



**Western Copper
Corporation**

Project Proposal

**Carmacks Copper Project
Yukon Territory**

Appendix E5

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

Technical Memorandum

To: Jonathan Clegg, Western Copper
cc: Dan Cornett, Access Consulting Group
From: Rick Lawrence
Date: 13 May 2006
File No.
Subject: **Review of Documents and Meeting Notes related to
Mineralogy of Leach Residues - Carmacks Project**

As per your instructions, I have reviewed all the documents you sent to me and following are some comments regarding the potential acid generating characteristics of the leach residues from the Carmacks Project and the need for further testwork. In addition, I have made some comments and observations on some related matters discussed in the project meeting held in Whitehorse on March 1, 2006.

The documents provided to me by Dan Cornett were as follows:

- Detoxification and Rinsing Testwork Report; prepared for Western Silver Corporation Carmacks Copper Project by Alexco Resource Corp., January 2006.
- Carmacks Copper - Transcript of Technical Committee Meeting, held on 1 March 2006 in Whitehorse.
- Evaluation of the Mineralogy of a Sample of Carmacks Acid Leach Residue; report prepared for Kilborn Engineering Pacific Ltd. by R. Lawrence, University of British Columbia, May 31, 1996.
- Technical Paper - Overview of Gangue Mineralogy Issues in Oxide Copper Heap Leaching, Jansen, M. and Taylor, A. (ALTA Copper Conference, Perth, Australia, 2003).

After reviewing the current and previous reports on leach residues analyses, my overall opinion is that no further mineralogical testwork on the leach residues is required. The results of acid base accounting reported in the Alexco report show very low sulphide sulphur contents, including no evidence of residual elemental sulphur added at the start if the leach tests.

Concerns were expressed at the March 1 Whitehorse meeting that silicate weathering could contribute to acid generation from the leach residues in the long term. Although the regulators are diligent to ask the question, the Jansen and Taylor paper on the gangue mineralogy issue is a red herring with respect to the acid generation from the leach residues. I do not believe that such reactions, which may occur at rates measured on a geological time scale, will result in any generation of acidity that will be measurable on a practical time scale. The concern that the pH might go down to pH 4-5 is therefore unfounded. The pH drops at the end of the tests that were talked

about are simply the result of excess alkalinity being washed out and not due to acid generating reactions taking place in the solid phase. Benoit Godin wants to know what the equilibrium pH will be. This is a fair question from his perspective. This could be addressed by running the current column tests for a longer time period to plot the pH trend during washing. In any event, in the post closure period, the geochemistry of the covered pile will only get better. Oxygen ingress will diminish to very low levels at the cover-pile interface once vegetation has been established and the cover begins to perform as a store-release cover.

I therefore believe that the results of any additional XRD and other mineralogical analyses would be as inconclusive as they were found to be in the earlier UBC report and, if so, may do nothing to dispel the concerns expressed about the long term mineralogical and geochemical transformations and their effect on acid generation. On the other hand, if Environment Canada wishes to engage John Kwong to do a study, I would have no argument against this as I believe John could arrive at a similar conclusion and the matter can be laid to rest.

As a minor note, it was stated in the Transcript that “the ABA results show that rinsing was effective”. I would say that “the rinsing test results show rinsing was effective and the ABA data show that acid generation from further rock weathering will not occur”.

Some additional brief comments on the Alexco Report and the Transcript of the March 1st meeting are as follows:

1. The column rinse tests seemed to have been effective, although I might have done the procedure differently. I am not necessarily an expert on this matter but I feel that adding lime or soda ash so soon in the rinse cycle, when copper and other ion concentrations are still high, does not seem to be the optimum way to do it. Intuitively, the water wash should be continued until concentrations are lower to prevent significant metal precipitation into the heap. Copper concentrations declined in the wash tests due to this mechanism rather than being washed out/diluted as implied. This precipitation in the heap might be a long term environmental concern due to potential resolubilization of copper and presumably other heavy metals.
2. Related to the last point in (1), what will happen to the rinse water? This will contain copper and other cations. I understand that there are plans for a water treatment plant. Precipitating metals externally in a plant with controlled sludge containment is probably preferred to uncontrolled precipitation in the heap.
3. There was discussion about lime versus soda ash. The columns plugged with lime because it is a calcium-based reagent and therefore formed gypsum by reaction with sulphate. Soda ash is sodium-based, and therefore gypsum is not formed. It must be remembered that soda ash is much more expensive than lime. In any event, getting the concentrations of metals and sulphate lower before adding alkali will reduce costs

significantly. Incidentally, the higher residual sulphate concentration in Column 9 is because sulphate did not precipitate with the use of soda ash.

4. As a general comment, I think too much discussion was made of the small differences in the results for the 4 columns (resting vs non-resting, minor differences in metals and pH, etc etc). I think a lot of the remaining questions on the rinsing/detox/acid generation can be resolved with careful experimental planning in the current large scale testwork, once the leach cycle is complete.

Please let me know if you would like to discuss any of my comments or if I have omitted to address any other issues.



Rick Lawrence, PhD, PEng.