecutions. Multiple litigation.	300
US$10 million - US$100 million	<10 fatalities, or significant irreversible effects to persons.	Very serious, long-term environmental impairment of ecosystem function.	Very serious widespread social impacts. Irreparable damage to highly valued items.	Serious public or media outcry (international coverage).	Significant prosecution and fines. Very serious litigation, including class actions.	100
US$1 million- US$10 million	Single fatality and/or severe irreversible disability («-30%) to one person.	Serious medium term environmental effects.	On-going serious social issues. Significant damage to structures/ items of cultural significance.	Significant adverse national media/ public/NGO attention.	Major breach of regulation. Major litigation.	30
US$100,000- US$1 million	Moderate irreversible disability or impairment (<30%) to one or more persons.	Moderate, short-term effects but not affecting ecosystem function.	Ongoing social issues. Permanent damage to items of cultural significance.	Attention from media and/or heightened concern by local community. Criticism by NGOs.	Serious breach of regulation with investigation or report to authority with prosecution and/ or moderate fine possible.	10
US$10,000- US$100,000	Objective but reversible disability requiring hospitalization.	Minor effects on biological or physical environment.	Minor medium-term social impacts on local population. Mostly repairable.	Minor, adverse local public or media attention and complaints.	Minor legal issues, non-compliances and breaches of regulation.	3
<US$10,000	No medical treatment required.	Limited damage to minimal area of low significance.	Low-level repairable damage to commonplace structures.	Public concern restricted to local complaints.	Low-level legal issue.	1

Reference: Golder, Introduction to the Systems Failure Modes and Effects Criticality Analysis

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The risk estimation proceeds with the assignment of a likelihood factor to each failure mode. Again this likelihood is based on knowledge and experience in the industry. The likelihood factors are derived from the following table:

Table 2 Likelihood Factor Definitions

For existing operations:

Given the Site, Company and Industry experience, it:	**Likelihood factor**
Could be incurred more than once in a year.	10
Could be incurred over a 1 to 2 year budget period	3
Could be incurred within a 5 year Strategic Planning period	1
Could be incurred within a 5 to 10 year time frame.	0.3
Could be incurred in a 20 to 30 year timeframe.	0.1
For a system failure: This consequence hasn't happened in the industry in the last 50 years.	0.03
For a natural hazard (earthquake, flood, windstorm, etc.): The predicted return period for an event of this strength/magnitude is 1 in 100 years or longer.	

For projects:

Study and Project Delivery Likelihood Factors	
Based on Company and Industry experience with similar Studies or projects, the event:	**Likelihood Factor**
Could be expected to occur more than once during the Study or Project Delivery	10
Could easily be incurred and has generally occurred in similar Studies or Projects	3
Incurred in a minority of similar Studies or Projects	1
Known to happen, but only rarely	0.3
Hasn't occurred in similar Studies or Projects, but could	0.1
Conceivable, but only in extreme circumstances	0.03

Reference: Golder, Introduction to the Systems Failure Modes and Effects Criticality Analysis

The product of the severity and likelihood factors becomes the risk factor associated with the failure; i.e.:

Severity Factor x Likelihood Factor = Risk Factor

As a result, a hazard which is assessed as having a particularly high severity factor but a very low likelihood factor may have an overall risk factor which is deemed acceptable. However, if the resulting risk level is deemed unacceptable, the risk should then be further mitigated by carefully chosen strategies. These may include design modifications, system management options, operator training, emergency response plans etc.

The likelihood and severity are combined to determine a risk factor for each of the particular risks. The Risk Factor Control matrix is shown below in Figure 1.

Figure 1 Risk Factor Control Matrix



An individual failure mode or hazard may have several risk factors depending in which category the impact is considered; environmental, socio-economic, legal, etc. The most severe of the risk factors would be considered when making the initial determination for mitigation measures. Other categories would then be reviewed to see if further mitigation measures are necessary to lower the risk in any of those categories to acceptable levels.

A more detailed explanation of the SFMECA process may be found in Appendix A and other texts may provide a more detailed understanding of the nature of risk assessment.

2.2 CARMACKS COPPER CONTINGENCY PLANNING

The main SFMECA process involved drawing on the knowledge of a team of experienced personnel, familiar with the project and familiar with potential failure modes, in a workshop environment. For the Carmacks Copper Mine Contingency Plan, a workshop was scheduled for October 27 and 28, 2009 and invitations were extended to representatives of Yukon Government, Little Salmon Carmacks First Nation Government, and Selkirk First Nation Government in addition to Western Copper consultants and representatives. The following personnel attended the workshop:

R. Clarkson – representing Yukon Government, Energy Mines and Resources
J. Clegg – Western Copper Corp.
D. Cornett – Access Consulting Group
C. Derome – Western Copper Corp.
J. Gadsby – Facilitator
J. Hull – Golder Associates
J. Ubilla – Golder Associates

The preparation for the SFMECA Workshop for the Carmacks Copper Mine started with a review of all facilities on the mine and identified possible failure mechanisms for each facility. Any possible cause that could result in a failure or hazard in any category was considered, ranging from natural events such as earthquakes to equipment failures, operator errors and management system deficiencies. Failures involving financial consequences to

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the mine operator were not included in this first review. This first review was tabulated as the Initial Hazard Identification Matrix and may be found in Appendix B.

The Workshop started with a recap of the risk assessment process and an overview of the SFMECA process. The remainder of the workshop involved a working session in which all facilities were carefully reviewed and each anticipated failure mode or hazard identified on the matrix was discussed at length. The effect, consequence and likelihood were derived based on consideration of the present state of the (feasibility level) design and the severity and likelihood factor tables. The discussions were not constrained by those hazards identified on the initial matrix. Where other hazards were identified during the course of discussions they were added to the list and discussed in a similar manner.

During the course of reviewing the Initial Hazard Identification Matrix it became evident that several of the noted hazards did not fit the description of an event that should or could be categorized as a hazard to be mitigated. Alternatively, some of the possible hazards were considered ones that would be mitigated in a normal Hazops type review conducted during the detailed design for the facilities. Such events were moved to a second list “Considered but not an issue”. This list can be found in Appendix E.

For any hazard that appeared to represent an unacceptable risk, discussions then focused on possible further mitigation measures that could lead to a reduction in the severity and/or reduce the likelihood of the event. These mitigation measures, actions, strategies will be incorporated in the design, construction and operational phases to bring these risks down to an acceptable level. For those scenarios where this cannot be prevented proactively, measures such as emergency response plans were discussed which would reduce the severity of an event in the unlikely case it should develop.

The risk was then reassessed in the light of these mitigation measures to determine the residual risk. This continued until it was agreed that the hazard had now dropped to an acceptable level. The mitigation measures were noted in the hazard matrix.

There is no rule to define the risk factor that represents an acceptable level of risk. Using the severity and likelihood factors shown in Tables 1 and 2, it was the opinion of the Workshop members that residual risk levels below 9 are acceptable.

The process continued for all facilities on the mine resulting in a new Hazard Matrix which lists all the facilities, the hazards or failure modes considered, the mitigation measures proposed and the residual risk. This Hazard–Matrix table is presented in Appendix C.

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3.0 FAILURE MODES EFFECTS ANALYSIS

This section presents the results of the failure mode effects analysis workshop discussions with the results outlined by major project component.

3.1 HEAP LEACH FACILITY

The Heap Leach Facility (HLF) is a valley fill heap leach pad with a rockfill confining embankment at the south-east boundary, together covering approximately 32.5 hectares. The valley floor of the HLF is generally south-facing and moderately sloping with an approximate overall slope of 14% (8º). The pad will be placed on overburden varying from an estimated 35 m at the lower portion of the heap and 2 to 4 meters in areas of the upper portion of the heap. The ground thermal conditions are estimated to correspond to discontinuous permafrost, and the permafrost is expected to thaw to a depth of approximately 16 m within the first year of operation and down to 35 m after 4 to 5 years of operation.

The heap leach pad base will consist of a composite soil and synthetic liner system and a Leak Detection and Recovery System (LDRS) below the primary liner system. The liner system extends over the entire area of the leach pad and the “upstream” face of the confining embankment (see Appendix D). The change in elevation from the toe of the confining embankment to the top of the heap (design capacity) is approximately 125 m, with a maximum heap thickness at any location of approximately 90 m, and an average thickness of less than 70 m.

The pad will be divided into cells for the purpose of solution management and leak detection. Ore which has been crushed and agglomerated will be stacked in a series of 8 m lifts and irrigated with dilute sulphuric acid to dissolve the copper. Each lift will be irrigated for approximately 200 days. The total cycle time for each lift including building, ripping, piping, leaching and pipe removal is approximately 270 days.

The Heap Leach pad has been designed to accommodate a maximum of 16.3 million tonnes of ore (design capacity). The present plan assumes the placement of 13.3 million tonnes of ore which is equal to the defined reserve (10.6 million tonnes) plus a 25% growth factor. A plan of the HLF can be found in Appendix D.

Once an area of the heap has been loaded and fully leached and no further leaching is planned for the area, rinsing of the heap will commence (concurrent rinsing). Rinsing will continue after all leaching has been completed (active rinsing) until the discharge solution reaches a stable pH. A neutralizing solution will then be circulated through the heap to raise the pH to levels acceptable for discharge. Upon completion of rinsing and neutralization the heap will be recontoured and an evapo-transpiration cover will be placed over the entire heap to reduce percolation of precipitation through the heap and hence reduce discharge volumes.

The Initial Hazard Identification Matrix listed 13 possible failure modes (see Appendix B) and during the course of the workshop another one was added. Of these 14, seven were deemed to be considered but not an issue and moved to the second list “Considered but not an issue”.

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The seven remaining failure modes are listed on the Risk Analysis Matrix in Appendix C.

Three of these failure modes (numbers 1, 2 and 7) presented overall risk factors which were deemed acceptable during the review, even though the risks could be further reduced by design and management features. These risks and associated mitigation measures are as follows:

1. Failure Mode Number 1 – Operations, Residual Risk Factor 1
   Risk: HLF embankment differential settlement due to permafrost degradation.
   Effects: Possible leakage and solution with elevated metals entering groundwater and Williams Creek.
   Mitigation: Design foundation preparation to accommodate conditions; perform comprehensive QA/QC during construction; monitor deformations in construction and operations; monitor solution flows in operations.

2. Failure Mode Number 2 – Operations and closure, Residual Risk Factor 1
   Risk: Storm larger than design occurs resulting in significant erosion, sediments reaching Williams Creek. Inefficient management of solutions.
   Effects: If power is lost during the storm and pumping ability is compromised there could be uncontrolled releases to Williams Creek with MMER levels and/or Water Licence discharge levels exceeded.
   Mitigation: Ensure design provides back-up power for the solution pumps; provide alternative for emergency disposal of excess solution (e.g. pit) and clearly outline procedure for handling such events in Solution Management Plan.

3. Failure Mode number 7 – Post closure, Residual Risk Factor 1
   Risk: Poor performance of heap evapo-transpiration cover system at mine closure.
   Effects: Excess solution post closure with possible elevated metals entering Williams Creek.
   Mitigation: Analysis indicates low risk but option to upgrade / repair cover after initial placement.

The remaining four failure modes are discussed individually below:

3.1.1 Failure Mode - HLF Embankment Instability

The HLF retaining embankment is a rockfill structure (naturally very stable) constructed of mine waste material (pre-stripping). The upstream slope is constructed at a slope of 3:1 (i.e. 3 horizontal to 1 vertical) and the downstream slope at 2.5:1. At its highest point the embankment crest is approximately 28 m above the natural ground level on its centerline. The pad liner system is continuous on the upstream face of the embankment. No pipes penetrate the embankment and a series of foundations drains are planned to provide for the dissipation of any groundwater pressure under it. A cross-section of the embankment may be found in Appendix D.

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If the HLF embankment was to fail catastrophically for any unspecified reason either during or after the operations phase, a potential consequence could be a “landslide” of ore and embankment material moving down hill towards Williams Creek.

Effects - Depending on the severity of the landslide, this could result in several possible outcomes. A sudden, severe or catastrophic occurrence could result in ore and embankment material sliding onto the plant site area with a possible loss of life. The landslide could also result in process solutions and sediments being carried into Williams Creek. The presence of the Events Pond in the direct path of any flow towards the creek would substantially mitigate this if the Events Pond remained intact. If it also failed it would add to the solution and sediment directed towards the creek. The HLF Sediment Pond is also in the direct path of any flow towards the creek but given its smaller volume it is not likely to provide any significant retention of solutions.

Severity Factor – An occurrence of this nature would be extremely damaging by any standards and the consequences drastic. Based on the potential for loss of life of greater than 10 people, should such an event occur, a Severity Factor (SF) of 300 would be assigned (see Table 1). Other considerations, while also very serious, would not lead to a higher factor.

Likelihood Factor – Based on the descriptions in Table 2 under the category of “Projects”, a Likelihood Factor (LF) of 0.3 was ascribed to this event – such occurrences have been known to happen but only rarely.

Risk Factor – The results of the above considerations is that, prior to any further mitigation measures the Risk Factor for such an event would be 300 x 0.3 = 90.

Mitigation / Comments – There are several measures that will be implemented as part of the proven and well established design and construction procedures to reduce the likelihood of an event of this nature:

The present state of engineering knowledge relating to the design of rockfill retaining embankments is quite advanced. Finite element computer programs have improved the reliability and consistence of these designs. Failures of any significant nature are, fortunately, very uncommon. Nonetheless, the potential for a failure must be anticipated and measures implemented to reduce the likelihood of an event.

3.1.1.1 Conservative parameters are being adopted for both static and seismic design situations. The Embankment is to be designed in strict accordance with the latest version of the Canadian Dam Safety Guidelines which dictates that the embankment classification is “High”. As a result of this it will be designed to withstand a seismic event with a return period of 2,500 years (peak horizontal acceleration of 10.9% of gravity according to the Geological Survey of Canada) with a factor of safety greater than or equal to 1.15. Static design parameters will require a factor of safety greater than 1.5. The embankment is constructed of rockfill from pit pre-stripping which is an inherently stable for of construction.

The design will be based on the recent geotechnical site investigation performed in 2007 in preparation for the detailed design of the embankment. That investigation determined that ground conditions in the region of the embankment had improved (less permafrost) from those assumed in the preliminary design report.

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During the course of the environmental assessment for the project, the preliminary designs were review by an independent engineer retained by the Government of Yukon and those designs were considered appropriate for the intended use.

At the time financing is raised for the project, the financial institutions involved in raising the money will require that the designs be reviewed by an independent engineer prior to finalizing the agreement. This will provide a second check on appropriateness of the design.

The Quartz Mining Licence requires that the detailed design for the embankment and the HLF in general be submitted to the Government of Yukon for an independent review prior to construction commencing. This in further oversight will provide further confidence that appropriate parameters were use in the design of the embankment.

3.1.1.2. As part of the detailed design, a Quality Assurance / Quality Control (QA/QC) Procedures Manual will be produced to specify the necessary testing and inspection of all aspects of the construction. Monitoring of this QA/QC effort and the installation contractors performance by a qualified engineer will also be performed during construction to minimize the chance of substandard construction.

3.1.1.3. Monitoring of the embankment during construction and operation will be performed on a regular basis. By this means, if unanticipated movement is taking place it will be detected early and provide an opportunity to implement alternative plans such a different stacking arrangements or reinforcement of the embankment. Regular inspections will be performed by a geotechnical engineer so any early signs of instability may be detected.

3.1.1.4. The main reason for the high residual risk with this hazard lies with the fact that the process plant is almost immediately down slope of the HLF and any embankment failure carries with it the risk of serious damage to the Process Plant with associated loss of life. A relocation of the Process Plant away from the base of the HLF could be considered in the detailed design; however, this may have further impacts that are unfavorable (e.g. the Process Plant area may not self drain into the Events Pond). Alternatively some other form of protection of the plant or alarm to protect plant personnel could be evaluated and all factors weighed accordingly.

Implementation of these measures will reduce the Likelihood Factor to at least one category lower, i.e. 0.1.

The result of these measures would also be that Health and Safety issues would not be the overriding factor determining the SF; environmental concerns would dictate and consequently the SF would be reduced to 30.

The net result is that the mitigated Risk Factor would be 30 x 0.1 = 3 which is deemed to be an acceptable figure.

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3.1.2 Failure Mode - HLF Ore Instability

The ore on the pad will be crushed to minus 19 mm and will be agglomerated prior to placement to encourage free draining. It will be placed in lifts 8 m high and will not be compacted during placement. The angular, free draining nature of the material will reduce the likelihood of instability.

A second potential failure mode of the HLF which could conceivably occur would be the instability of the ore even though the retaining embankment remained intact, possibly as a result of some extreme seismic activity. A similar consequence to the one described in Section 3.1.1 could potentially occur where a "landslide" of ore material overtops the embankment and slides down hill towards Williams Creek.

Effects – With the integrity of the HLF embankment retained the ultimate consequence might not be as severe however it is still possible that ore material might slough onto the plant site area with a possible loss of life. It is also possible that process solutions and sediments may be carried into Williams Creek. The mitigating effect of the Events Pond and the HLF Sediment Pond would be similar to the first case described above.

Severity Factor – Even though the ultimate consequence might be less severe than the case described in Section 3.1.1, the potential for loss of life remains and a Severity Factor (SF) of 300 would be remain (see Table 1).

Likelihood Factor – The Likelihood Factor (LF) of 0.3 determined previously is still appropriate.

Risk Factor – As in 3.1.1 the Risk Factor for such an event would be 300 x 0.3 = 90.

Mitigation / Comments – The mitigative measures that will be implemented to reduce the likelihood of an event of this nature are similar to those described in Section 3.1.1 except that monitoring would be of the ore pile rather than the embankment:

1. Conservative parameters will be adopted for both static and seismic design situations.
2. Strict monitoring will be performed during stacking to ensure that ore is placed according to plan.
3. Monitoring of the ore pile during placement to confirm that no unanticipated movement is taking place.
4. Annual inspections by geotechnical engineer.

Implementation of these measures will reduce the Likelihood Factor to one category lower, i.e. 0.1.

The same considerations as noted in Section 3.1.1 could be implemented to reduce the SF to 30.

The net result is that the mitigated risk would be 30 x 0.1 = 3 which is deemed to be an acceptable figure.

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3.1.3 Failure Mode – Deformation Leading to Failure of Liner System

A third possible failure considered in the FMECA review is the possibility that the liner system could deform severely as a result of differential settlement leading to a rupture in the liner and the release of process solutions into the groundwater below the heap and consequently into Williams Creek.

Effects – The liner system planned for the heap leach facility is designed with a number of safeguards to minimize the likelihood of a leak reaching the environment.

1. Firstly the liner is a linear low density polyethylene material which has been used for many years in heap leach pads because of its durability, flexibility and extensibility.
2. Secondly, the heap leach will be operated in a manner that maintains a minimum of solution ponding on the liner and hence reduces hydraulic head on the liner and minimizes the solution passing through small leaks.
3. Thirdly, the lower section of the liner, below the embankment crest elevation, has two geomembrane layers for additional safeguard.
4. Both the upper and lower liner sections have a 0.3 m layer of lower permeability soil underlying the primary geomembrane and this also would have to be substantially damaged in the same area as the damaged geomembrane to allow any significant amount of leakage.
5. A leak detection and recovery system will be installed beneath the entire primary geomembrane liner / low permeability layer and this system is designed to collect any leakage before it escapes and divert it back to the process. The system is monitored continuously so that operators will know if a section of the liner is leaking and action can be taken.
6. A system of foundation drains exists below the entire pad which is designed to allow any groundwater to drain from under the pad and prevent a build up of pore pressure in the sub-soils. The discharge from these foundation drains will be collected and monitored. Any leakage from the pad, which might pass the geomembrane, the low permeability soil liner, the leak detection and recovery system and (in the case of the lower liner section) the second geomembrane, will show up in the discharge from these drains and allow operators to take corrective action.
7. A Solution Management Plan will be in place that tracks solution inventories with the HLF, Events Ponds and Processing Plant on a daily basis. A significant leakage within the liner system would be identified as part of the solution inventory tracking and allow for immediate action to control any solution losses.
8. A series of monitoring wells is planned down gradient of the heap to monitor the near surface groundwater on a regular basis and the data will be reviewed on a regular basis by a geotechnical engineer.

Experience at Brewery Creek, which had similar features to the proposed liner system at Carmacks, has shown that heap leach pad liners systems can be constructed and operate in a very safe manner in the Yukon climate.

The number of mitigation measures already in place makes it extremely unlikely that a substantial leak in the pad liner system resulting in large quantities of process solution escaping and remaining undetected for long enough to cause a significant impact on the

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groundwater would happen. Discharge into the groundwater would definitely exceed MMER and/or Water Licence levels and would tend to turn the groundwater acidic and contaminate it with metals. This would flow towards Williams Creek and would be detected once it entered the creek since the creek will be monitored on a regular basis and any changes in the creek water chemistry would be picked up and the cause traced to its origin.

Severity Factor – The extent to which this would affect Williams Creek would depend on the quantity of solution leaked. The systems already designed would notify operators of solution losses and intercept the majority of leakage before it entered the groundwater and return the solution to safe storage. The solution that entered the groundwater would be gradually neutralized and the metals precipitated as it passed through the soils between the heap and the creek due to the natural attenuation capacity of the groundwater. The creek also has a significant natural attenuation capacity. Over the course of a year between 5 million m^3 and 12 million m^3 of water passes down Williams Creek. The water in the creek will rapidly flush and dilute any leaked process solution into the Yukon River where the immense volume of water would further dilute the flow to an inconsequential amount.

Because of the forgoing a Severity Factor of 100 was applied to the occurrence – "very serious long term environmental impairment of ecosystem function". This is a fairly conservative assessment, a SF of 30 could be inferred from the descriptions in Table 2 but it reflects the fact that any release is highly undesirable.

Likelihood Factor – a factor of 0.3 has been assigned to this event – "known to happen but only rarely".

Risk Factor – The RF for such an event would be 100 x 0.3 = 30.

Mitigation / Comments – A number of further measures are available to manage any leak. The following measures will be implemented or could be implemented in the event a problem is detected:

3.1.3.1. The leak detection and recovery system is designed to identify leaks from individual cells in the heap leach pad. Similarly, foundation drains are designed such that any flow detected in the drains can be sampled. Also monitor wells down gradient of the leach pad can provide prompt indication of any change in flows or chemistry that would signal a leak. A monitoring plan that provides for a frequent, systematic check of flow and water chemistry in all these locations will be put into effect as part of the operational procedures. By this means monitoring of these systems will follow a carefully devised plan and will provide for the early identification of any problems.

3.1.3.2. As part of a contingency plan, one method of stemming flow from any part of the heap is the installation of inter-lift liners to isolate the cell determined to be leaking. This in itself will not eliminate the leak as the cell in question will continue to drain for some time. However this method will provide sufficient isolation such that process solutions from other cells and higher lifts on the leach pad do not contribute further to the leak.

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3.1.3.3. A detailed Solution Management Plan will be prepared as part of the construction and operations plan for the Processing Facility and Heap Leach Facility. This plan will indentify how process solutions are tracked and monitored and relate to the overall HLF and Processing Facility solution balance. Real time monitoring of solution balance can help detect solutions losses from the system and allow for rapid implementation of remedial measures.

3.1.3.4. One method of preventing leaked process solutions in the groundwater from reaching Williams Creek is the installation of interceptor wells down gradient of the heap. Based on the groundwater hydrology done to date wells could be strategically located to intercept and remove contaminated groundwater prior to it reaching Williams Creek.

3.1.3.5. If the leak is determined to have occurred in a cell where the ore has only been stacked for one or two lifts, the location of failure in the cell may be fairly evident from deformations on the surface of the lift. In such a case it would be quite feasible to excavate the placed ore down to the liner and repair the liner in place.

By this means the severity could be reduced from 100 to at most a factor of 30 – "Serious medium term environmental effects" but more likely a 10 – "Moderate short-term effects but not affecting the ecosystem function". The resulting residual risk factor would then be between 9 and 3.

3.1.4 Failure Mode – Failure to Adequately Rinse and Neutralize Heap at Closure

The closure plan for the mine includes the rinsing of the heap with water to remove excess acidity and the application of a neutralizing solution (sodium carbonate or soda ash) to remove the remaining acidity and reduce the mobility of the remaining metals. Rinsing is planned to start in about year 4 of the mine life in areas of the heap that have been completely leached (concurrent rinsing). This phase of the rinsing will be carefully monitored to gauge its effectiveness and allow adjustments to be made to the rinsing process which would increase the efficiency.

Rinsing will continue after all leaching has been completed and continue until pH levels in the discharge solution stabilize. At this point the heap will be flushed with a neutralization solution to increase the pH of the discharge solution to levels acceptable for discharge. Tests in the laboratory have shown that this can reduce the post closure heap effluent to below MMER and/or Water Licence discharge levels which will ultimately permit a "walk-away" closure of the mine.

Concerns have been raised that the laboratory tests may not be indicative of the actual conditions in the heap at closure and the permeability of the heap may have reduced due to precipitation of minerals. The concern is that thorough rinsing and neutralization may than become impossible and that the heap will retain its low pH and high metal levels and continue to discharge them over an extended period after mine closure.

Effects – Should rinsing not be effective, the effluent coming directly from the heap could potentially remain above MMER and/or Water Licence levels for a considerable period of time. Without any other treatment being applied this could require Western

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Copper to operate the water treatment plant for a very long time after closure – virtually perpetual treatment. If Western Copper was unable to fulfill this requirement the Government of Yukon would be in a position to use the bond posted by the company to undertake this treatment.

The degree to which the creek would be contaminated, if the effluent was not treated, would depend on the quality of the effluent and the rate of discharge. However the assumption is made here that the quantity of the discharge and its quality is sufficient to warrant concern.

Severity Factor – Because of the forgoing a Severity Factor of 100 was applied to the occurrence – "very serious long term environmental impairment of ecosystem function".

Likelihood Factor – The Likelihood Factor (LF) of 1 was determined for this event based on the fact that other heap leach projects have been known to loose permeability in the ore, although no other copper heap leach has been rinsed prior to closure.

Risk Factor– The resulting Risk Factor for such an event would be 100 x 1 = 100.

Mitigation / Comments –

3.1.4.1 A number of mitigation measures are available to deal with this type of occurrence, some of which have already been planned. WCC recognized prior to submitting its YESAB Project Proposal for environmental assessment that, in order to err on the side of caution, it was prudent to consider some form of passive secondary treatment that could be used to "polish" the effluent from the heap leach. Options under study include a limestone drain, biological treatment cell, infiltration gallery and an engineered wetland. Combinations of these might prove most effective in the case of a situation described above. The Preliminary Closure and Reclamation Plan provides more details. These measures in addition to reducing natural water infiltration into the Heap with a properly designed and constructed evapo-transpiration cap are fully capable of more than "polishing" the residual Heap effluent and have been used in other locations to deal satisfactorily with some fairly extreme contaminated situations.

3.1.4.2. Also discussed in the Preliminary Closure and Reclamation Plan is the proposal to conduct a number of test cells early in the mine life. These test cells measuring 8 m square in plan by 8 m (the height of a full lift on the heap leach pad) would be crushed, agglomerated, placed and leached in precisely the same manner as is planned for the production portion of the heap leach. The cells would then be subject to rinsing and neutralization under carefully monitored conditions to identify any potential problems in full scale operation that might not have been obvious in the laboratory tests. By this means it is expected that the correct conditions for rinsing and neutralization can be established early in the mine life. At present three such cell are planned but more could be added.

3.1.4.3. An alternative means to close the heap, if rinsing proved unsatisfactory, would be to mix lime into the heap residue to raise the pH to a neutral or alkaline level and fix the metals. The most effective method would be to excavate the heap material with a large excavator and convey it to the agglomerator. Since the heap ore has been previously crushed it would be relatively easy to handle. In the

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agglomerator it would be thoroughly mixed with lime and from there it could be conveyed back to the leach pad or alternatively disposed of in the pit. The excavator, conveyors and agglomerator would all be readily available from the earlier mining and processing operation.

3.1.4.4. A short term solution to deal with solutions discharging from the heap after rinsing and neutralization, if they are shown to cause a potential effect to Williams Creek receiving waters, would be to test and develop a procedure to discharge solutions to the open pit for disposal. This is not considered a long term treatment approach for the HLF closure but rather a short term disposal option to address potential concerns with discharge of treated solutions to downstream receiving waters and thus reduce metal loadings to lower Williams Creek.

3.1.4.5. If solutions resulting from the heap after rinsing and neutralization are shown to cause a potential effect to Williams Creek receiving waters, a further option might be to test and develop a procedure to discharge solutions directly to the Yukon River via a pipeline. The massive dilution of the heap discharge in the Yukon River would result in negligible changes in the chemistry of the river. This may be an option for disposal of treated solutions from the HLF post closure to address potential concerns with discharge of treated solutions to downstream receiving waters and thus reduce metal loadings to lower Williams Creek. It would require significant study to determine if it was an acceptable solution and is not presently contemplated.

The use of the test cells to help refine the rinsing strategy and the information gained from the concurrent rinsing will reduce the LF by at least on category to 0.3. The adoption of any of the other mitigation and alternative measures means the severity could be reduced to a 10 at most – “Moderate short-term effects but not affecting the ecosystem function”. The resulting residual risk factor would then be 0.3.

3.2 EVENTS POND

The Events Pond is located immediately down slope (south-east) of the HLF and has a total capacity of 160,000 m^3. The Events Pond is designed for short term storage of leach solution from the heap under upset conditions and for collection and storage of contact stormwater and snowmelt runoff especially during extreme climatic conditions.

The Events Pond will be a constructed with a downstream rockfill embankment. The embankment design will be similar to that of the heap confining embankment. The embankment will have a crest elevation of 750 m, a 6 m crest width and an approximate crest length of 295 m. The embankment will have a maximum height of 22 m beneath the center line of the dam. The upstream and downstream slopes will be 3:1 (H:V). An emergency spillway will be constructed on the eastern side of the embankment and will discharge to the heap facility Sediment Pond. The spillway invert elevation will be 748 m and designed to pass the 1 in 200 year flood event with a minimum freeboard of 1.0 m.

The entire pond will be lined with a composite liner consisting of two layers of geomembrane and a layer of soil liner. The exact build up of the layers depends on the particular pond wall. A LDRS similar to that in the lower section of the HLF is also

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incorporated. The pond will be operated with a minimum level of fluid beneath the ice to reduce thermal shock to the geomembrane, if fluid is discharged to the Events Pond in the winter months.

The Initial Hazard Identification Matrix identified 5 possible failure modes (see Appendix B) and during the course of the workshop two were deemed to be considered but not an issue and moved to the "Considered but not an issue" table.

Three remaining failure modes presented overall risk factors which were deemed acceptable during the review, even though the risks could be further reduced by design and management features. These risks and associated mitigation measures are as follows:

1. Failure Mode Number 1 – Operations, Risk Factor 1
   Risk: Events Pond embankment settlement due to permafrost degradation.
   Effects: Possible leakage and solution with elevated metals entering groundwater and Williams Creek.
   Mitigation: Design foundation preparation to accommodate conditions; perform comprehensive QA/QC during construction; monitor deformations in construction and operations; monitor solution elevations in operations and adjust; repair embankment as necessary.

2. Failure Mode Number 2 – Operations and Closure, Risk Factor 3
   Risk: Storm larger than design occurs resulting in significant erosion, sediments reaching Williams Creek. Inefficient management of solutions.
   Effects: If power is lost there could be uncontrolled releases to Williams Creek with MMER and/or Water Licence discharge levels exceeded.
   Mitigation: Ensure design provides back-up power for the solution pumps including redundancy in the power feed/controller for the pumps, installed spare, and warehouse spare; provide alternative for emergency disposal of excess solution (e.g. pit) and clearly outline procedure for handling such events in Solution Management Plan.

3. Failure Modes Number 3 – Operations and Closure, Risk Factor 3
   Risk: Events Pond embankment instability leading to liner failure.
   Effects: Possible solution and sediments with low pH and elevated metals entering Williams Creek and ground water.
   Mitigation: Conservative static and seismic embankment design; perform rigorous QA/QC during construction. Routine and annual geotechnical inspections.

3.3 HEAP LEACH FACILITY SEDIMENT POND

The HLF Sediment Pond is directly down slope of the Events Pond and is designed to collect and control non-contact run-off (i.e. water which has not had any opportunity to contact ore or process solutions) from the areas surrounding the HLF. In addition it will accept treated water from the Water Treatment Plant prior to release into Williams Creek and serve as a source of water supply for process water. The capacity of the pond will be 40,000 m^3

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The pond will be formed by a well graded rockfill embankment approximately 8 m high at its highest point with a 4 m crest width and 3:1 side slopes. To limit seepage a minimum 0.3 m silt liner will be installed. An emergency spillway designed to accommodate a 1:200 year flood event will be constructed on the eastern side of the pond.

The Initial Hazard Identification Matrix identified five possible failure modes and during the course of the workshop two were deemed to be considered but not an issue and moved to the "Considered but not an issue" table. Three remaining failure modes presented overall Risk Factors of 3 which were deemed acceptable during the review, even though the risks could be further reduced by design and management features. The identified failure modes considered in the risk analysis are the same ones identified for the Events Pond (Section 3.2 above).

These risks and associated mitigation measures are the same as for the Events Pond and are not repeated here.

3.4 WASTE ROCK STORAGE AREA

The Waste Rock Storage Area (WRSA) is located immediately north of the open pit on a gentle, north-east facing slope with an average gradient of about 10% (6º). The WRSA covers an area of approximately 70 hectares and is designed to provide for permanent, secure storage and total confinement of up to 60 million tonnes of waste rock generated by the mine plan, which will be available for reclamation, with potential for a further 10 million tonnes if required.

The WRSA will be founded on layered soils composed mainly by two layers of silty sand and clay. Foundation soils are currently frozen below the active zone, and it is expected that limited thaw (about 3 m depth) will occur once the WRSA construction begin and the foundation soils will re-freeze as the WRSA is developed.

The waste rock will be placed in the storage area while the mine is operating, estimated to be approximately 335 days a year. The WRSA is constructed from the bottom up in lifts (as opposed to crest dumping from a relatively high elevation). It is planned that the dump will be developed in a series of 20 to 25-m high lifts. The internal or interim slopes will be developed at 1.4:1 (H:V) and the final or exterior slopes will be developed at 2.25H:1V with benches (overall slope will be 2.5:1 (H:V)). The dump will be developed from the east end and dumping will progress to the north and then to the west. This storage area will not be lined as analyses of the waste rock (acid-base accounting) indicate that the waste rock is not acid generating and will not leach metals. A major surface drainage ditch will surround the dump and collect surface water from the disturbed area and the dump.

Four possible failure modes were initially identified and all four were discussed during the course of the workshop. Of these four one was considered to represent slightly more risk than the rest and is discussed in 3.4.1 below. The others were considered to represent minimal risk even before mitigation and are summarized as follows:

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1. Failure Mode Number 2 – Operations and closure, Risk Factor 3
   Risk: Waste rock instability due to seismic event
   Effects: Pile movement leading to sediment release and possible fatality.
   Mitigation: Use conservative criteria for seismic stability calculations.

2. Failure Mode Number 3 – Operations and Closure, Risk Factor 1
   Risk: Elevated metal levels, ammonia, sediments detected in WRSA run-off.
   Effects: Depending on phase of mine life - elevated metals, ammonia, sediments entering Williams Creek and ground water.
   Mitigation: Rigorous ore / waste management procedures to eliminate possible ore storage in waste rock pile.

3. Failure Mode Number 4 – Closure, Risk Factor 0.3
   Risk: Poor performance of cover system.
   Effects: Lack of revegetation growth and possible erosion and sediment release to Williams Creek.
   Mitigation: Upgrade and repair cover system as necessary.

3.4.1 Failure Mode – WRSA Instability Due to Permafrost Degradation

The present design of the WRSA is based on ground thermistor readings and a thermal analysis which indicates that the permafrost in the ground will not degrade over the life of the mine. In fact the study shows that even with modest (1 deg C) rise in average temperatures the permafrost will reestablish itself and move up into the waste rock pile.

If the permafrost was to degrade the foundations of the WRSA could be compromised leading to a creep failure of the pile and waste rock material possibly moving downhill towards the WRSA Sediment Pond and in the general direction of North Williams Creek.

Effects - Depending on the magnitude of the failure, there could be a number of possible outcomes. The most serious one, and the only one considered here, would be a significant movement of material leading to sediment being discharged into Williams Creek. A loss of life is not considered to be a possible outcome due to the fact that the area down slope of the WRSA is only rarely visited by plant personnel. Further the waste rock pile will be instrumented and any signs of permafrost degradation would be evident before any form of failure.

Severity Factor – An occurrence of this nature should be avoided if at all possible to protect Williams Creek. It is likely however that similar sediment discharges have occurred naturally in the past and the creek has recovered. Based on this a Severity Factor (SF) of 10 would be assigned (see Table 1). Other considerations, while also very serious, would not lead to a higher factor.

Likelihood Factor – Based on the descriptions in Table 2 under the category of "Projects", a Likelihood Factor (LF) of 1 was ascribed to this event – such occurrences have occurred in a minority of similar projects.

Risk Factor – The results of the above considerations is that, prior to any further mitigation measures the Risk Factor for such an event would be 10 x 1 = 10.

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Mitigation / Comments – There are several measures that will be implemented to reduce the likelihood of an event of this nature:

1. Conservative parameters will be adopted for the static design situations.
2. Monitoring will be performed during construction to minimize the chance of substandard construction.
3. Monitoring of ground and rock pile temperatures during and post operation will give advance warning of permafrost degradation.
4. Monitoring of ground and rock pile movement during and post operation will give advance warning of potential movement of the rock pile. Alternative waste dumping sites within the WRSA will permit continued operation while the pile stabilizes.
5. Regular inspections by geotechnical engineer.

Implementation of these measures will reduce the Likelihood Factor to two categories lower, i.e. 0.1 and thus a Residual Risk Factor of 1.

3.5 WASTE ROCK STORAGE AREA SEDIMENT POND

The potential failure modes considered for the WRSA Sediment Pond were identical to those considered for the HLF Sediment Pond (Section 3.3 above). The severity of the potential occurrence is deemed to be lower than for the HLF Sediment Pond since there is no event would could ever result in the WRSA Sediment Pond containing any significant metal levels in the water and hence an uncontrolled discharge is less likely to have any harmful consequences.

The failure modes are not repeated here but the mitigation measures planned for the HLF Sediment Pond will be implemented at the WRSA Sediment Pond.

3.6 SLUDGE CONTAINMENT CELL

The Temporary Sludge Containment Cell (SCC) is located to the north of the HLF and is formed by a rockfill embankment on three sides and a geomembrane liner on the base and three sides. The embankment has a side slope of 2:1 (H:V) and a crest elevation of 891 m. The highest portion of the embankment is approximately 9 m above the existing ground at its centerline. The cell is designed to hold approximately 33,000 tonnes of sludge produced by the Water Treatment Plant during the initial stages of rinsing of the HLF. The cell is planned to be used only on a temporary basis as the contents will be transferred to the HLF once that facility has been completely rinsed and neutralized.

The sludge is alkaline in nature and the supernatant liquid does not contain significant heavy metals.

Three possible failure modes were identified for the SCC. None of these was considered to represent a significant risk and therefore they are only briefly described below.

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1. Failure Mode Number 1 – Operations and Closure, Risk Factor 0.1
   Risk: Embankment instability leading to liner failure.
   Effects: Potential release of sludge.
   Mitigation: Use conservative criteria for stability calculations and implement appropriate QA/QC during construction.

2. Failure Mode Number 2 – Operations and Closure, Risk Factor 0.1
   Risk: Embankment settlement due to permafrost degradation.
   Effects: Potential release of sludge.
   Mitigation: Careful foundation preparation; monitoring for deformation; management of solution levels and water balance; repair of embankment; regular inspection by geotechnical engineer.

3. Failure Mode Number 3 – Closure, Risk Factor 0.1
   Risk: Inadequate storage capacity.
   Effects: Possible overflow of embankment and release of sludge.
   Mitigation: Management of sludge levels; raise embankment elevation to provided additional storage.

3.7 PROCESS PLANT

The Process Plant is considered to be the facilities comprising the Solvent Extraction Plant, the Electrowinning Plant, the Tank Farm, the Acid Plant, the Water Treatment Plant and the Substation. The area is located south of the Heap Leach embankment and immediately west of the Events Pond.

The Process Plant area does not readily lend itself to a failure mode analysis of the nature of the analyses recorded above. The various facilities will all be the subject of detailed Hazops risk analyses during the detailed design phase. Despite this, eight failure modes were identified in the initial review with four of those hazards identified being studied in the Workshop. Two of the hazards were deemed to be relatively minor risks while two were of a more substantial nature and are discussed in detail in Sections 3.7.1 and 3.7.2.

The two hazards representing relatively minor risk factors are described as follows:

1. Failure Mode Number 2 – Operations, Risk Factor 3
   Risk: Uncontrolled fire in Acid Plant.
   Effects: Potential release of SO_2 to atmosphere and shutdown of mine.
   Mitigation: Design to minimize risk of plant fire (Hazops); develop procedures and training plans to prevent occurrence.

2. Failure Mode Number 4 – Operations, Risk Factor 0.9
   Risk: Rupture of solution or acid pipeline and containment liner.
   Effects: Potential release of process solutions or acid, contamination of soils and groundwater.
   Mitigation: Conservative design of pipelines and liner systems; leak detection devices; careful monitoring of solutions during operations (Solution Management Plan); regular inspection of facilities (requires leak in both pipe and liner); repair any noted leaks immediately; develop procedures and personnel training.

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3.7.1 Failure Mode – Upset Conditions Resulting in Discharge of Process Solutions to the Environment

The various component facilities of process plant, in general, are designed to contain solution within the plant buildings in the event of a spill or leak. It is conceivable that certain upset conditions might result in a spill of large enough capacity that the containment was overtopped.

Effects – With a large enough spill the liquids would run over the ground and naturally drain to the Events Pond, however since the ground is not surfaced, such spills would result in contamination of the soils and possibly the groundwater.

Severity Factor – Every attempt should be made to avoid such an occurrence if at all possible to protect the groundwater. However given that the site will be graded to drain naturally to the Events Pond, the majority of the spill should end up being contained with only a small portion actually affecting the groundwater. Based on this a Severity Factor (SF) of 10 would be assigned (see Table 1). Other considerations, while also very serious, would not lead to a higher factor.

Likelihood Factor – Based on the descriptions in Table 2 under the category of "Projects", a Likelihood Factor (LF) of 1 was ascribed to this event – such occurrences have occurred in a minority of similar projects.

Risk Factor – The results of the above considerations is that, prior to any further mitigation measures the Risk Factor for such an event would be 10 x 1 = 10.

Mitigation / Comments – There are several measures that could be implemented to reduce the likelihood of an event of this nature:

1. Conservative (capacity) design of Process Plant containment areas.
2. Solution Management Plan tracks process solutions.
3. Provision of direct drainage to Events Pond.
4. Development of operating procedures and personnel training to minimize risk of spill.

Implementation of these measures is estimated to reduce the Likelihood Factor to at least 0.1 for an overall Risk Factor of 10 x 0.1 = 1.

3.7.2 Failure Mode – Acid Plant Upset Resulting in Release of Acid to Environment

The Acid Plant is purchased as a "package unit" designed and supplied by specialists in the field. The basic design of the plant is such that any "normal" spill of acid will result in the acid draining to a lime pit which will neutralize the acid before it has chance to enter the environment.

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Effects – Should an upset condition occur leading to a significant spill outside the containment of the plant, the effect would potentially be serious with the possibility of a fatality.

Severity Factor – Based on this potential for loss of life a Severity Factor (SF) of 100 would be assigned (see Table 1). Other considerations, while also very serious, would not lead to a higher factor.

Likelihood Factor – Based on the descriptions in Table 2 under the category of "Projects", a Likelihood Factor (LF) of 0.3 was ascribed to this event – such occurrences have been know to happen but only rarely.

Risk Factor – The results of the above considerations is that, prior to any further mitigation measures the Risk Factor for such an event would be 100 x 0.3 = 30.

Mitigation / Comments – A spill within the plant that results in contamination outside the plant is not acceptable from a plant design view point. The plant can and should be designed such that this is impossible. A spill outside the plant remains a remote possibility.

The supplier has produced many such plants and safety issues are a prime consideration in the design and operation. When operated in accordance with the specified procedures these plants are safe and reliable. Moreover, the plants have many safety mechanisms designed into them that largely preclude the ability to operate in a dangerous manner. The basic design of the plant within the plant boundaries will result in the acid draining to a lime pit which will neutralize the acid before it has chance to damage the environment.

An event that would cause a spill outside the plant would be more likely the result of an accident occurring in the handling of the acid outside the plant.

Given the degree to which safety is built into the design of these plants, mitigation measures need to focus on the human factor in the operations. The following measures are proposed:

3.7.2.1. The supplier of the plant will provide strict operating procedures for the plant. These procedures will be the result of many years of operational experience with similar plants. The procedures will provide guidance for dealing with normal conditions as well as upset conditions. The procedures will represent best industry practices operation of this type of facility.

3.7.2.2. It is important that personnel charged with the operation of the plant be intimately familiar with the procedures to minimize the opportunity for operational error. The plant supplier will provide commissioning staff to assist with the initial start up of the plant as well as training for the operators and maintenance staff. Management protocol for the mine will require that all operations and maintenance crew receive regular instruction on the plant to ensure that their skills are maintained at a high level.

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3.7.2.3. To minimize the possibility of an accidental discharge outside the acid plant careful design of plant and surrounding infrastructure will be required. The acid plant supplier will be in a position to offer advice on this aspect of the design as well as operators of similar plants elsewhere.

Implementation of these measures will reduce the Likelihood Factor to at least one category lower possibly more, i.e. 0.1 – 0.03, with a consequent reduction in the overall Risk Factor to the 10 – 3 range.

3.8 OPEN PIT

The Open Pit is located immediately to the north-east of the HLF. It is elongated in a northwest – southeast direction and at its fullest development will be approximately 840 m long by 460 m wide and 270 m deep on its highest wall. The ore is a relatively narrow band of intrusive gneiss within the granodiorite country rock. The granodiorite is massive with no major structures in the pit that would result in major instability considerations.

The inter-ramp angle in the pit is 52.6 degrees on all walls. There will not be any final ramps on the high wall side of the pit. The pit designs are based on the slope angles noted above with double benching of 10 m benches. The pit design includes haul roads and adequate working room for the equipment. The roads are 25 m wide and at a maximum grade of 10%. The 25 m road design is to accommodate trucks of the 100 tonne class, such as the Caterpillar 777D truck.

The first review identified three hazards, one of which was moved to Table 2. The Workshop review identified one additional hazard. Of the three issues examined, two were considered relatively low risk, the other is discussed in Section 3.8.1 below.

The two low risk items are as follows:

1. Failure Mode Number 2 – Operations, Risk Factor 0.09
   Risk: Fuel spills from mining equipment.
   Effects: Potential contamination of soils and groundwater.
   Mitigation: Regular inspection of equipment; development of procedures and personnel training.

2. Failure Mode Number 3 – Operations, Risk Factor 1
   Risk: Water quality in the pit lower than expected.
   Effects: Possible need for water treatment of pit water at closure.
   Mitigation: Monitor water during operations.

3.8.1 Failure Mode – Pit Slope Instability

The pit walls have been the subject of testing and geotechnical study and it has been concluded that a major wall failure due to large structural instability of the pit wall is extremely unlikely. A local bench failure on the pit walls however is possible and must

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be considered. Similar issues have occurred in other open pits although this is not common.

Effects – A failure of a local nature, i.e. a bench failure, would not be considered serious and such failures are not uncommon in open pit mining. A large scale wall failure is far more serious and could have severe consequences with the potential for loss of life but as noted above is considered extremely unlikely.

Severity Factor – Based on the potential for loss of life, a large wall failure would result in a Severity Factor (SF) of 30 (see Table 1). Other considerations, while also very serious, would not lead to a higher factor.

Likelihood Factor – Based on the descriptions in Table 2 under the category of "Projects", a Likelihood Factor (LF) for a global failure of 1 was ascribed to this event – "incurred in a minority of similar studies or projects".

Risk Factor – The results of the above considerations is that, prior to any further mitigation measures the Risk Factor for such an event would be 30 x 1 = 30.

Mitigation / Comments – The testing and detailed geotechnical study of the pit walls concluded that there is no structural problem with the host rock that would lead to pit slope stability problems. There are however some indications that there may be strength issues with some of the rock which might lead to minor stability issues of a local nature. Where similar issues have occurred in other open pits this has been addressed by careful geotechnical monitoring as the pit is developed with changes to the mine plan to handle any deviations from design conditions.

3.8.1.1. The mitigation of this hazard will start with the adoption of conservative bench and pit slope factors in the design of the pit. These will be based in industry best practice for this type of design and rock strength figures from testing of actual rock samples.

3.8.1.2. It is impractical to sample all the rock prior to commencing development of the pit. There will need to be a plan in place during pit development to strictly monitor rock quality in the pit wall as the pit is developed. Deviations from the assumed rock quality characteristic will then need to be noted and any change in the design of the pit necessitated by these deviations will need to be implemented as the pit is developed.

3.8.1.3. The careful management of operations during mining will play a major role in mitigating any issues related to pit slope stability. An experienced mine superintendent will be required to manage operations in an efficient and safe manner and to ensure that all the preceding mitigation measures are implemented. In addition, regular inspection by a geotechnical engineer will identify potential risks before they become real hazards.

These mitigation measures are expected to reduce the likelihood of such and occurrence to a factor of 0.1 which would result in a risk of 3.

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3.9 CAMP AND ADMINISTRATION FACILITIES

The Camp and Administration facilities are located west of the Plant Site and are accessed from the main access road prior to entering the Plant Site. The facilities comprise the worker accommodation units, kitchen diner and recreation facilities and the mine office units. In addition there will be water supply and sewage disposal facilities as well as an emergency power unit.

Three hazards were identified in the initial review but only one was discussed in detail at the Workshop; the others two were moved to Table 2. The one hazard discussed was not considered a significant risk and is outlined below.

1. Failure Mode Number 1 – Construction and Operations, Risk Factor 0.9
   Risk: Release of waste in excess of permit limits.
   Effects: Possible contamination of soil and groundwater.
   Mitigation: Monitor discharge during operations; provide operator training and procedures manual; prepare plan for emergency clean-up.

3.10 CLIMATE

The initial review considered four climate related conditions that could potentially pose hazards to the development, operation and closure of the mine. During the workshop these were further divided to form six categories. Of these six, none was identified that was considered to present a serious risk to the mine and environment.

The six are outlined as follows:

1. Failure Mode Number 1 – Construction and Operation, Risk Factor 0.09
   Risk: Climate significantly drier that predicted during construction and operation.
   Effects: Greater demand for groundwater.
   Mitigation: Consider increasing retention capacity for run-off, snowmelt and pit water; adjust water balance.

2. Failure Mode Number 2 – Construction and Operation, Risk Factor 0.09
   Risk: Climate significantly wetter than predicted during construction and operation.
   Effects: Possible requirement for treating water during operations.
   Mitigation: Potential for early increase Water Treatment Plant capacity; adjust water balance.

3. Failure Mode Number 3 – Construction and Operation, Risk Factor 0.09
   Risk: Climate significantly colder than predicted during construction and operation.
   Effects: Delay in operations due to extended winter conditions.
   Mitigation: Development of appropriate operating procedures to extend operating period including Health and Safety conditions.

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4. Failure Mode Number 4 – Construction and Operation, Risk Factor 0.09
   Risk: Climate significantly warmer than predicted during construction and operation.
   Effects: Potential for unplanned permafrost degradation leading to instability of some structures e.g. WRSA.
   Mitigation: Monitor ground temperatures in critical structures and develop alternative designs if problems noted.

5. Failure Mode Number 5 – Construction and Operation, Risk Factor 0.09
   Risk: Climate significantly drier that predicted during closure.
   Effects: Greater demand for groundwater.
   Mitigation: Consider increasing retention capacity for run-off, snowmelt and pit water; adjust water balance.

6. Failure Mode Number 6 – Construction and Operation, Risk Factor 0.09
   Risk: Climate significantly wetter that predicted during closure.
   Effects: Requirement for treating more water.
   Mitigation: Possible need to increase capacity of Water Treatment Plant; adjust water balance.

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4.0 ALTERNATIVE MEASURES

4.1 PRIORITIZATION OF RISKS

The Failure Modes with the greatest Risk Factors discussed in Section 3.0 above are listed below. None have residual Risk Factors greater than 10. It is the opinion of the Workshop members that Residual Risk Factors less than 10 represented situations where the design, as mitigated, would result in a risk that could be monitored by mine management and controlled adequately.

Table 3 Risk Factors for Failure Modes

Hazard Description / Failure Mode	Initial Risk Factor	Residual Risk Factor
HLF - Embankment instability	90	3
HLF - Ore instability	90	3
HLF - Deformation leading to failure of liner system	30	9 – 3
HLF - Failure to adequately rinse and neutralize heap at closure	100	3 – 1
Events Pond - Storm larger than design occurs	9	3
Events Pond – Embankment instability leads to liner failure	9	3
HLF and WRSA Sediment Ponds – Settlement due to permafrost degradation	9	3
HLF and WRSA Sediment Ponds – Storm larger than design occurs	9	3
HLF and WRSA Sediment Ponds - Embankment instability leads to liner failure	9	3
WRSA – Pile instability due to permafrost degradation	10	3
WRSA – Pile instability due to seismic event	9	3
Process Plant - Acid Plant fire	10	3
Process Plant - Acid Plant upset resulting in release of acid to environment	30	10 – 3
Open Pit - Slope instability	30	3

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4.2 MONITORING AND SURVEILLANCE TECHNIQUES

The following monitoring and surveillance programs are presently or will be in place which will assist in the mitigation of the hazard or failure modes discussed previously.

4.2.1 Thermistors and piezometers are presently in place at various locations around the site; in particular in the area adjacent to the heap leach embankment and also in the proposed waste rock storage area. Further ones may be placed as a result of decisions made in the detailed design process. Monitoring of these will provide indication of changes in the permafrost regime and ground water levels which may impact the final design of the heap embankment. This monitoring activity will continue through

operations as a means of detecting changes below the HLF and WRSA that may necessitate operational changes.

4.2.2 Ground water and surface water quality samples are taken regularly throughout the site in order to understand the natural changes in the water regime and provide comparisons during operations. This will continue through operations and help identify as soon as possible any changes in water quality that might indicate a leak in the liner or equipment of one of the facilities.

4.2.3 It will be necessary to maintain throughout operations and closure, an accurate monitoring of any potential movement of the HLF embankment and the WRSA. An accurate system of survey monuments will be established around the site to facilitate this.

4.2.4 The Solution Management Plan will dictate the routine monitoring of internal process solutions including flows to and from the plant from the HLF or Events Pond; flows from the leak Detection and Recovery System, foundation drains and water treatment plant, and measurements of solution storage volumes and inventories (heap, events ponds, sediment control ponds). A meteorological station will be in place and tied to the tracking of solution inventories on site.

4.3 FURTHER INVESTIGATIVE WORK AND COSTS TO IMPLEMENT

The mitigative measures proposed in Section 3.0 in order to bring the Residual Risk Factors within acceptable limits will require further work in order to refine their application. The following work is planned:

4.3.1 Contingency Treatment Cells (ref 3.1.4)

The three passive treatment techniques proposed for “polishing” of HLF effluent under post closure conditions will require further design and testwork to determine which technique or combination of techniques will be best suited. The passive treatment techniques include limestone drains where alkalinity is added to the water to enhance metals precipitation under alkaline conditions, biological treatment cells either in a backfilled pond or in native ground through an infiltration gallery where metals would be removed as a metal sulfide, and wetlands which would reoxidize water treated through the biological treatment cell or limestone drain.

Test work to facilitate design of these systems would include creating test columns that would receive rinse solutions from only partially neutralized heap material, or alternatively, artificial solutions made to have chemistry that would be similar to the partially rinsed heap materials. The objective of the column operation would be to define metal removal capacity as a function of the material type (limestone, biological sulfide materials, or aeration material simulating wetlands) per unit mass. The column size and flow rates would be sized to provide adequate contact time.

To determine the operating parameters of a limestone cell, an upflow column would be tested, and would be operated until metals concentration in the effluent was the same as the influent, i.e., until “breakthrough”. The mass of metals removed would then be

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determined as a function of the mass of the limestone. It is expected that each metal would have different metals removal capacity, and that some metals may have minimal removal through a limestone column.

To determine the operating parameters of a biological treatment cell, neutral materials (i.e., not providing additional alkalinity) would be loaded in a treatment cell, and recirculated with a carbon source until a sulfate reducing condition was established. The column would then be operated with the column rinse water or synthetic drainage solution for a period of time to determine water quality that could be maintained in a "semi-passive" operations mode (i.e., where a reagent tank periodically refilled is the only active step). After stable conditions are maintained for several pore exchanges, the column will be switched to a condition where no reagent addition is performed, and operated until metals concentration in the effluent was the same as the influent, i.e., until "breakthrough". The mass of metals removed would then be determined as a function of the mass of the biological treatment cell material. Metals removal in sulfide-producing columns is typically better than in a limestone column, but there is a period of active management of biological treatment systems.

Paired with both the limestone and the biological treatment column, an aeration column will also be operated to evaluate the water chemistry improvement associated with the aeration of the column effluent. These columns will also be operated in a saturated or upflow manner, but the water would go through a splash basin to aerate the water prior to flow through the column. The column would be loaded with native soils from the site that might be used for creation of a wetland cell. This column would simulate the benefit of aeration only that might be associated with a wetland, and sorption associated with plants or organic materials in wetlands will not be assessed in the column operation. Metals removal in an aeration column is typically associated with sorption and coprecipitation with manganese and iron oxides. Aeration columns also will tend to neutralize strongly alkaline drainages that might be associated with initial operation of limestone cells.

After the results of the columns have been obtained, metals removal rates can be compared with projected drain-down volumes of the treated heap, and possible sizes associated with specific metals loading could then be designed.

The objective of these passive treatment systems would be to achieve a walk-away solution should the planned measures not perform satisfactorily.

4.3.2 Model Cells (ref 3.1.4)

The proposed model cells will be planned in order to test the leaching, rinsing and neutralization of the ore. The plan will include determination of the extent of leaching (as required by the Decision Document) as a function of leaching time to ensure that the ore on the pad leaches to the full extent, the effect of rinsing and neutralization under several different scenarios, and the application of a cover and monitoring of the discharge over several weather events (i.e. snow and rain) to confirm previous tests that showed compliant levels of metals will discharge from leached, rinsed, and neutralized Carmacks ore.

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Three test cells are presently proposed but more may be constructed. The key variable between the test cells will be the rinsing and neutralization method. It is expected that the rinsing and neutralization method developed by Western Copper will form the baseline test, while variables such as total rinse solution application, rest periods, total neutralization solution application etc will be examined.

The test cells will be constructed to contain ore stacked to the same height as the planned heap lifts (8 m). The drainage of each of the test cells will be isolated so that copper extraction and discharge metal concentrations can be determined for each of the cells independently.

Discharge from the leached, rinsed, and neutralized test cells will be subjected to "polishing" treatment as outlined in Section 4.3.1 above.

4.3.3 Metallurgical testing to demonstrate that mixing of the spent heap with lime will successfully raise the pH of the heap and immobilize metals and has been completed. Further engineering work is now required to design an effective system to complete this exercise and to define the costs associated with it. A scoping study to examine this concept and refine the options and costs would be the next step. A similar study would be required to evaluate the practicality of installing a pipe from the HLF to discharge long term heap drainage to the Yukon River if it was determined to be a viable option.

Once Western Copper is in possession of all the key licenses and has the necessary funding in place, these work plans will be set out in detail and a schedule for their execution will be developed.

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5.0 CONCLUSIONS

The Workshop conducted in October 2009, provided an opportunity for a thorough review of the risks associated with the construction, operation and closure of the Carmacks Copper project in its present state of design.

The group identified and evaluated a total of 76 risks or failure modes for the various facilities. Of those, 39 were risks that the group felt were either dealt with in a normal design Hazop review or were not a significant risk to start with.

The remaining 37 were given careful consideration and nine were deemed to have Risk Factors high enough to warrant the need for possible further mitigation measures. In all cases the group was able to propose one or more mitigation measures which either jointly or individually resulted in a Residual Risk Factor low enough to be accepted as controllable.

Of all the facilities, the ones with risks or failure modes that resulted in initial Risk Factors (prior to mitigation measures) significantly greater than 10 were as follows: the Heap Leach Pad had four, the Acid Plant had one and the Open Pit had one. All these risk can be mitigated to reasonable levels. The risks are listed below:

Table 4 Failure Modes and Risk Factors

Risk or Failure Mode	Initial Risk Factor	Residual Risk Factor
HLF - Embankment instability	90	3
HLF - Ore instability	90	3
HLF - Deformation leading to failure of liner system	30	9 – 3
HLF - Failure to adequately rinse and neutralize heap at closure	100	3 – 1
Process Plant - Acid Plant upset resulting in release of acid to environment	30	10 – 3
Open Pit - Slope instability	30	3

There are several surveillance measures presently in place or planned to be in place that will assist in the mitigation of risks. These include thermistor and piezometer installations, groundwater and surface water monitoring, survey control and the preparation of a solution management plan.

The possible implementation of any of the mitigation measures will require additional testwork and engineering. The most significant of these are the work associated with the design of the contingency treatment ponds to polish the heap effluent; the model cell design and operation; the study to examine putting the leached ore back in the pit and study to examine the piping of heap effluent to the Yukon River.

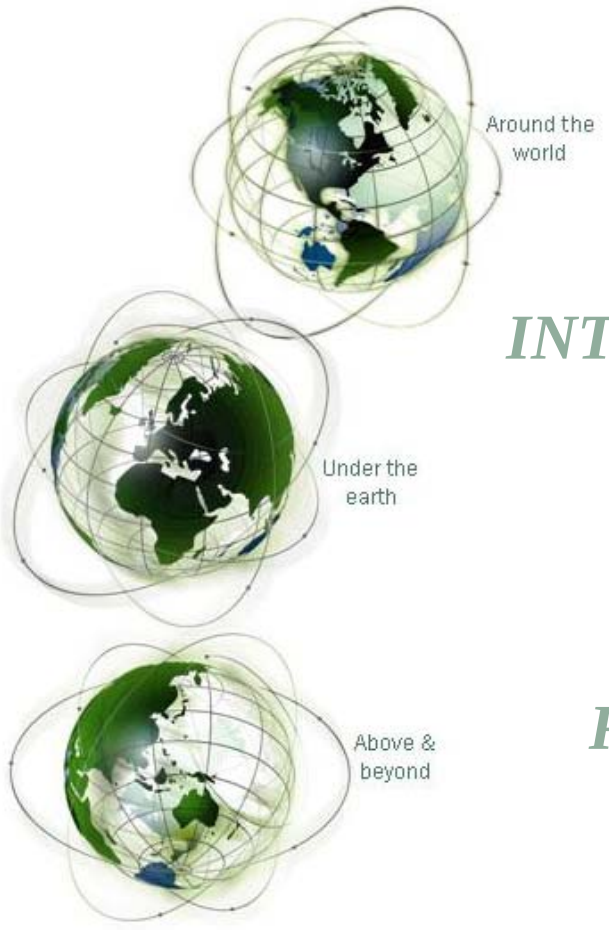
All of the mitigation measures proposed and the additional work plans will be evaluated further and incorporated into the detailed design phase of the project once Western Copper has all the necessary licenses and funding in place.

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Appendix A

Golder SFMECA Report

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INTRODUCTION TO THE SYSTEMS FMECA METHOD FOR RISK ASSESSMENT

1) **Description of the Systems FMECA**
2) **Risk Matrix**
3) **Risk Register**
4) **Risk Mitigation or Treatment**

Consequence Category	CONSEQUENCE SEVERITY				
	A) Low	B) Minor	C) Moderate	D) Major	E) Critical
I H & S					
II Environment					
III Community					
IV Operation					
V Cost					

LIKELIHOOD	
Index	Events/Year
5) Almost Certain	>1
4) Likely	1 -1/10
3) Possible	1/10 – 1/100
2) Unlikely	1/100 – 1/1000
1) Rare	1/1000 – 1/10000

INCREASING RISK

Risk Element	Problem Issue Failure	Causes	Consequences	Exisitng Safeguards	Frequency	Severity					Comments Uncertainty
						H&S	Environment	Community	Operation	Cost	
1.3 Dam	A) Seepage	Design limit	Tailings released to the environment.		3	A	C	C	D	A	High water level required in wet year. Community concerns.

SECTION 1

DESCRIPTION OF THE SYSTEMS FMECA METHOD

Proven Method

The Systems Failure Modes and Effects Criticality Analysis (FMECA) is an adaptation of the FMEA method originally developed to assess the detailed risk associated with parts and components of equipment. This adaptation includes the study of large systems rather than small components, the identification of existing risk mitigation measures and the estimation and ranking of risk. The Systems FMECA method covers all of the standard risk assessment steps.

Analysis Objectives

As with all risk assessments, the first step involves defining the objectives and context for the assessment. Objectives will focus the assessment on specific impacts that may include any number of risks to people, the environment or financial parameters. The scope of the analysis will define the system and how it can be divided into principal units to be analysed separately (and then as a complete system).

Team Workshop

The Systems FMECA method is based on a team of experienced personnel led by a risk facilitator assessing risks in a systematic workshop process. A team may include operations, engineering, environmental and management personnel led by an experienced risk facilitator. The experience of team members provides the knowledge base and the workshop format provides a method to build synergies among the different types of experience. (Other stakeholders such as representatives from the public or government may also participate in one or more workshops. Including stakeholders promotes communication and understanding in a transparent process.) In addition to team knowledge, background information is collated before the workshop including the operational or industry history, hazardous materials and inventories, principal operating activities, and the process description during normal and upset conditions. Specific background information requirements depend on the objectives and scope of the risk assessment.

Overview

Significant failure modes and their associated consequences are first identified using an assessment protocol and the knowledge base of the risk assessment team. Existing controls to mitigate risk are also identified. Then the safety, environmental or financial risk (as defined in the objectives), is estimated for each failure mode and associated consequence using a risk matrix approach.

Analysis Process

A Systems FMECA is a comprehensive process designed to identify potential significant "failure modes" associated with the system being assessed (e.g. an operating facility assessed unit by unit). The "failure mode" describes how a system may fail and includes all possible causes ranging from natural events such as earthquakes to equipment failures, operator errors and management system deficiencies. Potential safety, environmental or financial "effects" as defined in the study objectives are also identified for each failure mode. For example, environmental "effects" may be measured in terms of environmental clean up costs following a release from a facility. A series of events usually needs to occur before a "failure mode" results in an "effect" and therefore the complete series of events is assessed. Following the identification of this series of events, the risk or "criticality" is estimated using a Risk Matrix approach described in the following sub-section.

An example protocol of prompts that may be used to identify failure modes for each unit in the system is summarised as follows:

Identify Failure Modes

- hazards inherent in the unit operations;
- historical causes of failures (and their relative likelihood);
- inputs such as utilities and operation communications;
- outputs such as wastes;
- environmental threats such as storms and earthquakes;
- operation modes such as normal and shutdown conditions and maintenance;
- protection safeguards such as controls and emergency plans;
- facility condition such as fit for use;
- facility design such as capacity and technology; and
- management systems such as procedures, training, inspections, and monitoring.

The protocol is used systematically with all units and then for the complete system.

In addition to addressing potential failure modes for unplanned events, normal or planned operations should also be evaluated to identify potential risks. For example, fugitive emissions may have environmental effects that are not meeting criteria.

Existing Safeguards

The final step in the risk identification process is to identify the existing principal control measures, contingency plans and recovery procedures that will mitigate risk. The objective of the analysis is to estimate the residual risks of the system as planned. When the risk assessment is complete, these residual risks may require reduction.

SECTION 2

RISK MATRIX

Measuring Risk

For each of the significant failure modes and corresponding consequences (hazard scenarios) identified in the Systems FMECA, a measure of the associated risk is estimated using risk matrix methodology. A risk matrix is comprised of one index representing the measure of frequency and another index representing the measure of consequence severity. When a failure mode and consequence scenario is identified, the associated risk is estimated by locating it within the risk matrix.

A number of attributes of the risk matrix are illustrated in the format presented in Figure 1.

Figure 1
Risk Matrix Format

		CONSEQUENCE SEVERITY				
	CATEGORY	A) Very Low	B) Low	C) Moderate	D) High	E) Very High
	I Health & Safety					
	II Community					
	III Environment					
	IV Operation					
	V Cost					
LIKELIHOOD						
Index	Events/Year					
5) Probable	>1					
4) Likely	1 - 1/10					
3) Possible	1/10 - 1/100					
2) Unlikely	1/100 - 1/1,000					
1) Rare	1/1,000 - 1/10,000					

Increasing Risk

Likelihood Index

As shown in Figure 1, the likelihood or frequency index on the left of the matrix ranges from a “rare event” to a “probable” event and is more formally defined in terms of frequency with an events/year value. The example index is divided into orders of magnitude with the expectation that the knowledge base of the team and the historical industry performance record will be sufficient to estimate the level of risk to this accuracy.

Consequence Categories

In this example, five categories of consequences are being assessed:

- people impacts measured according to I) Health & Safety and II) Community concerns;
- environmental impacts measured according to III) Magnitude of impacts on the biological or physical environment; and
- financial impacts measured according to IV) Operational downtime and V) Total costs.

There may be many other categories of consequences and definitions of the severity of consequence impacts dependent of the risk assessment objectives. In general, all categories may be addressed as people, environment or financial impacts. Any one or more may be relevant for a particular risk assessment and all of these risks can be estimated using the Risk Matrix method.

Consequence Severity Index

The severity of effects for each category of consequence is defined by an index ranging from "Very Low" to "Very High." Although these indices are blank in the figure, they would be defined as appropriate for the risk management program. In total there are five separate risk matrices shown in Figure 1 (one for each consequence category) and each hazard scenario would be located in one or more of these five matrices as appropriate.

Example Risk Measurement

For example, an "Environmental" risk estimate of **4D** translates to Frequency Level **4** or "Likely" which is quantified as a frequency between 1 event in 1 year and 1 event in 10 years. The Consequence Severity Level **D** or "High" would be quantified further in the consequence index. This same hazard scenario may also have an "Operational" risk estimate of, for example, **2E**. In order to assess the respective consequence severities, the hazard scenarios must be evaluated in terms of the exposed people or surrounding biological, physical and social components of the environment. Further analysis may be required following the Systems FMECA to refine either the frequency or consequence severity estimates.

The five levels of Frequency and five levels of Consequence Severity shown in Figure 1 may be changed into any number of levels depending on the risk management program. In addition, the common frequency index for all consequences categories is normal practice but not required. All the consequence categories are described in this example according to the same consequence severity index. Therefore, there is an implied equivalence between each consequence category (i.e. a Level **C** (Moderate) consequence level for, say *Health & Safety* is equivalent to a Level **C** (Moderate) consequence level for other categories, say *Environment*).

Risk Evaluation

Following the identification and measurement of risks, they must be evaluated and then managed appropriately. The evaluation of risk requires determining the acceptability of risk as defined through the different locations (or risk values) within the risk matrix developed for the risk assessment.

The criteria for evaluating risks are developed for the risk management program and are useful for comparing risks among different operations. The risk matrix shown in Figure 1 was divided into four groups representing the criteria for managing risks. These groups are colour coded from lower risk Green to Yellow to Orange to highest risk Red. These different locations in this risk matrix have been categorised into corresponding levels of action requirements (or next steps) for managing the risks. Normal practice is to combine the risk matrices into between three to five levels of risk and retain the same criteria for all risk matrices used in the risk assessment (in the Figure 1 example, five risk matrices).

The high priority risk level (colour-coded red) may be associated with a management action to “Reduce Risk.” Action steps may involve more detailed study to improve the risk estimate and determine if it is actually lower than estimated. In some cases, all mitigation options may prove to be uneconomic and senior management may decide to accept the risk but continue to manage it actively.

The intermediate risk levels (colour coded orange and yellow) may be associated with various management actions to “Reduce Risk as Appropriate” and involve balancing the cost of mitigating risk with the benefits received. Action steps may again involve further study to improve the risk estimate. They may also include prioritising the application of resources according to the identified risks and implementing measures to decrease risk either by decreasing frequency, consequences or a combination of the two. The risk matrix illustrates this concept of reducing risk. Different cost implications are often associated with the choice of decreasing frequency, consequences or a combination of the two.

The lowest risk level (colour-coded green) may be associated with the management action to “Monitor and Control Risk” and involve accepting the risk as long as it is both monitored and controlled to ensure it does not creep up to the next level.

RISK REGISTER

Results from the Systems FEMCA are documented in a risk register that is normally a table format and includes the following information:

Documentation

- system, unit description;
- failure mode;
- causes;
- consequences (one or more for each failure mode);
- existing controls (safeguards);
- residual risk estimate according to frequency and consequence location in each risk matrix; and
- notes

A schematic of a Risk Register format is presented in Figure 2.

Figure 2
Risk Register Format

Risk Element	Problem Issue Failure	Causes	Consequences	Exisitng Safeguards	Frequency	Severity					Comments Uncertainty
						H&S	Environment	Community	Operation	Cost	
1.3 Pipeline Section 4	A) Rupture in River	Operation (Overpressure)	Crude released to the environment, travel downstream	Block/check valves across river, Leak detection	3		C	C		D	Low water level. Community concerns.

As shown, the register documents a description of the hazard scenario including existing safeguards, an estimate of the residual risk for all relevant categories, and any further comments or background on uncertainty associated with the assessment. There may be many types of uncertainty in the assessment (knowledge base, random process, etc.) and they may be described qualitatively or through another index (high, medium or low).

RISK MITIGATION OR TREATMENT

Risk mitigation is not addressed through the Systems FMECA process but rather, is addressed as a follow up activity. Experience has proved that “solving problems” during a Systems FMECA workshop is ineffective for both the risk identification and estimation process and the risk mitigation process. Risk mitigation is therefore segregated as a follow up activity.

The risk register described in Section 3 also provides the basis for documenting management actions such as assessing and implementing risk mitigation measures, monitoring risks and communicating results throughout the risk management process. Often the risk management documentation will follow in the same table format as the risk register and include proposed action, who is responsible for action, required completion date, results of action (e.g. more detailed analysis, assessment of risk mitigation options, cost-benefit analysis, monitoring frequency, etc.).

Appendix B

Hazard Identification Matrix

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CARMACKS COPPER PROJECT RISK ANALYSIS

COMPONENT	ID	PROJECT STAGE	FAILURE MODE	EFFECTS	ECONOMIC IMPACT	SEVERITY	LIKELIHOOD	RESIDUAL RISK	MITIGATION/ COMMENTS
HEAP LEACH		Operation & Closure	**Inability to manage surface water**	Uncontrolled releases, sediment and metals exceeding MMER levels entering Williams Creek					
		Operation & Closure	**Large storm occurs resulting in significant erosion, sediments reaching Williams Creek**	Uncontrolled releases, sediment and metals exceeding MMER levels entering Williams Creek					
		Operation & Closure	**HLF embankment instability**	Potential embankment failure leading to "landslide" and solution and sediment release into Williams Creek. Potential for loss of life.					
		Operation & Closure	**HLF ore instability**	Potential embankment failure leading to "landslide" and solution and sediment release into Williams Creek. Potential for loss of life.					
		Operation & Closure	**Overtopping prior to closure (poor decision making, precipitation greater than anticipated)**	Erosion, potential to exceed discharge limits, fines and mining shutdown.					
		Operation & Closure	**Deformation leading to failure of liner system**	Contamination of ground water resulting in elevated metal levels in Williams Creek					
		Operation & Closure	**Local community unrest (i.e. leading to operation disruption and/or property damage)**	Production temporarily halted, repairs required to damaged equipment, potential exceedance of downstream discharge limits ?????					
		Operation & Closure	**Global Seismic instability (intolerable deformation of embankment)**	Potential embankment failure leading to "landslide" and solution and sediment release into Williams Creek. Potential for loss of life.					
		Operation & Closure	**Local Seismic instability (shallow failure without release of ore or solution)**	Minor repairs required to embankment, delays.					
		Operation & Closure	**Terrorist attack leading to solution release**	Solution release, contamination of Williams Creek, potential for mine shutdown. ????????					
		Closure	**Failure to adequately rinse and netrualize heap at closure**	Depends on effluent quality; elevated metal levels in heap discharge.					
		Closure	**Quantity of discharge from heap far exceeds predictions**	Elevated metal levels in heap discharge.					
		Closure	**Failure to implement placement of evapotranspiration cover**						
EVENTS POND		Operation & Closure	**Inability to manage surface water**	Uncontrolled releases, sediment and metals exceeding MMER levels entering Williams Creek					
		Operation & Closure	**Large storm occurs resulting in significant erosion, sediments reaching Williams Creek**	Uncontrolled releases, sediment and metals exceeding MMER levels entering Williams Creek					
		Operation & Closure	**Events Pond embankment instability**	Potential embankment failure leading to "landslide" and solution and sediment release into Williams Creek. Potential for loss of life.					

CARMACKS COPPER PROJECT RISK ANALYSIS

COMPONENT	ID	PROJECT STAGE	FAILURE MODE	EFFECTS	ECONOMIC IMPACT	SEVERITY	LIKELIHOOD	RESIDUAL RISK	MITIGATION/ COMMENTS
		Operation & Closure	**Overtopping prior to closure (poor decision making, precipitation greater than anticipated)**	Erosion, potential to exceed discharge limits, fines and mining shutdown.					
		Operation & Closure	**Deformation leading to failure of liner system**	Contamination of ground water resulting in elevated metal levels in Williams Creek					
HLF SEDIMENTS POND		Operation & Closure	**Inability to manage surface water**	Uncontrolled releases, sediment and metals exceeding MMER levels entering Williams Creek					
		Operation & Closure	**Large storm occurs resulting in significant erosion, sediments reaching Williams Creek**	Uncontrolled releases, sediment and metals exceeding MMER levels entering Williams Creek					
		Operation & Closure	**Pond embankment instability**	Potential embankment failure leading to "landslide" and solution and sediment release into Williams Creek. Potential for loss of life.					
		Operation & Closure	**Overtopping prior to closure (poor decision making, precipitation greater than anticipated)**	Erosion, potential to exceed discharge limits, fines and mining shutdown.					
		Operation & Closure	**Pond settlement due to permafrost degradation**	Possible leakage and solution with elevated metals levels entering groundwater					
WASTE ROCK STORAGE AREA (WRSA)		Operation & Closure	**WR pile instability due to premafrost degradation**	Pile movement leading to possible loss of life					
		Operation & Closure	**Elevated metal levels detected in WRSA run-off**	Depending on phse of mine life, elevated metal levels in Williams Creek					
		Operation & Closure	**Collection ditches not performing adquately leading to erosion**						
		Closure	**Faiulre to implement cover system**						
WRSA SEDIMENTS POND		Operation & Closure	**Inability to manage surface water**	Uncontrolled releases, sediment exceeding MMER levels entering Williams Creek					
		Operation & Closure	**Large storm occurs resulting in significant erosion, sediments reaching Williams Creek**	Uncontrolled releases, sediment and solution with elevated metals levels (?) entering Williams Creek					
		Operation & Closure	**Pond embankment instability**	Potential embankment failure leading to sloughing and sediment release into Williams Creek. Potential for loss of life(?)					
		Operation & Closure	**Overtopping prior to closure (poor decision making, precipitation greater than anticipated)**	Erosion sediments entering Williams Creek					
		Operations & Closure	**Pond settlement due to permafrost degradation**	Possible leakage and solution with elevated metals levels (?) entering groundwater					

CARMACKS COPPER PROJECT RISK ANALYSIS									
COMPONENT	ID	PROJECT STAGE	FAILURE MODE	EFFECTS	ECONOMIC IMPACT	SEVERITY	LIKELIHOOD	RESIDUAL RISK	MITIGATION/ COMMENTS
SLUDGE CONTAINMENT AREA		Operation & Closure	Inability to manage surface water	Overtopping of pond embankment					
		Operation & Closure	Large storm occurs resulting in significant erosion, sediments reaching Williams Creek	Overtopping of pond embankment					
		Operation & Closure	Pond embankment instability	Potential embankment failure leading to sloughing and release of sludge.					
		Operation & Closure	Overtopping prior to closure (poor decision making, precipitation greater than anticipated)	Overtopping of pond embankment					
		Operation & Closure	Pond settlement due to permafrost degradation	Possible leakage and solution entering gourndwater					
		Closure	Failure to place sludge on top of heap and facility decomission						
PLANT		Operations	Plant upset causing overflow of solutions to environment						
		Operations	Acid plant upset resulting in release of acid to environment						
		Operation & Closure	Extended pump failure dry season						
		Operation & Closure	Extended pump failure wet season						
		Operations	Rupture of solution/acid pipe line						
		Operatins	Power or other failure resulting in extended plant shutdown						
		Closure	Failure to disassembly the plant leading to physical instability						
		Closure	Failure to remove chemical hazards leading to contamination of surrounding soils						
OPEN PIT		Operations	Inability to manage groundwater						
		Construction & Operation	Pit slope instability						

CARMACKS COPPER PROJECT RISK ANALYSIS									
COMPONENT	ID	PROJECT STAGE	FAILURE MODE	EFFECTS	ECONOMIC IMPACT	SEVERITY	LIKELIHOOD	RESIDUAL RISK	MITIGATION/ COMMENTS
		Closure	Water in pit more acid than expected						
TRUCK SHOP SERVICE COMPLEX		Closure	Failure to disassembly the truck shop leading to physical instability						
		Closure	Failure to remove chemical hazards leading to contamination of surrounding soils						
CAMP		Operations	Release of waste in excess of permit limits						
		Closure	Failure to disassembly the camp leading to physical instability						
		Closure	Failure to remove fuel or other wastes leading to contamination of surrounding soils						
SITE ACCESS ROAD		Operations	No mine access	Unable to access mine site. Inability to manage operations.					
		Operations & Closure	Accident on road resulting in reagent entering Merrice Creek or Williams Creek						
		Operations & Closure	Accident on road resulting in fatality						
		Closure	Failure to implement erosion control measures leading to erosion and Williams Creek contamination						
CLIMATE		Construction & Operation	Climate change - significantly drier than currently predicted						
		Construction & Operation	Climate change - significantly wetter than currently predicted						
		Closure	Climate change - significantly drier than currently predicted						
		Closure	Climate change - significantly wetter than currently predicted						
FRESH WATER DIVERSION STRUCTURES		Construction & Operation	Freshwater diversion system not functioning						

CARMACKS COPPER PROJECT RISK ANALYSIS

COMPONENT	ID	PROJECT STAGE	FAILURE MODE	EFFECTS	ECONOMIC IMPACT	SEVERITY	LIKELIHOOD	RESIDUAL RISK	MITIGATION/ COMMENTS
HEAP LEACH		Operation & Closure	**Inability to manage surface water**	Uncontrolled releases, sediment and metals exceeding MMER levels entering Williams Creek					
		Operation & Closure	**Large storm occurs resulting in significant erosion, sediments reaching Williams Creek**	Uncontrolled releases, sediment and metals exceeding MMER levels entering Williams Creek					
		Operation & Closure	**HLF embankment instability**	Potential embankment failure leading to "landslide" and solution and sediment release into Williams Creek. Potential for loss of life.					
		Operation & Closure	**HLF ore instability**	Potential embankment failure leading to "landslide" and solution and sediment release into Williams Creek. Potential for loss of life.					
		Operation & Closure	**Overtopping prior to closure (poor decision making, precipitation greater than anticipated)**	Erosion, potential to exceed discharge limits, fines and mining shutdown.					
		Operation & Closure	**Deformation leading to failure of liner system**	Contamination of ground water resulting in elevated metal levels in Williams Creek					
		Operation & Closure	**Local community unrest (i.e. leading to operation disruption and/or property damage)**	Production temporarily halted, repairs required to damaged equipment, potential exceedance of downstream discharge limits ?????					
		Operation & Closure	**Global Seismic instability (intolerable deformation of embankment)**	Potential embankment failure leading to "landslide" and solution and sediment release into Williams Creek. Potential for loss of life.					
		Operation & Closure	**Local Seismic instability (shallow failure without release of ore or solution)**	Minor repairs required to embankment, delays.					
		Operation & Closure	**Terrorist attack leading to solution release**	Solution release, contamination of Williams Creek, potential for mine shutdown. ????????					
		Closure	**Failure to adequately rinse and netrualize heap at closure**	Depends on effluent quality; elevated metal levels in heap discharge.					
		Closure	**Quantity of discharge from heap far exceeds predictions**	Elevated metal levels in heap discharge.					
		Closure	**Failure to implement placement of evapotranspiration cover**						
EVENTS POND		Operation & Closure	**Inability to manage surface water**	Uncontrolled releases, sediment and metals exceeding MMER levels entering Williams Creek					
		Operation & Closure	**Large storm occurs resulting in significant erosion, sediments reaching Williams Creek**	Uncontrolled releases, sediment and metals exceeding MMER levels entering Williams Creek					
		Operation & Closure	**Events Pond embankment instability**	Potential embankment failure leading to "landslide" and solution and sediment release into Williams Creek. Potential for loss of life.					

CARMACKS COPPER PROJECT RISK ANALYSIS

COMPONENT	ID	PROJECT STAGE	FAILURE MODE	EFFECTS	ECONOMIC IMPACT	SEVERITY	LIKELIHOOD	RESIDUAL RISK	MITIGATION/ COMMENTS
		Operation & Closure	**Overtopping prior to closure (poor decision making, precipitation greater than anticipated)**	Erosion, potential to exceed discharge limits, fines and mining shutdown.					
		Operation & Closure	**Deformation leading to failure of liner system**	Contamination of ground water resulting in elevated metal levels in Williams Creek					
HLF SEDIMENTS POND		Operation & Closure	**Inability to manage surface water**	Uncontrolled releases, sediment and metals exceeding MMER levels entering Williams Creek					
		Operation & Closure	**Large storm occurs resulting in significant erosion, sediments reaching Williams Creek**	Uncontrolled releases, sediment and metals exceeding MMER levels entering Williams Creek					
		Operation & Closure	**Pond embankment instability**	Potential embankment failure leading to "landslide" and solution and sediment release into Williams Creek. Potential for loss of life.					
		Operation & Closure	**Overtopping prior to closure (poor decision making, precipitation greater than anticipated)**	Erosion, potential to exceed discharge limits, fines and mining shutdown.					
		Operation & Closure	**Pond settlement due to permafrost degradation**	Possible leakage and solution with elevated metals levels entering groundwater					
WASTE ROCK STORAGE AREA (WRSA)		Operation & Closure	**WR pile instability due to premafrost degradation**	Pile movement leading to possible loss of life					
		Operation & Closure	**Elevated metal levels detected in WRSA run-off**	Depending on phse of mine life, elevated metal levels in Williams Creek					
		Operation & Closure	**Collection ditches not performing adquately leading to erosion**						
		Closure	**Faiulre to implement cover system**						
WRSA SEDIMENTS POND		Operation & Closure	**Inability to manage surface water**	Uncontrolled releases, sediment exceeding MMER levels entering Williams Creek					
		Operation & Closure	**Large storm occurs resulting in significant erosion, sediments reaching Williams Creek**	Uncontrolled releases, sediment and solution with elevated metals levels (?) entering Williams Creek					
		Operation & Closure	**Pond embankment instability**	Potential embankment failure leading to sloughing and sediment release into Williams Creek. Potential for loss of life(?)					
		Operation & Closure	**Overtopping prior to closure (poor decision making, precipitation greater than anticipated)**	Erosion sediments entering Williams Creek					
		Operations & Closure	**Pond settlement due to permafrost degradation**	Possible leakage and solution with elevated metals levels (?) entering groundwater					

CARMACKS COPPER PROJECT RISK ANALYSIS									
COMPONENT	ID	PROJECT STAGE	FAILURE MODE	EFFECTS	ECONOMIC IMPACT	SEVERITY	LIKELIHOOD	RESIDUAL RISK	MITIGATION/ COMMENTS
SLUDGE CONTAINMENT AREA		Operation & Closure	Inability to manage surface water	Overtopping of pond embankment					
		Operation & Closure	Large storm occurs resulting in significant erosion, sediments reaching Williams Creek	Overtopping of pond embankment					
		Operation & Closure	Pond embankment instability	Potential embankment failure leading to sloughing and release of sludge.					
		Operation & Closure	Overtopping prior to closure (poor decision making, precipitation greater than anticipated)	Overtopping of pond embankment					
		Operation & Closure	Pond settlement due to permafrost degradation	Possible leakage and solution entering gourndwater					
		Closure	Failure to place sludge on top of heap and facility decomission						
PLANT		Operations	Plant upset causing overflow of solutions to environment						
		Operations	Acid plant upset resulting in release of acid to environment						
		Operation & Closure	Extended pump failure dry season						
		Operation & Closure	Extended pump failure wet season						
		Operations	Rupture of solution/acid pipe line						
		Operatins	Power or other failure resulting in extended plant shutdown						
		Closure	Failure to disassembly the plant leading to physical instability						
		Closure	Failure to remove chemical hazards leading to contamination of surrounding soils						
OPEN PIT		Operations	Inability to manage groundwater						
		Construction & Operation	Pit slope instability						

CARMACKS COPPER PROJECT RISK ANALYSIS									
COMPONENT	ID	PROJECT STAGE	FAILURE MODE	EFFECTS	ECONOMIC IMPACT	SEVERITY	LIKELIHOOD	RESIDUAL RISK	MITIGATION/ COMMENTS
		Closure	Water in pit more acid than expected						
TRUCK SHOP SERVICE COMPLEX		Closure	Failure to disassembly the truck shop leading to physical instability						
		Closure	Failure to remove chemical hazards leading to contamination of surrounding soils						
CAMP		Operations	Release of waste in excess of permit limits						
		Closure	Failure to disassembly the camp leading to physical instability						
		Closure	Failure to remove fuel or other wastes leading to contamination of surrounding soils						
SITE ACCESS ROAD		Operations	No mine access	Unable to access mine site. Inability to manage operations.					
		Operations & Closure	Accident on road resulting in reagent entering Merrice Creek or Williams Creek						
		Operations & Closure	Accident on road resulting in fatality						
		Closure	Failure to implement erosion control measures leading to erosion and Williams Creek contamination						
CLIMATE		Construction & Operation	Climate change - significantly drier than currently predicted						
		Construction & Operation	Climate change - significantly wetter than currently predicted						
		Closure	Climate change - significantly drier than currently predicted						
		Closure	Climate change - significantly wetter than currently predicted						
FRESH WATER DIVERSION STRUCTURES		Construction & Operation	Freshwater diversion system not functioning						

Appendix C

Risk Analysis Matrix

DRAFT

CARMACKS COPPER PROJECT RISK ANALYSIS - TABLE 1

COMPONENT	ID	PROJECT STAGE	FAILURE MODE	EFFECTS	ECONOMIC IMPACT	SEVERITY	LIKELIHOOD	RISK	MITIGATION / COMMENTS	RESIDUAL LIKELIHOOD	RESIDUAL RISK
HEAP LEACH	1	Operation	HLF embankment settlement due to permafrost degradation	Possible leakage and solution with elevated metals levels entering groundwater and Williams Creek.	Medium	10	0.3	3	Foundation preparation. Monitoring deformations and solution levels. Water balance adjustments and repair efforts.	0.1	1
	2	Operation & Closure	Storm larger than design occurs resulting in significant erosion, sediments reaching Williams Creek. Inefficient management	Lost Power, uncontrolled releases, sediment and metals exceeding MMER levels entering Williams Creek.	Medium	10	0.3	3	Back up power for pumps. Design of facility considering large storm event and solutions level monitoring. Plan to direct water to pit.	0.1	1
	3	Operation & Closure	HLF embankment instability	Potential embankment failure leading to "landslide", solution and sediments release into Williams Creek. Potential for loss of life.	High	300	0.3	90	Conservative static and seismic design. Monitoring during construction and operation.	0.1	3
	4	Operation & Closure	HLF ore instability	Potential ore failure leading to "landslide", solution and sediment release into Williams Creek. Potential for loss of life.	High	300	0.3	90	Conservative static and seismic design. Monitoring during stacking and irrigation.	0.1	3
	5	Operation & Closure	Deformation leading to failure of liner system	Contamination of ground water resulting in elevated metal levels in Williams Creek.	High	100	0.3	30	Foundation preparation. Double liner at lower portion of heap. Monitoring capabilities considered in design. Groundwater is chemically basic.	0.1	3 - 9
	6	Closure	Failure to adequately rinse and neutralize heap at closure	Depends on effluent quality; elevated metal levels in heap discharge.	High	100	1	100	Laboratory tests prior to start up. Testing cells during operation prior to closure. Add lime and move to pit. Pipe effluent to Yukon River	0.3	1 - 3
	7	Post Closure	Poor performance of cover system	Potential for elevated metal levels in heap discharge.	Low	10	0.3	3	Upgrade / repair cover system.	0.1	1
EVENTS POND	1	Operation	Events pond embankment settlement due to permafrost degradation	Possible leakage and solution with elevated metals levels entering groundwater and Williams Creek.	Medium	10	0.3	3	Foundation preparation. Monitoring deformations and solution levels. Water balance adjustments and repair efforts.	0.1	1
	2	Operation & Closure	Storm larger than design occurs resulting in significant erosion, sediments reaching Williams Creek. Inefficient management	Lost Power, uncontrolled releases, sediment and metals exceeding MMER levels entering Williams Creek.	Low	30	0.3	9	Back up power for pumps. Design of facility considering large storm event and solutions level monitoring. Plan to direct water to pit.	0.1	3

CARMACKS COPPER PROJECT RISK ANALYSIS - TABLE 1

COMPONENT	ID	PROJECT STAGE	FAILURE MODE	EFFECTS	ECONOMIC IMPACT	SEVERITY	LIKELIHOOD	RISK	MITIGATION / COMMENTS	RESIDUAL LIKELIHOOD	RESIDUAL RISK
	3	Operation & Closure	**Events Pond embankment instability leading to liner failure**	Potential embankment failure leading to "landslide", solution and sediments release into Williams Creek. Potential for groundwater contamination resulting in elevated metal levels in Williams Creek. Potential for loss of life.	**Medium**	**30**	**0.3**	**9**	Conservative static and seismic design. Foundation preparation. Monitoring during construction and operation.	**0.1**	**3**
HLF SEDIMENTS POND	1	Operation	**HLF sediments pond embankment settlement due to permafrost degradation**	Possible leakage and solution with elevated metals levels entering groundwater.	**Low**	**30**	**0.3**	**9**	Foundation preparation. Monitoring deformations and solution levels. Water balance adjustments and repair efforts.	**0.1**	**3**
	2	Operation & Closure	**Storm larger than design occurs resulting in significant erosion, sediments reaching Williams Creek. Inefficient management**	Lost Power, uncontrolled releases, sediment and metals exceeding MMER levels entering Williams Creek.	**Low**	**30**	**0.3**	**9**	Back up power for pumps. Design of facility considering large storm event and solutions level monitoring. Plan to direct water to pit.	**0.1**	**3**
	3	Operation & Closure	**HLF sediments pond embankment instability leading to liner failure**	Potential embankment failure leading to "landslide", sediments release into Williams Creek. Potential for loss of life.	**Low**	**30**	**0.3**	**9**	Conservative static and seismic design. Foundation preparation. Monitoring during construction and operation.	**0.1**	**3**
WASTE ROCK STORAGE AREA (WRSA)	1	Operation & Closure	**WR pile instability due to permafrost degradation**	Pile movement leading to sediment release.	**Low**	**10**	**1**	**10**	Conservative static design. Foundation preparation. Monitoring ground temperatures during construction and operation.	**0.3**	**3**
	2	Operation & Closure	**WR instability due to seismic event**	Pile movement leading to sediment release, possible fatality.	**Medium**	**30**	**0.3**	**9**	Conservative seismic design. Monitoring during construction and operation.	**0.1**	**3**
	3	Operation & Closure	**Elevated metal levels detected in WRSA run-off**	Depending on phase of mine life, elevated metal levels in Williams Creek.	**Low**	**10**	**0.3**	**3**	Waste / ore management procedures to minimize the possibility of storing ore in WRSA.	**0.1**	**1**
	4	Closure	**Poor performance of cover system**	Potential for elevated sediment levels in Williams Creek	**Low**	**3**	**0.3**	**0.9**	Upgrade / repair cover system.	**0.1**	**0.3**
WRSA SEDIMENTS POND	1	Operation & Closure	**Storm larger than design occurs resulting in significant erosion, sediments reaching Williams Creek. Inefficient management**	Lost Power, uncontrolled releases, sediment and metals exceeding MMER levels entering Williams Creek.	**Low**	**10**	**0.3**	**3**	Back up power for pumps. Design of facility considering large storm event and solutions level monitoring. Plan to direct water to pit.	**0.1**	**1**

CARMACKS COPPER PROJECT RISK ANALYSIS - TABLE 1

COMPONENT	ID	PROJECT STAGE	FAILURE MODE	EFFECTS	ECONOMIC IMPACT	SEVERITY	LIKELIHOOD	RISK	MITIGATION / COMMENTS	RESIDUAL LIKELIHOOD	RESIDUAL RISK
	2	Operation & Closure	**WRSA sediment pond embankment instability leading to liner failure**	Potential embankment failure leading to "landslide", sediments and solution with elevated metal levels release entering groundwater and Williams Creek. Potential for loss of life.	**Low**	**30**	**0.3**	**9**	Conservative static and seismic design. Foundation preparation. Monitoring during construction and operation.	**0.1**	**3**
	3	Operation & Closure	**WRSA sediments pond embankment settlement due to permafrost degradation**	Possible sediments and solution with elevated metals levels entering groundwater and Williams creek.	**Low**	**10**	**0.3**	**3**	Foundation preparation. Monitoring deformations and solution levels. Water balance adjustments and repair efforts.	**0.1**	**1**
SLUDGE CONTAINMENT AREA	1	Operation & Closure	**Sludge containment area embankment instability leading to liner failure**	Potential embankment failure leading to sloughing and release of sludge.	**Low**	**1**	**0.3**	**0.3**	Conservative static and seismic design. Foundation preparation. Monitoring during construction and operation.	**0.1**	**0.1**
	2	Operation & Closure	**Sludge containment area embankment settlement due to permafrost degradation**	Potential embankment failure leading to sloughing and release of sludge.	**Low**	**1**	**0.3**	**0.3**	Foundation preparation. Monitoring deformations and solution levels. Water balance adjustments and repair efforts.	**0.1**	**0.1**
	3	Closure	**Inadequate containment capacity**	Not enough space in the facility to store the sludge.	**Low**	**1**	**0.3**	**0.3**	Sludge deposition management, dig up efforts, build larger embankment or build secondary facility.	**0.1**	**0.1**
PLANT	1	Operation	**Plant upset causing discharge of solutions to environment**	Potential for contamination of surrounding soils and groundwater.	**Low**	**10**	**1**	**10**	Design to minimize solutions release risk. Clean up efforts, procedures development and personnel training.	**0.1**	**1**
	2	Operation	**Acid plant explosion**	Potential for uncontrolled fire, fatality, and mine shutdown.	**High**	**100**	**0.03**	**3**	Design to minimize explosion risk, procedures development and personnel training.	**0.03**	**3**
	3	Operation	**Acid plant upset resulting in release of acid to environment**	Potential for contamination of surrounding soils and groundwater, uncontrolled fire and fatality.	**High**	**100**	**0.3**	**30**	Design to minimize acid release risk. Clean up efforts, procedures development and personnel training.	**0.1 - 0.03**	**10 - 3**
	4	Operation	**Rupture of solution / acid pipe line and liner**	Potential for contamination of surrounding soils and groundwater. Potential for fatality.	**Medium**	**30**	**0.1**	**3**	Pipeline conservative design, and monitoring during operation. Clean up efforts, procedures development and personnel training.	**0.03**	**0.9**

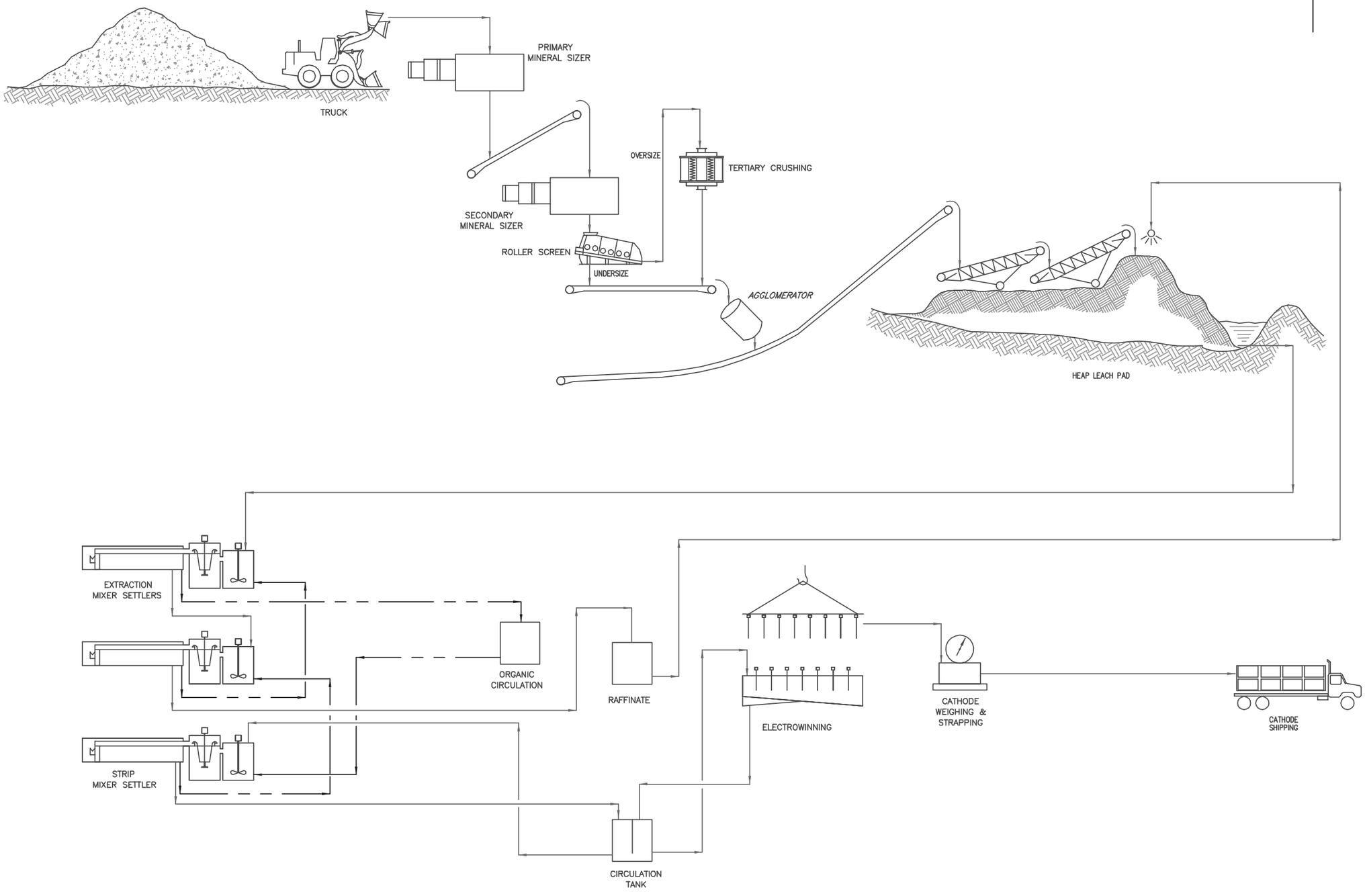
CARMACKS COPPER PROJECT RISK ANALYSIS - TABLE 1

COMPONENT	ID	PROJECT STAGE	FAILURE MODE	EFFECTS	ECONOMIC IMPACT	SEVERITY	LIKELIHOOD	RISK	MITIGATION / COMMENTS	RESIDUAL LIKELIHOOD	RESIDUAL RISK
OPEN PIT	1	Construction & Operation	Pit slope instability	Potential for fatality, loss of equipment, delays in operation and mine shutdown.	High	30	1	30	Bench / slope conservative design. Management of pit development and monitoring.	0.1	3
	2	Operation	Spills by equipment	Potential for groundwater contamination and delays in operation.	Low	3	1	3	Clean up efforts, procedures development and personnel training.	0.03	0.09
	3	Closure	Water quality in pit lower than expected	Requirement for water treatment at closure.	Medium	10	1	10	Monitor water quality during operation, treatment after closure.	0.1	1
CAMP, OFFICES, HOSPITAL, GATE HOUSE	1	Operation	Release of waste in excess of permit limits	Potential for soil and groundwater contamination.	Low	3	1	3	Management, personnel training, clean up procedures.	0.3	0.9
CLIMATE	1	Construction & Operation	Climate change - significantly drier than currently predicted	Requirement for more groundwater.	Low	3	0.1	0.3	Operations and water balance adjustments.	0.03	0.09
	2	Construction & Operation	Climate change - significantly wetter than currently predicted	Requirement for treating more water.	Medium	3	0.1	0.3	Operations and water balance adjustments, potential for treatment plant increased capacity.	0.03	0.09
	3	Construction & Operation	Temperatures colder than expected	Delays in operation.	Low	3	0.1	0.3	Development of H&S procedures.	0.03	0.09
	4	Construction & Operation	Temperatures warmer than expected	Permafrost degradation, potential for WRSA, embankments, stockpiles and borrow pits deformation and instability.	Low	3	0.1	0.3	Monitoring ground temperatures and embankment / slopes deformations.	0.03	0.09
	5	Closure	Climate change - significantly drier than currently predicted	Requirement for more groundwater.	Medium	3	0.1	0.3	Closure water balance adjustments.	0.03	0.09
	6	Closure	Climate change - significantly wetter than currently predicted	Requirement for treating more water.	Low	3	0.1	0.3	Closure water balance adjustments, potential for treatment plant increased capacity.	0.03	0.09

Appendix D

Drawings

DRAFT



Type A Water Use Licence Application

Carmacks Copper Project Yukon Territory

Western Copper Corporation

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

Original drawing from M3 Engineering & Technology Corp., "Carmacks Copper Project Copper Process Simplified Flowsheet", Drawing 000-FS-001

Simplified Flowsheet of the Carmacks Copper Project Process

Figure Number:

3-7

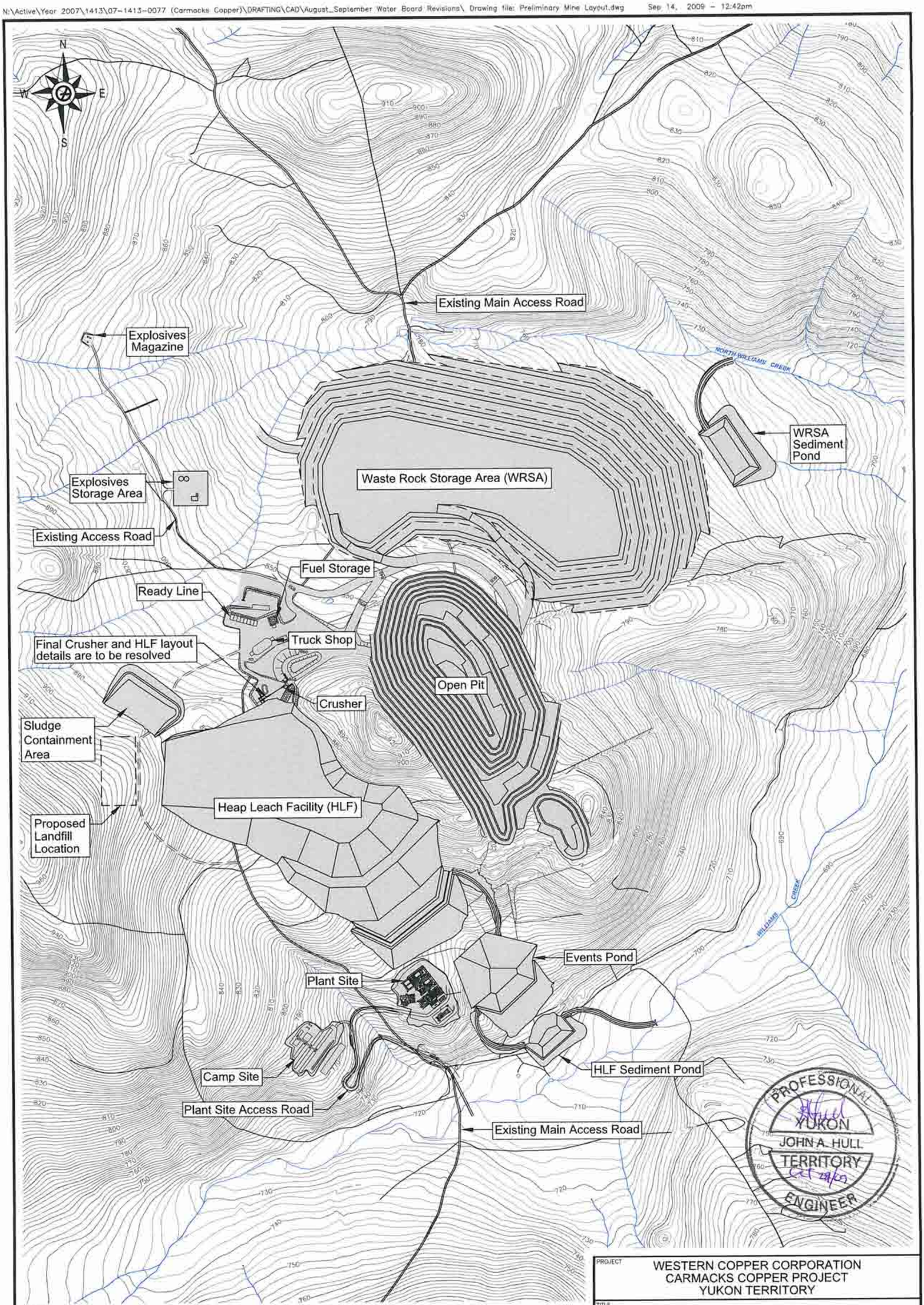
ACCESS CONSULTING GROUP

Revised by: HD	Checked by: NS/DC

Date: June 2008

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PROFESSIONAL ENGINEER
JOHN A. HULL
YUKON TERRITORY
Oct 29/09

NOTES

1.) Elevations Shown are in metres above Mean Sea Level.
2.) Grid Coordinates Shown in UTM NAD 83, Zone 8.
3.) Leak Detection and Recovery System (LDRS) not Shown for Clarity.
4.) Perimeter Ditches not Shown for Clarity.

REFERENCES

1.) Western Copper Corporation, CAD Survey Files: ndetail.dwg and sdetail.dwg, Received May 14th, 2008.
2.) M3 Engineering Ltd., CAD Files: 100-CI-010P5.dwg, Dated March 13th, 2008.
3.) Eagle Mapping Ltd., CAD Files: SH1-UTM.dwg to SH9-UTM.dwg, Dated November 1st, 2007.
4.) Western Copper Corporation, CAD File: End_Of_Yr_06.dwg, Dated March 30th, 2007.

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NOT FOR CONSTRUCTION

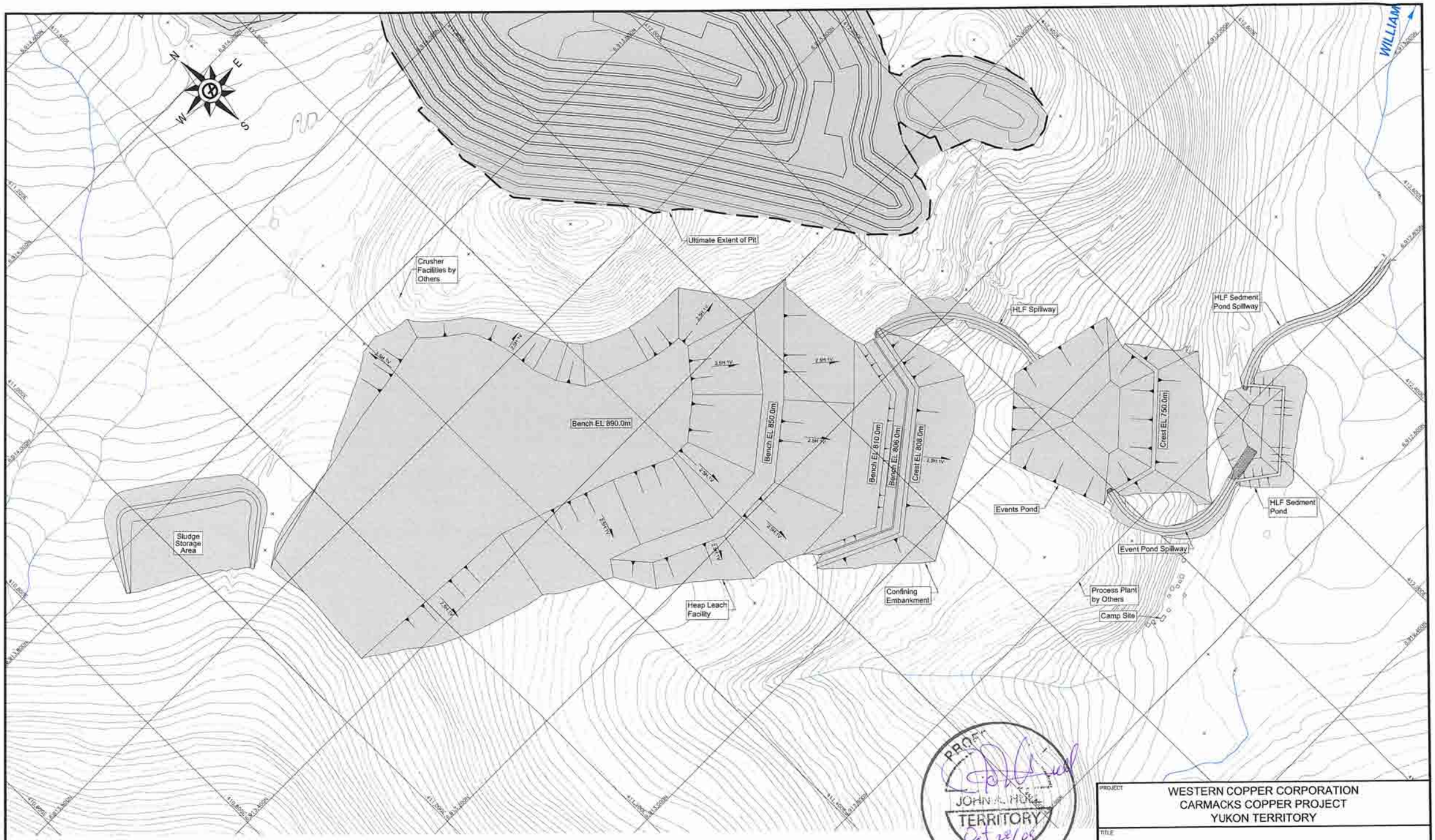
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CARMACKS COPPER PROJECT
YUKON TERRITORY

TITLE: **PRELIMINARY MINE LAYOUT**

Golder Associates
Abbotsford, BC

PROJECT No. 07-1413-0077			PHASE 1000	TASK	
DESIGN	F.E.	SEP-14-09	FILE No.		
CADD	D.T.	SEP-14-09	SCALE AS SHOWN	REV.	0
CHECK	JH	Oct 29-09	**FIGURE 1**		
REVIEW	JH	Oct 29/09			



NOTES

1.) Elevations Shown are in metres above Mean Sea Level.
2.) Grid Coordinates Shown in UTM NAD 83, Zone 8.
3.) Leak Detection and Recovery System (LDRS) not Shown for Clarity.
4.) Perimeter Ditches not Shown for Clarity.

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4.) Western Copper Corporation, CAD File: End_Of_Yr_06.dwg, Dated March 30th, 2007.

DRAWING REDUCED

FOR DISCUSSION PURPOSES ONLY
NOT FOR CONSTRUCTION

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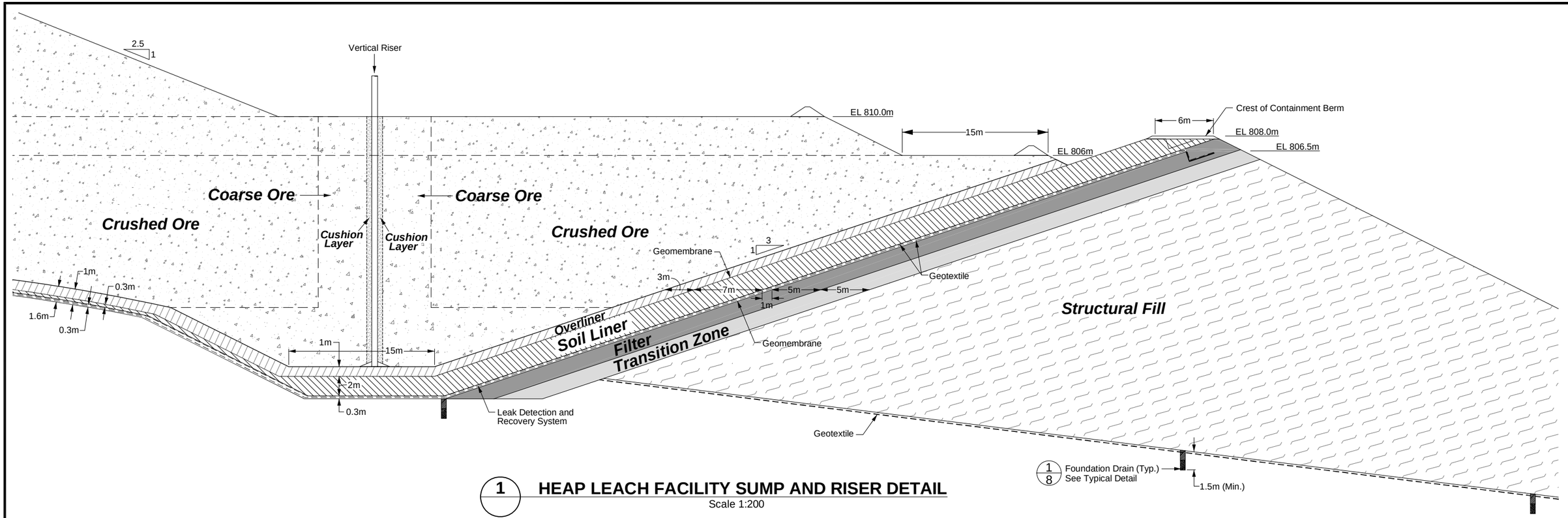
PROJECT
WESTERN COPPER CORPORATION
CARMACKS COPPER PROJECT
YUKON TERRITORY

TITLE
HEAP LEACH FACILITY PLAN

Golder Associates
Abbotsford, BC

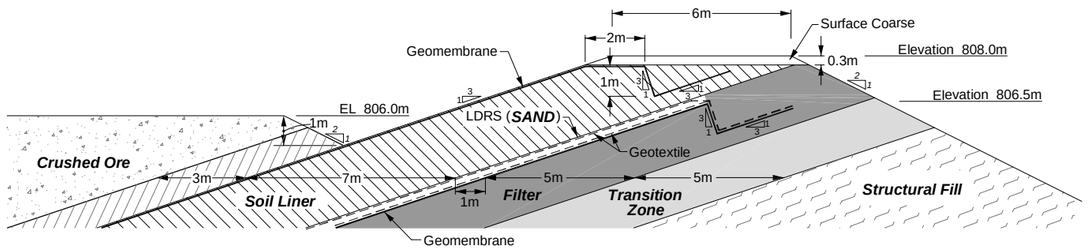
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CHECK	JH	Oct 29-09		
REVIEW	JAH	Oct 29/09		

FIGURE Q6



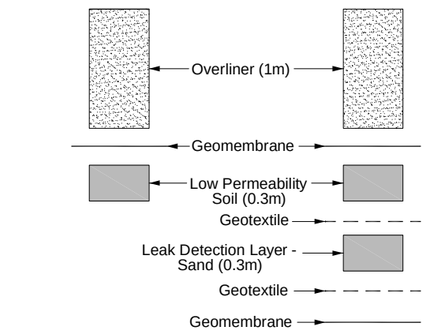
1 HEAP LEACH FACILITY SUMP AND RISER DETAIL

Scale 1:200



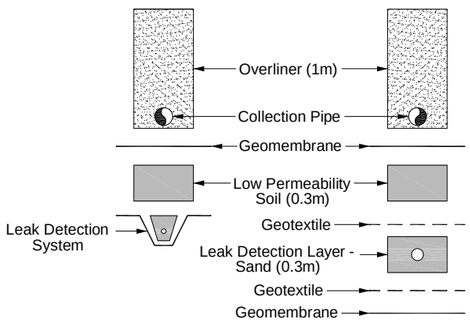
2 CONFINING EMBANKMENT CREST DETAIL

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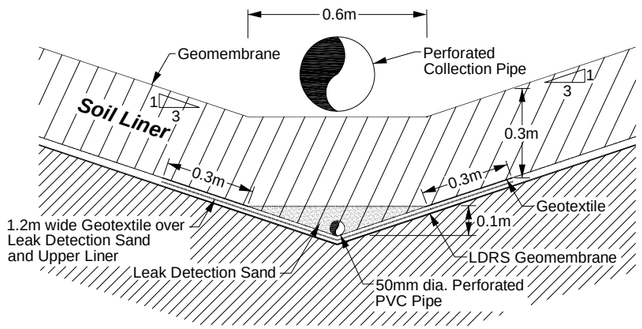
3 TYPICAL SECTION SHOWING LINER ARRANGEMENT

Scale 1:25



4 TYPICAL SECTION SHOWING LINER ARRANGEMENT BENEATH COLLECTION PIPING

Scale 1:25



5 TYPICAL LEAK DETECTION AND RECOVERY SYSTEM DETAIL

Scale 1:10

FOR DISCUSSION PURPOSES ONLY
NOT FOR CONSTRUCTION

PROJECT
WESTERN COPPER CORPORATION
CARMACKS COPPER PROJECT
YUKON TERRITORY

TITLE
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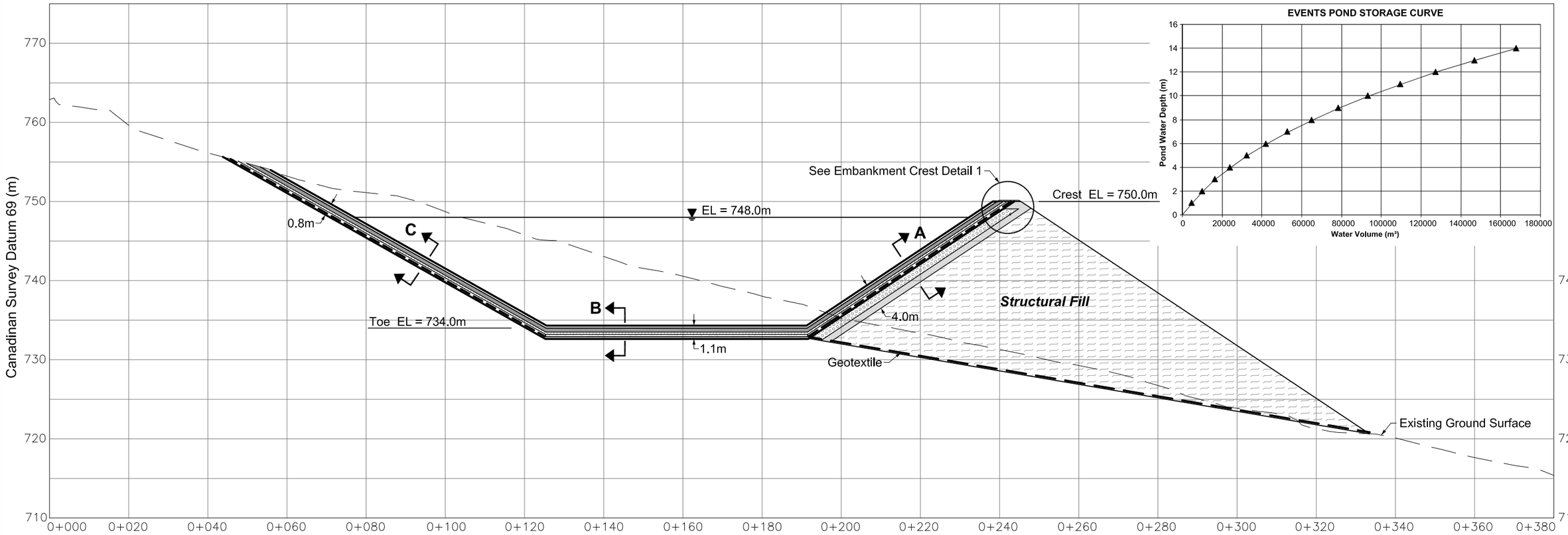
Golder Associates
Abbotsford, BC

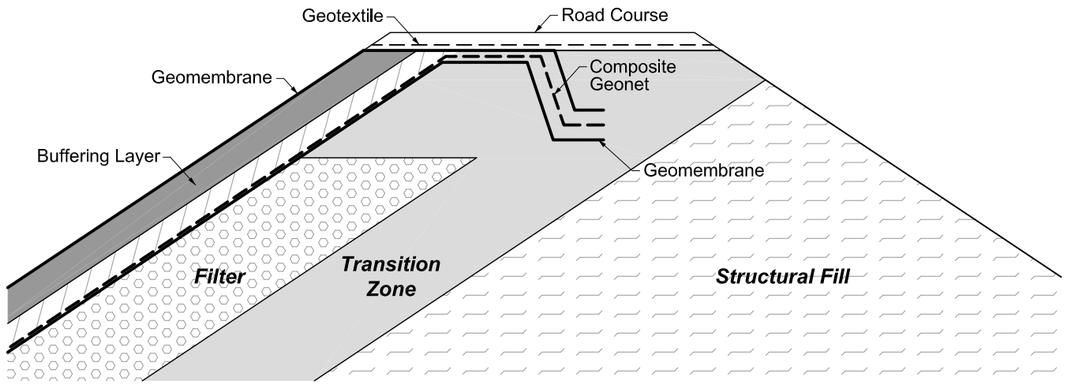
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CHECK				
REVIEW				

FIGURE 11

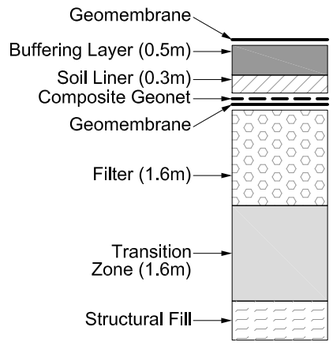
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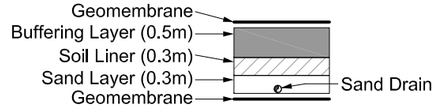




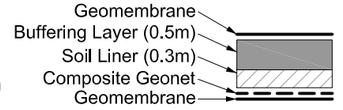
1 **EMBANKMENT CREST DETAIL**
See Detail Scale



A **TYPICAL SECTION**
Not to Scale



B **TYPICAL SECTION**
Not to Scale



C **TYPICAL SECTION**
Not to Scale

DRAFT - NOT FOR CONSTRUCTION
For Discussion Purposes Only

0 20
VERTICAL SCALE (m)

0 40
HORIZONTAL SCALE (m)

0 5
DETAIL SCALE (m)

PROJECT
WESTERN COPPER CORPORATION
CARMACKS COPPER PROJECT
YUKON TERRITORY

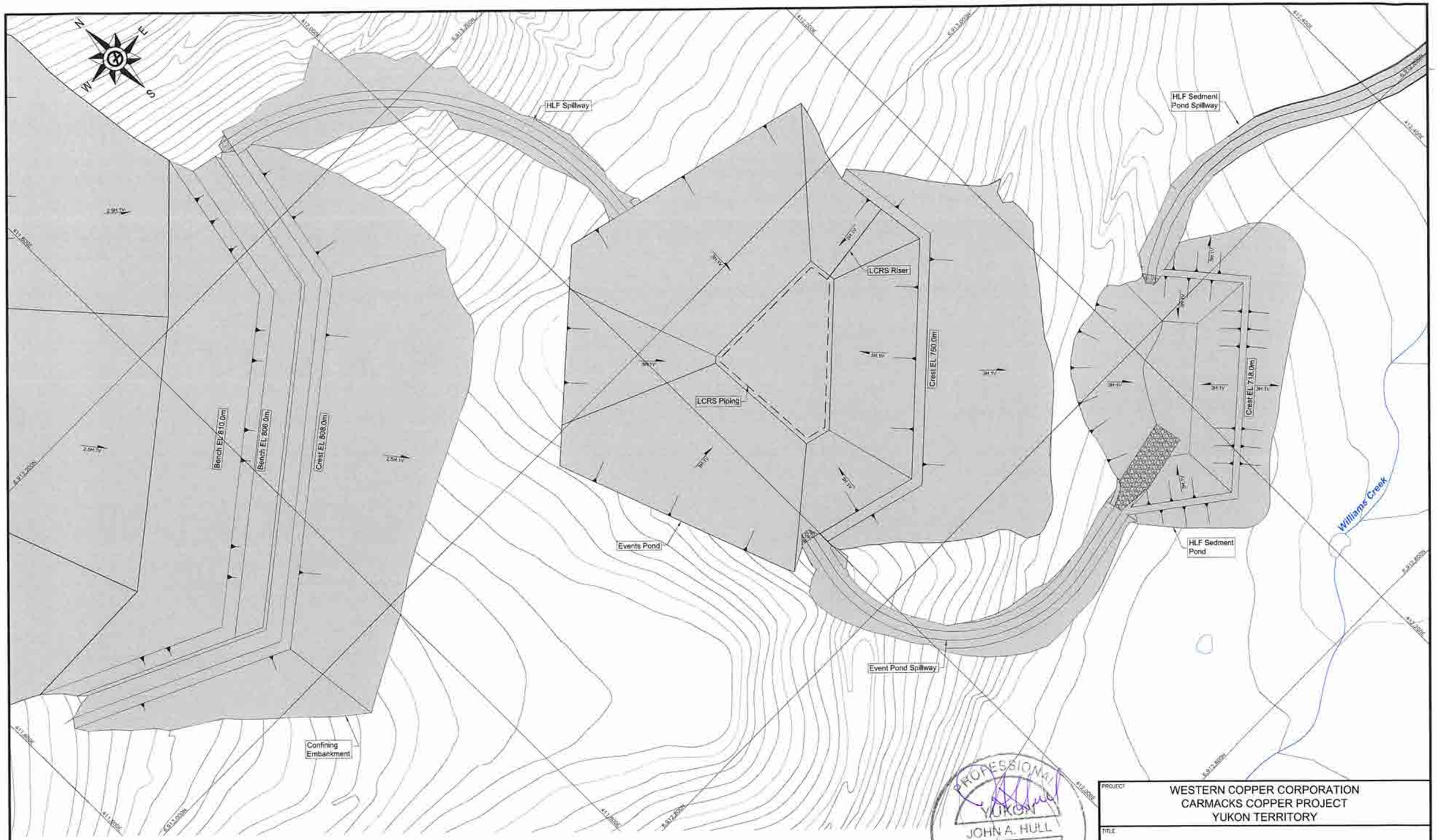
TITLE
EVENTS POND CROSS SECTION

Golder Associates
Abbotsford, BC

PROJECT No. 07-1413-0077			FILE No. Events Pond Section	
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CADD	D.T.	JAN-05-10		
CHECK				
REVIEW				

FIGURE 12A

N:\Active\Year 2007\1413\07-1413-0077 (Carmacks Copper)\DRAFTING\CAD\Presentation - 2010\ Drawing file: Event Pond Typical Section - 05Jan10.dwg Jan 06, 2010 - 2:43pm



NOTES

1.) Elevations Shown are in metres above Mean Sea Level.
2.) Grid Coordinates Shown in UTM NAD 83, Zone 8.
3.) Leak Detection and Recovery System (LDRS) not Shown for Clarity.
4.) Perimeter Ditches not Shown for Clarity.

REFERENCES

1.) Western Copper Corporation, CAD Survey Files: ndetail.dwg and sdetail.dwg, Received May 14th, 2008.
2.) M3 Engineering Ltd., CAD Files: 100-CI-010P5.dwg, Dated March 13th, 2008.
3.) Eagle Mapping Ltd., CAD Files: SH1-UTM.dwg to SH9-UTM.dwg, Dated November 1st, 2007.
4.) Western Copper Corporation, CAD File: End_Of_Yr_06.dwg, Dated March 30th, 2007.

DRAWING REDUCED

FOR DISCUSSION PURPOSES ONLY
NOT FOR CONSTRUCTION

PROFESSIONAL ENGINEER
YUKON TERRITORY
JOHN A. HULL
NOV 23/09

0 100
SCALE (m)

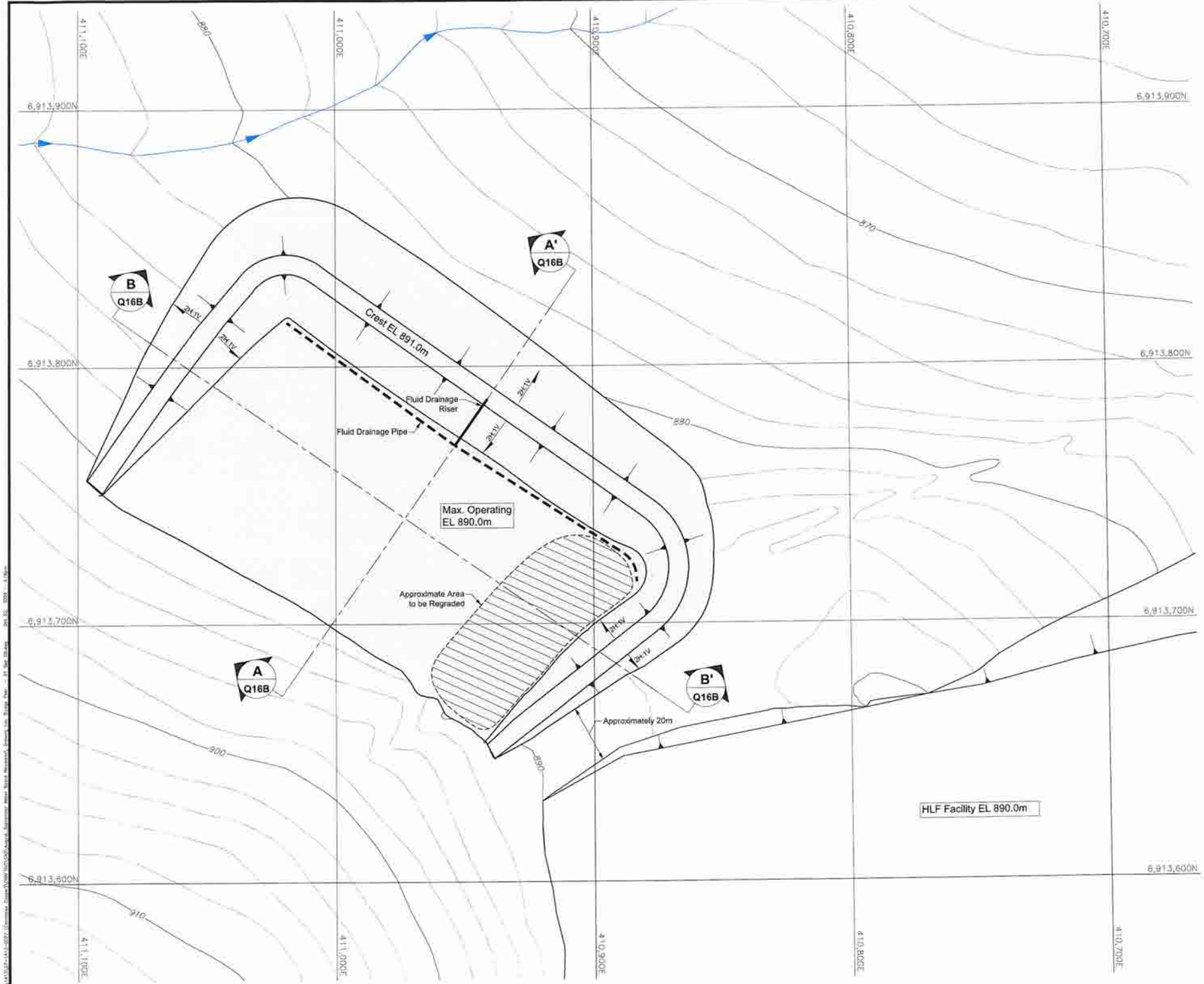
PROJECT: WESTERN COPPER CORPORATION
CARMACKS COPPER PROJECT
YUKON TERRITORY

TITLE: **EVENTS POND PLAN**

Golder Associates
Abbotsford, BC

PROJECT No. 07-1413-0077			FILE No.	-	
DESIGN	F.E.	23-NOV-09	SCALE AS SHOWN	REV.	0
CADD	D.T.	23-NOV-09			
CHECK	J.U	NOV. 09			
REVIEW	[illegible]	NOV 09			

FIGURE 11A



N
W E
S

PROFESSIONAL ENGINEER
YUKON TERRITORY
JOHN A. HULL
Oct 28/09

DRAWING REDUCED

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NOT FOR CONSTRUCTION

0 75
SCALE (m)

NOTES
1.) Elevations Shown are in metres above Mean Sea Level.
2.) Grid Coordinates Shown in UTM NAD 83, Zone 8.
3.) Perimeter Ditches not Shown for Clarity.

REFERENCES
1.) Western Copper Corporation, CAD Survey Files: ndetail.dwg and sdetail.dwg. Received May 14th, 2008.
2.) M3 Engineering Ltd., CAD Files: 100-CI-010P5.dwg, Dated March 13th, 2008.
3.) Eagle Mapping Ltd., CAD Files: SH1-UTM.dwg to SH9-UTM.dwg, Dated November 1st, 2007.
4.) Western Copper Corporation, CAD File: End_Of_Yr_06.dwg, Dated March 30th, 2007.

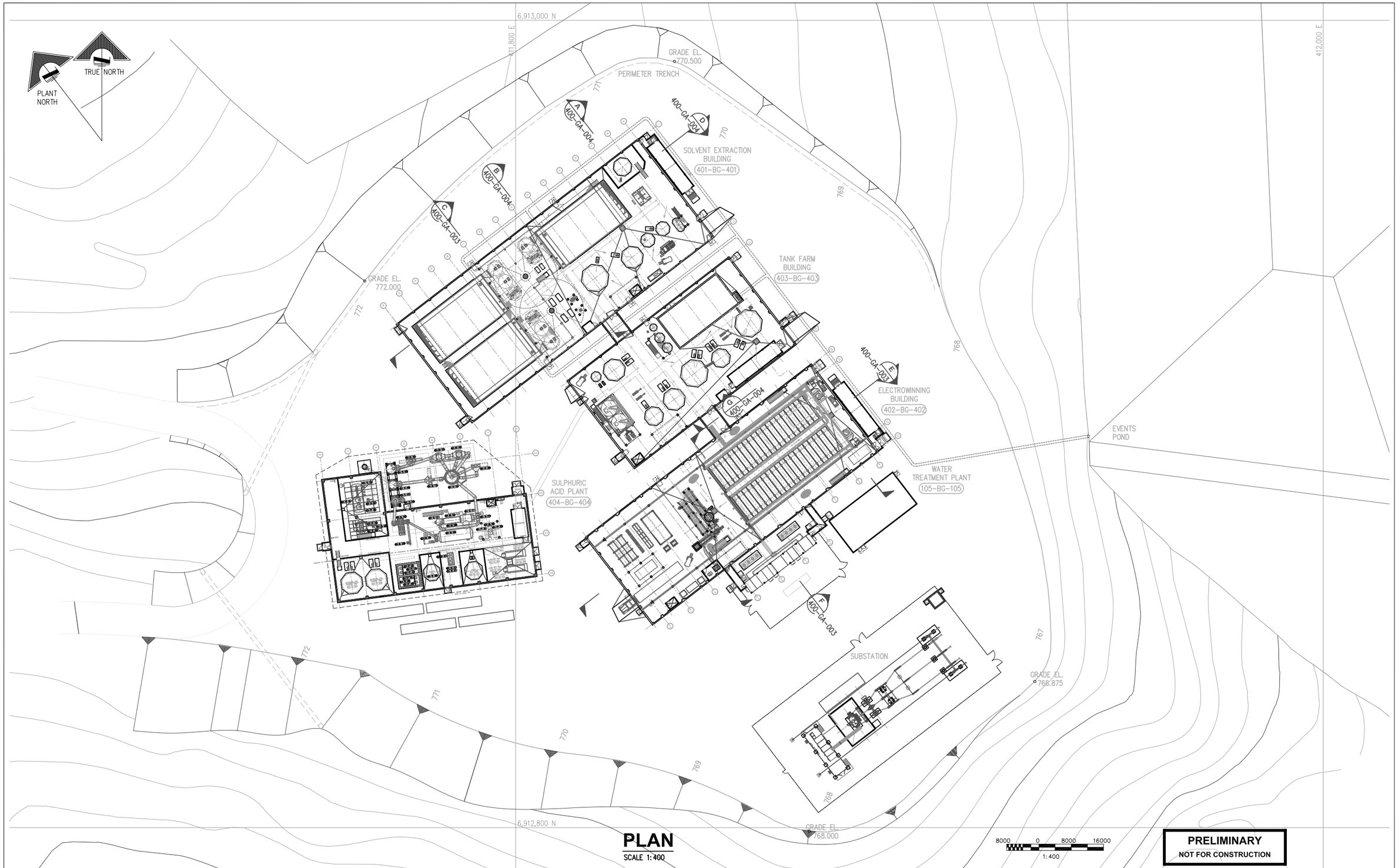
PROJECT
WESTERN COPPER CORPORATION
CARMACKS COPPER PROJECT
YUKON TERRITORY

TITLE
HLF SLUDGE CONTAINMENT PLAN

Golder Associates
Abbotsford, BC

PROJECT No. 07-1413-0077			PHASE 1000	TASK	
DESIGN	JH	Oct 20-09	FILE No:		Sludge Plan
CADD	D.T	SEP-02-09	SCALE AS SHOWN	REV.	0
CHECK	JH	Oct 24 09			
REVIEW	JH	Oct 09			

FIGURE Q16A



PLAN
SCALE 1: 400

PRELIMINARY
NOT FOR CONSTRUCTION

REFERENCES		REFERENCES	
DWG. NO.	TITLE	DWG. NO.	TITLE

REVISIONS					
NO.	DESCRIPTION	BY	APP'D	DATE	CLIENT

REVISIONS					
NO.	DESCRIPTION	BY	APP'D	DATE	CLIENT

PROGRESS PRINT

SCALE: 1: 400		DATE
DESIGNED BY	MD	JUN 07
DRAWN BY	MD	JUN 07
CHECKED BY		
PROJECT MGR		
CLIENT APPR.		

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WESTERN COPPER CORPORATION

CARMACKS COPPER PROJECT
SX-EW AREA
GENERAL ARRANGEMENT
SITE PLAN

JOB NO. M3-PN06192.01
DWG NO. **400-GA-001**
REV NO. P4
DATE 10 OCT 08

File: P:\2006\06192.01\GA\400-GA-001.dwg LAST UPDATE: OCT 10, 2008 @ 9:48 AM BY: md262 LAST REV: P1 PLOT SCALE: 1:25.4

Appendix E

Table 2

DRAFT

CARMACKS COPPER PROJECT RISK ANALYSIS - TABLE 2				
COMPONENT	**ID**	**PROJECT STAGE**	**FAILURE MODE**	**EFFECTS**
HEAP LEACH		**Pre-production, Operation & Closure**	**Inability to manage non-contact water around the heap**	Uncontrolled releases, sediment and metals exceeding MMER levels entering Williams Creek.
		Operation	**Overtopping prior to closure (poor management, precipitation greater than anticipated)**	Use of spillway, potential to exceed discharge limits, fines and mining shutdown.
		Operation	**Poor copper recovery**	Early mine shutdown based on economics.
		Operation & Closure	**Local community unrest (i.e. leading to operation disruption and/or property damage)**	Production temporarily halted, repairs required to damaged equipment, potential exceedance of downstream discharge limits.
		Operation & Closure	**Vandalism leading to solution release**	Solution release, contamination of Williams Creek, potential for mine shutdown.
		Closure	**Quantity of discharge from heap far exceeds predictions**	Elevated metal levels in heap discharge.
EVENTS POND		**Pre-production, Operation & Closure**	**Inability to manage non-contact water around the Events Pond**	Uncontrolled releases, sediment and metals exceeding MMER levels entering Williams Creek.
		Operation	**Overtopping prior to closure (poor management, precipitation greater than anticipated)**	Use of spillway, potential to exceed discharge limits, fines and mining shutdown.
HLF SEDIMENTS POND		**Pre-production, Operation & Closure**	**Inability to manage non-contact water around the HLF sediments pond**	Uncontrolled releases, sediment exceeding MMER levels entering Williams Creek.
		Operation	**Overtopping prior to closure (poor management, precipitation greater than anticipated)**	Use of spillway, potential to exceed discharge limits, fines and mining shutdown.
WASTE ROCK STORAGE AREA (WRSA)		**Operation & Closure**	**Toe drain not performing adequately leading to erosion**	Repair efforts required.

CARMACKS COPPER PROJECT RISK ANALYSIS - TABLE 2				
COMPONENT	**ID**	**PROJECT STAGE**	**FAILURE MODE**	**EFFECTS**
		Operation & Closure	**Collection ditches not performing adequately leading to erosion**	Repair efforts required.
WRSA SEDIMENTS POND		**Pre-production, Operation & Closure**	**Inability to manage non-contact water around the WRSA sediments pond**	Uncontrolled releases, sediment exceeding MMER levels entering Williams Creek
		Operation	**Overtopping prior to closure (poor management, precipitation greater than anticipated)**	Use of spillway, potential to exceed discharge limits, fines and mining shutdown.
SLUDGE CONTAINMENT AREA		**Operation**	**Storm larger than design occurs resulting in significant erosion. Inefficient management**	Potential for lost of power, uncontrolled sludge releases.
		Operation	**Overtopping prior to closure (poor management, precipitation greater than anticipated)**	Overtopping of pond embankment, potential for erosion.
		Operation & Closure	**Inability to manage non-contact water around the sludge containment area**	Overtopping of pond embankment. Potential for erosion.
		Closure	**Failure to place sludge on top of heap and facility decommission**	Change to closure planning and closure for sludge containment area.
OPEN PIT		**Operation**	**Inability to manage ground water and precipitation**	Operational delays and risk for personnel and equipment.
		Operation	**Inefficient management of ore v/s waste rock**	Potential for high metal levels in WRSA discharge.
		Closure	**Long term stability requirements not satisfied**	Potential for pit wall deformations or bench slope slumps.
TRUCK SHOP SERVICE COMPLEX		**Operation**	**Uncontrolled fire**	Operational details and potential fatality.
		Closure	**Failure to disassembly the truck shop leading to physical instability**	Change to closure plan and new approach required.

CARMACKS COPPER PROJECT RISK ANALYSIS - TABLE 2				
COMPONENT	**ID**	**PROJECT STAGE**	**FAILURE MODE**	**EFFECTS**
		Closure	**Failure to remove chemical hazards leading to contamination of surrounding soils**	Change to closure plan and new approach required.
CRUSHER		**Operation**	**Accident causing serious injuries or fatality**	Potential for operational delays, fatality and mine shutdown.
FUEL STORAGE		**Operation**	**Uncontrolled fire**	Potential for operational delays, fatality.
EXPLOSIVES STORAGE		**Operation**	**Nitrate Spill**	Potential for fatality and operational delays.
PLANT		**Operation**	**Power or other failure resulting in extended plant shutdown**	Potential for solution release exceeding MMER limits.
		Operation	**Uncontrolled fire**	Potential for operational delays, fatality and mine shutdown.
		Operation	**Failure of water treatment plant system**	Operational delays, non compliance.
		Closure	**Failure to disassembly the plant leading to physical instability**	Change to closure plan and new approach required.
		Closure	**Failure to remove chemical hazards leading to contamination of surrounding soils**	Change to closure plan and new approach required.
CAMP, OFFICES, HOSPITAL, GATE HOUSE		**Pre-production, Operation & Closure**	**Forrest uncontrolled fire**	Potential for fatality, operational delays or mine shutdown.
		Closure	**Failure to disassembly the camp leading to physical instability**	Change to closure plan and new approach required.

CARMACKS COPPER PROJECT RISK ANALYSIS - TABLE 2				
COMPONENT	**ID**	**PROJECT STAGE**	**FAILURE MODE**	**EFFECTS**
		Closure	**Failure to remove fuel or other wastes leading to contamination of surrounding soils**	Change to closure plan and new approach required.
SITE ACCESS ROAD		**Operation**	**Failure to implement erosion control measures leading to erosion and Williams Creek contamination**	Potential for fines and mine shutdown.
		Operation	**Mine access blocked**	Unable to access mine site. Inability to manage operations.
		Operation & Closure	**Accident on road resulting in reagent entering Merrice Creek or Williams Creek**	Covered in transportation plan.
		Operation & Closure	**Accident on road resulting in fatality**	Operational delays, potential for fines.

Western Copper Corporation

2009 ANNUAL QUARTZ MINING LICENCE REPORT

SUBMITTED TO YUKON GOVERNMENT, ENERGY MINES AND RESOURCES

YUKON QUARTZ MINING LICENCE QML-0007

Appendix J

J. Gadsby Letter Re: Suggestions for Consideration on the Project (January 2009)

John Gadsby P.Eng.
#8-737 Royal Place, Courtenay, BC, V9N 3R4,
Tel: 250 334 3031, email: jgadsby@telus.net

January 20, 2009

To: The Yukon Government
The Little Salmon Carmacks First Nation
The Selkirk First Nation
Western Copper Corporation
Natural Resources Canada

Carmacks Copper Project
Technical Workshop in Whitehorse - Tuesday January 13, 2009
Suggestions For Consideration on the Project

This letter is issued in advance of a document package that will contain notes on the discussions and the formal presentations. It summarizes my observations of the discussion and my suggestions for follow-up and actions.

Introduction

In response to an invitation from the Little Salmon Carmacks First Nation (email dated November 19, 2008 from Robert Moar) John Gadsby offered his availability and willingness to facilitate a technical meeting in Whitehorse concerning the proposed Carmacks Copper Project. A formal contract was issued by the Yukon Government to provide this service.

The purpose of the workshop was to consider the environmental/engineering aspects of the mine components contained within the mine-site area and which would remain post-closure of mining operations

The proposed Carmacks Copper Project is an open-pit mine with a planned 5 to 7 year operating mine life. The copper-oxide ore will be processed using acid heap leaching followed by an electrowinning process. The principal components remaining on the mine site after mine closure and decommissioning will be the open pit, the waste rock pile and the heap-leach pile. The proposed mine site will be situated on crown land for which Western Copper Corp has mineral claims to develop resources. The project is located within the traditional territories of both the Little Salmon Carmacks First Nation and Selkirk First Nation.

The meeting was held on the understanding that it was "without prejudice". This is a legal term that means: *"comments and information presented cannot be taken as the last work/word on the subject matter".*

The meeting commenced at 8.30 hrs and finished at 17.10 hrs.

The meeting consisted of prepared presentations by the Facilitator, The YG and Western Copper Corporation. Participants made their comments during the presentations and this was followed by a three–hour open discussion period.

Notes of the discussion were taken during the workshop. These notes will be sent out for comment to participants before being issued as a final document together with copies of the three presentations. The notes will simply serve as record of the discussion.

Presentations:

- **John Gadsby** presented a short overview of the development and evolution of the concept of "Designing and Operating for Mine Closure" and the importance of considering the total Mine-Life Cycle from exploration through to post-closure of mining operations for the design, management, operation and ultimate decommissioning of mining projects.

- **The Yukon Government** explained the regulatory process required in order that the proponent obtains the necessary permits for mining and processing. The YG will require reports and reviews during operations and commitments to decommission with the eventual return of the site to the Yukon Government

- **Western Copper Corporation** presented an overview of the preliminary closure and decommissioning plan, which had been submitted to the Yukon Government in late December 2008. These documents were forwarded to Little Salmon Carmacks First Nations and Selkirk First Nation for review and comments, which are due by January 30, 2009. Western Copper noted that the project is:

    - At the end of the detailed feasibility stage and entering the final design phase prior to site development leading into mining and processing operations:
    - Environmental monitoring, management, reporting and review work will be required from the site development period to some 15 years post-closure of operations in order to obtain efficiency for processing and meeting post-closure land-use objectives; and
    - Based upon current studies Western Copper expected that following decommissioning the site could be handed back to the YG without need for ongoing monitoring and maintenance - the ideal "walk-away" condition.

Discussion Period

From the discussion made by representatives for the First Nations, the Yukon Government, and Western Copper, I noted the following which I believe are key issues at this stage of the project review process:

- Carmacks Copper is the first proposed new mine to be taken through the Yukon Environmental Assessment and Socio-Economic Assessment Act (YESAA, 2005)

and the third application under the Mine Site Reclamation and Closure Policy and supporting financial assurance and technical guidelines.

- The Little Salmon First Nations are concerned that:
    - To date, the issues they have raised have not been adequately considered in the assessment process;
    - They would like a better understanding of how they can participate and the level of their participation in the ongoing YG review and licensing process; and
    - The documents they consider critical to their concerns will be readily accessible to them (i.e water use licence application, detailed technical designs etc.)

It is my view that the First Nations concerns can be separated into the need for more effective communication, between the FNs and the YG or WC and technical adequacy of the studies, particularly with respect to the post-closure condition of the heap-leach pad.

Communications

From the comments and verbal exchange between participants at the workshop, I consider it essential to improve methods of communicating between the key groups. This project is the first major mine application to proceed through YESAA and the subsequent regulatory processes. It provides an opportunity for all parties to be pro-active in their participation and communication methods.

I make the following suggestions:

- The YG as the lead agency should schedule and arrange more formal face-to-face meetings to exchange information during the review process. I understand that at present the YG relies upon email to advise First Nation's governments that their comments on being sought on a project. The documentation and decisions are posted on the YG/EMR web site to be accessed by the First Nation's governments;

- At the same time, when notification is received by the First Nations governments it is incumbent upon them to respond and advise if there is any information they require to participate. In the event that the First Nation government rejects the opportunity to participate it would be prudent for them to give their reasons;

- Similarly, I encourage formal invitations and acceptance between Western Copper and First Nations staff for specific meetings with pre-defined purposes and objectives of the meeting. As noted during the discussion period by Western Copper it would be advantageous for Western Copper and First Nations to

establish a small working group to plan these meetings and other joint activities; and

- Western Copper Corporation should install a library in its Whitehorse office containing their public report and pertinent reference material. The library can be accessed on request and should contain both hard copies and electronic files.

Technical Adequacy of the Design Studies

In the past ten years much progress has been made by the industry at large on the ability to predict future environmental impacts and the necessary mitigation strategies to minimize unacceptable environmental impacts. Research is continuing. Monitoring of operating mines as well as decommissioned and abandoned mines adds to the experience in planning and decommissioning new mines. However, it is important to recognise that the design, construction and ultimately the closure of mine structures: mine workings; waste rock piles; spent ore (heap leach pads) and tailings facilities, is an iterative process throughout the mine-life cycle. Modifications to the design and operating techniques may be necessary to accommodate not only changes in the physical methods to obtain the ore but also the characteristics of the ore. Consequently, the design is never completed until the structures reach their maximum size and the site is finally decommissioned and closed out. It is essential, therefore, that appropriate management and monitoring systems remain in effect throughout the mine life. In my view, this responsibility lies both with the mining company and the regulatory review system.

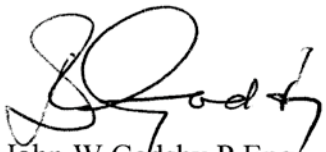
From the discussion in the workshop, Little Salmon Carmacks First Nation's concern is for closing down the site, specifically the heap leach pad, in a "walk-away" condition possibly at some 15 years after the closure of mining. Frequent monitoring, review and possible modifications to the process during the 5 to 6 year operating life will provide more information to identify contingencies, and if necessary modifications the process with the objective of achieving the walk-away condition. It would seem prudent, therefore, and in the interest of both Western Copper and the Regulator, that some contingency planning and alternative methods of decommissioning to reduce long-term risks be identified now as part of the review process.

To achieve this, I suggest that a Technical Advisory Committee (CCP-TAC) be formed in the immediate future to work with Western Copper to provide advice on which alternative closure technologies might be used and the associated contingency plans. The sole purpose of this committee would be to identify alternatives, consequences and risks. The final details for selection of any possible alternative conceptual closure plans would be the responsibility of Western Copper Corporation.

In addition I suggest that:

- This Technical Committee have one technical representative from the First Nations, the Yukon Government and Western Copper (i.e total of three members);
- The TAC should meet and document their findings no later than the end of February 2009; and
- Notwithstanding the need to minimize any conflict of interest, funding for TAC participation should be left for the parties to discuss and agree upon.

Respectfully submitted



John W Gadsby P.Eng

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