March 2017

Ajax Mine Application for Environmental Assessment Certificate/
Environmental Impact Statement

"Round 2" Working Group Comments from Ministry of Environment

This document contains a compilation of the "round 2" review comments that EAO received in memo or email format from the Ministry of Environment (MOE) during the review of the KGHM Ajax Mining Inc.'s (KAM's) Application for an Environmental Assessment Certificate / Environmental Impact Statement. For "round 2" comments received in tracking table format, please refer to the Working Group tracking table, located here:

https://projects.eao.gov.bc.ca/p/ajax-mine/docs?folder=231

For the purposes of documenting comments, EAO requires that the Proponent compile all written comments from Working Group members in a comment tracking table. The Proponent must provide responses to the Working Group submissions, in a table format or memo format as necessary, to EAO's satisfaction.

Ministry of Environment

Environmental Protection
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MEMORANDUM

To: **Peter Reid**
Principal
Stantec Consulting Ltd.
via email.

File: 44150-20\Ajax
Date: 7th July, 2016

From: Ralph Adams
Air Quality Meteorologist
Monitoring, Assessment, and Stewardship
Environmental Protection
Kamloops

RE: Approval of Modelling Addendum.

Dear Mr. Reid:

I have reviewed the Addendum Modelling Plan (addendum) that you supplied to BC EAO last week. The addendum was prepared by Stantec in response to a request for additional information relating to the dispersion modelling component of the KGHM-Ajax application dated April 28th, 2016. In particular it addressed the sensitivity of dispersion model output to mitigation levels, and the effect of non-varying emission rates on model output. A draft addendum was supplied to the BC EAO and others on 24th May, 2016. After a period of review, a conference call to discuss the addendum took place on June 20th, 2016. The participants included: Stantec, KGHM-Ajax, BC EAO, Environment Canada modelling teams, BC MoE modelling team, and SLR modellers. After those discussions a revised addendum was supplied to the BC EAO on June 23rd, 2016. The revised addendum was sent to all modelling teams for review on June 24th, 2016. Jason Reed of SLR responded to me on June 27th with two detailed questions. These were discussed on July 4th during a conference call between Stantec, KGHM-Ajax, and BC MoE. You followed up on July 5th with an email containing a detailed to response to one of Mr. Reed's questions.

It is my opinion that the proposed modelling and reanalysis of past modelling output described in the addendum will supply the information requested by the EAO. Please proceed with the proposed remodelling and analysis.

I would like to emphasize that the objective of the addendum is not to correct errors in the original modelling, but to supply information on the sensitivity of model output to mitigation levels and the use of constant emission factors. To supply this information, two specific examples have been selected: the haul roads will be used to assess model sensitivity to mitigation levels and the tailings impoundment to assess the effect of constant and time varying emission rates on model output.

In my review I have referred to two documents:

- A memorandum from Peter Reid and Reid Person (Stantec) to Nettie Ore (KGHM) dated June 23rd 2016, Stantec file #123510762, reference *Stantec Response to Request for Information EAO 004*. I refer to this document as the Addendum Modelling Plan or addendum.
- An email from Peter Reid to me dated July 5th, 2016 with Subject line *Addendum Model Plan: Wind Speed Threshold question.*

If you wish to discuss these requests in more detail please contact me directly.

Sincerely,

Ralph Adams

cc: Tracy James, BC Environmental Assessment Office, Victoria, BC.
Jason Reed, SLR International, Fort Collins, CO.
Brian Asher, Environment Canada, Winnipeg, MB.

MEMORANDUM

Ministry of Environment

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To: **Tracy James**
Project Assessment Manager
BC Environmental Assessment Office
via email

File: 44150-20 Ajax
Date: September 14, 2016

From: Ralph Adams
Air Quality Meteorologist
Monitoring Assessment and Stewardship
Environmental Protection

RE: Comments on KGHM-Ajax response to EAO information request of April 28th, 2016.

Dear Ms. James,

On 28th April, 2016 you sent a request for additional information to Nicola Banton with KGHM-Ajax Mine (KAM),your reference 299047. This request covers several issues. The approach to responding to some of these issues were subsequently included in a modelling addendum prepared by Stantec on behalf of KAM and which I approved in an memo to Mr. Peter Reid dated 7th July, 2016. The responses to these requests were supplied to the EAO as a series of technical memos from Stantec to KAM. The objective of this document is to supply my comments on the responses to the various sections of the request.

I have used the numbering in your information request to KAM of April 28th.

1 a. Mitigation Measures

This request was for information, for each emission source, on how KGHM plans to achieve the proposed levels of mitigation. In addition, examples of operating mines in similar geological and climatic zones should be included.

The response to this request is found in a technical memo from Peter Reid of Stantec to Nicola Banton of KAM dated May 30th, titled *Stantec Response to Request for Information EAO-001*. The requested information has not been supplied other than in very general terms. In the memo, references are made to two studies to support the feasibility of 90% dust mitigation on haul

roads. The first is a study conducted by Golder Associates for De Beers Mining.[1] The report describes a study where mitigation efficiency due to watering of haul roads was studied. The study included replicated measurements at two De Beers Diamond Mines: The Victor Mine in Northern Ontario, and the Snap Lake North East of Yellow Knife in the NWT. The results show that, at the Victor Mine, very high levels of mitigation (over 90%) could be achieved for up to 6 hours after watering. However, in the case of the Snap lake Mine, levels did not exceed 80% even shortly after watering. The conclusion of the report was:

> The results also indicate that 80% mitigation of road dust emissions can be achieved for 4 to 6 hours after water is applied to the haul roads.

The authors of the study also concluded:

> ...the study also found that the measured ground levels dust concentration is also strongly dependent of *sic.* ambient relative humidity.

In my opinion, the De Beers study does not supply evidence that 90% mitigation can be maintained at the proposed Ajax mine.
The second study cited to support the feasibility of 90% dust mitigation of haul roads was prepared for the California Air Resources Board.[2] I have been unable to locate a copy of the study, however the only references to the study I have been able to locate refer to a study of light duty trucks on unpaved roads. Not haul roads. Krysia Zurakowski of the BC EAO requested a copy of the study from KAM and was informed that a copy was not available and that it was information from a secondary source.
I do not believe that sufficient information has been supplied to complete your request 3a.

2 a. Monitoring and Verification

This request was for the proposed approach for monitoring results and verifying results. The request was also made for a conceptual contingency plan that outlines the approach the KAM would take in the event that the results were not being achieved and description of the proposed triggers that would initiate actions.
The responses to this request are found in a Fugitive Dust management Plan dated April 11th, 2016, and a technical memo from Peter Reid at Stantec to Nicola Banton at KAM dated May 30th 2016. The memo provides a good description of existing ambient monitoring, and makes suggestions for expansion of the system using additional meteorological towers and digital cameras. I agree with the information included in this section and it is in agreement with the discussions about ambient monitoring that have been ongoing between me and KAM for several years.[3] However, the request for discussion of trigger values and contingency plans and actions

[1] Golder Associates (2012) Determination of Natural Winter Mitigation of Road Dust Emissions from Mining Operations in Northern Canada. Report Number 11-1365-0012-6050/DCN-091.

[2] Flocchini, R.G., Cahill, R.T. Matsamura, O. Caracho, and Z. Q. Lu, 1994. Evaluation of the Emissions of PM_{10} particulates from Unpaved Roads in the San Joaquin valley. Final Report prepared for the San Joaquin valley Unified Air Pollution Control District, US.EPA, and California Air Resources Board, April, 1994, 61p.

[3] In my opinion, the final monitoring system would need to include continuous dust monitors associated with each of the major sources.

is not included in the response. It is suggested by the proponent that this will be completed during permitting.

3 Air Dispersion Model

Requests for information in section 3 *Air Dispersion Model* required an Addendum Modelling Plan developed by Stantec in consultation with the EAO to deal with request (3a, 3c). The results of the modelling described in the Addendum Modelling plan are presented in a memo *Stantec Response to Request for Information EAO 004*. The response to other request was through a series of technical memos prepared by Stantec. Request 3d was responded to in the memo *Stantec Response to to Request for Information EAO 005*. Request 3e was responded to in the memo *Stantec Response to to Request for Information EAO 006*.

3a. Sensitivity to mitigation efficiency

The information requested was supplied. The addendum modelling plan was followed. No additional information is required to continue review.

3b. Inclusion of mitigation sensitivity in the assessment of other valued components

I have not been able to locate a response to this request in the information I have reviewed. I note that in a memo dated July 27th from ERM to KAM with the tile *Ajax Project - Summary of Round 1 Technical Working Group Comments and Responses - Air Quality* the author states:

> As part of Round 2 review / response, following receipt of feedback from technical reviewers, KAM anticipates running an additional air quality modelling scenario. . .

I assume that this is the response to request 3b. If this is accepted by EAO, I would recommend that another modelling workshop be held where the various modelling groups could discuss the implications of the numerous changes that have been made and determine the details of the additional modelling run before it is completed. This includes the information that has been presented in response to requests 3a and 3c.

3c. Effect of constant and time varying emission factors on model output

The information requested was supplied. The addendum modelling plan was followed. No additional information is required to continue review.

3d. Relative contribution of various sources to modelled ambient levels

The information requested was supplied. The pie-charts and table supplied in memo *Stantec Response to to Request for Information EAO 005*. I require clarification on one point. Are the values shown those from the original modelling and submission, or do they include the changes recently made to the blasting emission factors and the haul roads?

3e. Choice of worst-case operational year.

The information requested was supplied in the memo *Stantec Response to to Request for Information EAO 006* . I have read the information and it appears correct and supports the choice of years 4 and 8 as the worst case years. However, I cannot offer an expert opinion as this is outside my area of expertise. This data should be reviewed by a member of the working group with expertise in mine operations.

Summary and Recommendations

The information that was not included in the KAM response to your request for information dated April 28th were those related to request 1a, 2a, and 3b.

1a. Mitigation Measures

Importance to EAO: The mitigations measures applied to all sources and the confidence in meeting those levels are important in determining the confidence in the dispersion modelling outputs. Without the evidence to support the mitigation levels used in the modelling, the confidence in the model output decreases.
Recommendation: Given the work that has been done on this question, my conclusion is that there is no additional evidence to support the mitigation levels used on the haul roads in particular, and the TSF to a lesser extent. The review of the modelling should continue without this information.

2a. Monitoring and Verification

Importance to EAO: Due to the low confidence in the mitigation levels used in the modelling (see above); the methods used to monitor dust and to control dust become more important. KAM has declined to supply detailed information, suggesting that it be delayed until the permitting process as would normally be done in mine applications. Due to the special circumstances of the proposed Ajax mine, this may not be acceptable. In my opinion, for the reasons discussed above, the feasibility of the mine rather than the details are operation require detailed information regarding the proposed monitoring and dust control plans.
Recommendation: Much work has already been completed on the dust monitoring component; this should be expanded to the dust control component. This will require input from EAO, MOE and other stakeholders. The outline of the plan including trigger levels and proactive rather than reactive dust control measures should be prepared in conjunction with finalisation of the dispersion modelling outputs.

3b. Inclusion of mitigation sensitivity in the assessment of other valued components

Importance to EAO: It is critical for the reviewers of the dispersion modelling component of the application to supply conclusions regarding their confidence in the model output to the other

disciplines using those data. As well as the issue of sensitivity to mitigation levels, the numerous incremental changes in the proposed sources and emission factors over the last months make a review of the exiting model output critical.

Recommendation: I suggest that another modelling workshop be convened to discuss all the changes and allow the EAO and reviewers of the dispersion modelling to reach consensus on next steps. As discussed above KAM has suggested a final modelling run to include all changes. The workshop would result in another modelling addendum that includes all the required changes.

Sincerely

Ralph Adams

(250) 371-6279

cc: Brian Herbert, Senior Project Manager, Environmental Protection Division

MEMORANDUM

Ministry of Environment

Environmental Protection Division
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To: **David Angus**
Project Assessment Officer
Environmental Assessment Office
via email

File: KGHM-Ajax Mine
Date: January 17, 2017

From: Ralph Adams
Air Quality Meteorologist
Monitoring Assessment and Stewardship
Environmental Protection

RE: Request for Working Group input on batch 3 responses.

Dear Mr. Angus

In your email of December 12th, 2016 you asked for my comments on several responses included in the batch 3 responses from the proponent. I have reviewed those responses related to air quality and dispersion modelling and I find that in all cases I consider the proponents response adequate and no further information is required in order for my review to proceed. I do note that in several cases there will be additional work required during later stages of the review and permitting. In the case of comment COK-SLR 801.1 I thought I should explain my opinion. This comment from SLR via the City of Kamloops concerns the use of data from the Walloper Road weather station operated by the BC Ministry of Highways. on the Coquihalla Highway. The station is near the southern limit of the modelling domain and was specifically included in the original Levelton CALMET modelling at my request. The reason for including the station is that it supplies valuable information to the CALMET modelling system on the plateau to the South of Kamloops.
SLR has raised concerns that these data are anomalously high during the first

half of 2003 compared to the other surface stations and if the high precipitation data are incorrect, this would lead to an over-estimate of dust deposition and an underestimate of ambient particulate concentrations. The reason for this is that the CALMET model includes algorithms to account for wet deposition. In wet deposition, precipitation falling though the atmosphere removes particles from the atmosphere and these are deposited on the surface; hence dust deposition is increased and some of the particulate matter is removed from the air decreasing ambient concentrations.

The anomaly in the first half of 2003 in the Walloper station was noted very early in the project and SLR are correct that the Detailed Modelling plan from 2015 does state that the data would not be used in the CALMET model runs (the data other than precipitation was to be used)[1]. As SLR has noted this was not done and in the final modelling results the CALMET model was run with the anomalous included.

It is not clear if this was simply an error in that an incorrect file was used, or if a decision was made after the modelling plan was approved to include the anomalous data, I can find no record of this being discussed with the Ministry.

The question then is whether the proponent should be required to rerun the CALMET model with the Walloper precipitation data removed. If this were required it would then require that CALPUFF and other models (such as the HHERA models) be redone. This would require an enormous amount of work and result in substantial delays and should only be required if the inclusion of the anomalous precipitation data is expected to result in significant errors in the model output. I do not think this is the case for the following reasons:

- The dust deposition rate would be expected increase, this is conservative. However when tests were conducted by Stantec while developing the modelling plan they found that deposition rates remained largely unchanged.

- Ambient particulate concentrations would be expected to decrease due to the increase in deposition, this is not conservative. However, when this was tested by Stantec during development of the modelling plan the effects were small, on the order of 0.1 to 1%. These are very small effects and can be considered as part of the expected uncertainty in the model output.

[1] Ajax Mining Project Detailed Model Plan p. 4.9

- There are already large uncertainties in the model output due to the known uncertainties in the use of a very complex dispersion models, but also due to uncertainties in the value and method of application of the emission rates for the various sources. Any errors due to the inclusion of the anomalous precipitation data are likely to be insignificant compared to these uncertainties.

- I have discussed this issue with my colleagues in both the BC Ministry of Environment and Environment Canada. The consensus is that the errors due to the inclusion of the anomalous precipitation data should be very small, in particular in the area of most concern, within a few kilometres of the northern boundary of the proposed mine site.

For these reasons I do not think it necessary to require the CALMET and other models be run again with the anomalous Walloper precipitation data removed.
Sincerely,

Ralph Adams

(250) 371-6279

cc:Brian Herbert, Senior Project Manager, Environmental Protection Division, BC Ministry of Environment.

Zurakowski, Krysia EAO:EX

From: Adams, Ralph ENV:EX
Sent: Friday, October 14, 2016 2:19 PM
To: James, Tracy A EAO:EX; Zurakowski, Krysia EAO:EX; Herbert, Brian ENV:EX
Cc: Matscha, Gabriele ENV:EX; Merkulova, Lyudmila ENV:EX; Bruce Carmichael

Subject: Size of particle assumed in Calpuff deposition modelling of proposed Ajax Mine.

Follow Up Flag: Follow up
Flag Status: Flagged

In September, the question was posed by the impact biologists reviewing the water quality modelling that is part of the Ajax mine proposal, as to what the size range of deposited particles are modelled. I am sorry this took so long to answer, but as you will see, although the answer is simple, it took considerable work to determine what the implications to the water quality modelling results are.

The simple answer supplied by Stantec was that the maximum particle size modelled is 30 micrometres. That is correct, although some would argue that 40 micrometers may be more appropriate.

Now for the rest of the story. You may recall that during the meeting where this was discussed I made the comment that this may simply be a semantic argument about the definition of Total Suspended Particulate Matter (TSP) , and Peter Reid responded that it was probably to do with the efficiency curves of hi-vols (Andersen high volume samplers). It turns out that we were both right.

- The EPA AP-42 chapters 11 and 13 supply emission factor formulae for the fugitive sources used in the Ajax modelling. The formulae supply factors for three size classes of particulate matter: PM2.5, PM10 and TSP. The notation PMx refers to all particles with a diameter less than x. Note that TSP includes PM10 and PM2.5, and PM10 includes PM2.5.

- The definition of TSP is that it constitutes particles that, once entrained, will remain suspended for a considerable time which allows them to be transported over large distances (PM2.5 easily travels around an entire hemisphere). Unfortunately, there is not a universally accepted definition of the upper size limit of TSP. In the BC modelling guidelines we use a definition of 40 micrometres, but in much of the EPA guidance documentation they refer to an upper size of 30 micrometres.

- Even the size of a particle is a rather abstract concept. Most particles in the air are not spherical and are often in the form of plates, rods or irregular aglomerations of smaller particles. The size referred to in modelling and the emission factors is the equivalent aerodynamic diameter. This is defined as the diameter of a spherical particle, with a density equal to that of water, that behaves the same way in air as the particle in question. Or to be more precise, have the same Stokes coefficient, which tells you about the behaviour of a spherical particle of known density falling, under gravity, through a fluid of know viscosity).

- The instruments that we use to measure PM in the atmosphere usually use size selective inlets which allow only particles less than a specified equivalent aerodynamic diameter to pass. The size which is allowed to pass through is referred to as the cut-point. However, the cut-point is not perfect. Some particles less than the cut-point will be eliminated, and some particles larger than the cut-point will pass through the inlet. The cut-point is defined as the diameter where 50% of particles of that size pass through the inlet. A perfect instrument would show a step-change from 100% to 0% at the desired diameter. But the instruments we now have are not perfect, and in particular the older instruments have rather poor efficiency curves. In practice this means that if

you were to examine the particles that pass through an inlet, you would find that particles larger than the cut-point had passed through, and that some particles smaller than the cut-point had been eliminated.

- There is also a distinction made in some EPA documents between suspended particulate (SP) and TSP. SP is defined as PM30 (all particles with an effective aerodynamic diameter less than 30 micrometres), but TSP is defined as the mass concentration of particles that would be measured by the instrument that has a nominal 30 micrometer cut-point (in other words it is based not on effective diameter, but on the actual particles collected by the sampler). The instruments that were used to develop the fugitive dust emissions factors were hi-volume samplers that had particularly poor efficiency curves, and under some conditions such as high wind-speeds could include a significant proportion of particles greater than 30 micrometers in size.

As you can see, there are three areas of uncertainty, the definition of TSP, the fact that particles are not spheres with the density of water, and the errors of the instruments used to measure TSP. Given these uncertainties, this is my summary of the implications for your evaluation of the water quality modelling results.

The CALPUFF model assumes that particles that it transports are 30 micrometers or less in size. The model includes parameterisations of the physical deposition processes which include both wet deposition (removal by precipitation) and dry deposition (collision with a surface of specified aerodynamic roughness). Particles of difference sizes are removed from the plume at different rates. The model assumes that the particles have unity density (that is the density of water). This is usually an underestimate. The effect would be conservative at longer distances, that is particles would be transported farther before deposition.

The assumption is made in both the model parameterisation, and the emission factors due to the way they were developed, that particles greater than 30 or 40 micrometers in effective aerodynamic diameter are not transported. Another way of stating this is that although larger particles can be emitted or entrained by wind, they will settle so rapidly that they are not considered in the dispersion modelling. I have not been able to locate any information or research on the ranges of distances that these particles (which are not included in the modelling) would be transported. It would clearly be strongly related to windspeed. The greater the windspeed, the farther a particle would be transported before settling out of the plume under the influence of gravity. The numbers I have heard over the years are on the order of ten to a few hundred metres.

Given that the high-winds required to entrain, and then transport, these larger particles are relatively infrequent, and the events are short-lived, I think it unlikely that they would result in a significant contribution to total deposition after the first hundred metres of so from a source. I have no information on which to offer an opinion on deposition at shorter distances.

During the discussion we had last month, Bruce Carmichael also asked what my opinion was of the assumptions made in the water-quality model that: all deposition within 50 metres of a water-body would be transported to the water-body, and that 100% of the deposited dust would dissolve in the water-body. This is outside my area of expertise, but based on first principles and conversations I have had with my colleagues, the consensus was that these assumptions would supply very conservation estimates of the contribution of dust deposition to water quality.

Regards,

Ralph Adams - Air Quality Meteorologist
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Zurakowski, Krysia EAO:EX

From: Merkulova, Lyudmila ENV:EX
Sent: Thursday, August 25, 2016 8:50 AM
To: Zurakowski, Krysia EAO:EX
Cc: Herbert, Brian ENV:EX; Doll, Andrea ENV:EX
Subject: Comments to Round 1 responses - MOE 083

Follow Up Flag: Follow up
Flag Status: Flagged

Categories: Round 2 comment

Hi Krysia,

Please see below my comments/questions to the response of the proponent to the request for information MOE – 083 (blasting EFs error):

In memo 0705_KAM_Revised Project Alone Case Dispersion Modelling the proponent provided revised 24-hr and annual predicted concentrations of TSP, PM10, PM2.5, dustfall and other COC resulting from modelling re-run with revised emission factors from blasting and updated haul truck engine horsepower including Annual Tailings Storage Facility emissions.

- It's unclear whether revised emission factors (daily constant and time varying) for TSF have been included for modelling the revised 24 hr predicted concentrations. Clarification is required. If not included please present the results of 24 hr predicted concentrations for TSP, PM10, PM2.5 and dustfall with revised emission factors for TSF, blasting and haul truck engine power.
    - **To EAO**: this information may be important due to the fact that additional emission load may change the 24 hr predicted concentrations (the updated results increased by 9% for PM2.5). HHERA and potentially water quality group should be informed accordingly.
- How have the 1-hr particulate concentrations changed based on revised EFs for blasting, haul truck engine horsepower and TSF time-varying EFs for project alone case (1 hour with emissions from blasting and the rest of the day without this activity).
    - **To EAO**: the revised 1-hr predicted particulate concentrations have not been presented in the response to MOE 083. However, in Integrated Summary Memo – Air Quality, dated July 27 on p.5 it was noted that the increase in revised predicted 1 hr concentrations resulting from TSF time-varying emissions is substantial. Although there are no objectives for 1hr concentrations for particulate matter, an increase in 1-hr PM concentration resulting from the change in emissions not solely from TSF but from other sources as well may be significant and HHERA and water quality group should be informed accordingly.
- Were surface water quality modelling results revised based on the updated dust load?
    - **To EAO**: please see explanation above.

Responses to the other requests MOE 080, 081, 082 are acceptable.

Thanks,
Luda

Lyudmila Merkulova
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May 16, 2016 File: Ajax Project - KAM

Tracy James
Project Assessment Manager
Environmental Assessment Office
2nd Floor 836 Yates St
Victoria BC V8W 1L8

Dear Tracy:

RE: Ajax Mine Project – Ministry of Environment Review of Responses to Round 1 Comments and Round 2 Comments

INTRODUCTION

I have reviewed the information, on behalf of Ministry of Environment (MOE), as provided by KGHM Ajax Mining Inc. (KAM) in response to my Round 1 comments related to surface water hydrology for the Ajax Mine Project (the project) Environmental Assessment (EA) Application.

The following documents formed the basis of my review:

- Comment tracking table entitled "WG ITT (MASTER_21-Apr-2016).xlsx"
- BGC memo (BGC-010, 0412_KAM_Surface Water) entitled "*Ajax Project Environmental Assessment Certificate Application/Environmental Impact Statement for a Comprehensive Study – Responses to Information Requests from COK, MOE and SSN*" (BGC, April 12 2016)

The first part of the memo summarizes my review of the responses by KAM for the Round 1 comments. My evaluation outlines where the response provided is adequate to resolve the identified issue and where additional information/clarification is required for the environmental assessment and/or permitting. Each response is identified by the comment Identification (ID) number as provided by KAM in the comment tracking table.

The second part of the memo includes additional comments related to surface water quantity and water management design. The Round 2 comments are as a result of the sub-Working Group (WG) meeting held on April 6, 2016 and additional review of the EA application.

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KAM RESPONSES TO MOE ROUND 1 COMMENTS – APRIL 21, 2016

MOE-001

Thank you for the clarification, the response is adequate to address the comment for the EA. However, the current hydrometric data collection at the project site does not meet the minimum standard of practice expected by MOE, as outlined in Manual of British Columbia Hydrometric Standards – Version 1.0 (RISC, 2009).

While some components of the program do meet expected RISC standards, others do not. For example, all data grades require at least 1 (or more) benchmark level surveys conducted per year; however, none of the project site stations meet this minimum standard as no benchmark surveys were reported to be conducted in 2014, while only periodic surveys are reported between 2008-2011.

The current hydrometric data collection program will not be sufficient in the permitting phase for long-term monitoring at the project site. MOE recommends that ongoing data collection programs be designed and implemented with the intent of achieving at least the Grade B data grade. In the permit application, MOE will also require the hydrometric data to be graded and a discussion of quality and accuracy included in the data analysis. [EA Comment Closed, Permitting Requirement]

MOE-002

The response is adequate to address the comment for the EA. MOE appreciates the clarification that the 2014 rating curve for JACINF was applied to the 2008-2011 stage record to produce an updated measured streamflow record for the open water months (May to October). [EA Comment Closed]

MOE-003

The response does not address the comment and further information is requested. Error values presented in the response memo BGC-010 (Table SSN.318-3) appear to be out by an order of magnitude. In the follow up response, MOE requests that the "error" for each measured point on the rating curve for each station be defined based on the RISC hydrometric standards (2009), as follows:

$$\frac{Measured\ discharge - Rating\ Curve\ discharge}{Rating\ Curve\ discharge}\ x\ 100\%$$

The average of the error values is defined as the "average" error of the curve and the standard deviation of the error values is the "standard" error of the curve. This gives an indication of how well the rating curve(s) fit the measured discharge points. For example according to RISC (2009), a discharge rating accuracy (average error) of less than 7% is rated as a Grade A level of data quality. **[EA Information Request Outstanding]**

MOE-004

Thank you for the clarification, the response is adequate to address the comment for the EA. However, as discussed in the response to comment MOE-001, annual benchmark surveys of the staff gauge(s) relative to the station benchmark(s) are required to achieve the minimum expected standard of data collection of Grade B, according to the RISC hydrometric standards (2009). MOE will request in the permitting phase that the ongoing long-term monitoring program will be developed to include surveys of the staff gauges relative to station benchmarks at least one per season. [EA Comment Closed, Permitting Requirement]

MOE-005

Thank you for the clarification, no further action required. It is recommended for future reporting that the annual average potential evapotranspiration value be based on the sum of the average monthly values, rather than presenting monthly and annual values that are based on different years of record. [EA Comment Closed]

MOE-006

Comment, no further action required. [EA Comment Closed]

MOE-007

No response was provided to address this comment; therefore this comment is still outstanding. **[EA Information Request Outstanding]**

MOE-008

Thank you for the clarification, no further action required. [EA Comment Closed]

MOE-009

The response is adequate to address the comment in terms of the water balance model for the EA. MOE acknowledges the minimal effect the updated variable potential evapotranspiration (PET) record has on the corresponding runoff predictions in the water balance model and that the updated methodology will be applied to the water balance in the permitting phase. However, the water quality predictions are likely more sensitive to evaporative losses from open water surfaces; therefore MOE requires that the updated potential evapotranspiration (PET) record (1897-2011) be used as an input to the water quality model in the EA. Also, refer to the Round 2 comments included in this memo for an additional information request related to inclusion of evaporative losses from the Peterson Creek Downstream Pond (PDCP) in the water quality model. **[EA Information Request Outstanding]**

MOE-010

Comment, no further action required. [EA Comment Closed]

MOE-011

No response was provided to address this comment; therefore this comment is still outstanding. MOE acknowledges that a climate change scenario for the water balance was introduced to the WG during the sub-WG meeting on April 6, 2016. MOE requests KAM prepare a memo to describe the assumptions for the climate change scenario for the water balance and the resulting streamflow predictions for the EA. The memo should provide a comparison of the predicted streamflow results for the climate change scenario to the variable climate case (VCC) scenario (Table 8-1, Appendix 6.4-C) and include a discussion of the monthly variability in streamflow predictions under each model scenario.

At this time, MOE does not necessitate the water quality model to be run for the climate change scenario if it can be demonstrated that the variability in the climate change scenario streamflow results are predicted to be within the flow range previously captured by the variable climate case water balance. **[EA Information Request Outstanding]**

MOE-012

Thank you for completing the lake level fluctuations for Jacko Lake. The information provided in the response quantifies the changes to Jacko Lake levels, however does not include a discussion of the residual effects on surface water quantity (Chapter 6.4), as requested in the original comment. The lake level fluctuations in Jacko Lake during the project phases also influence other Valued Components (VC) in the application and there was no indication in the response if KAM intends to update the EA to evaluate how the Jacko Lake fluctuations will impact these VCs. **[EA Information Request Outstanding]**

MOE-013

Thank you for the clarification, the response is adequate to address the comment for the EA. [EA Comment Closed]

MOE ROUND 2 COMMENTS

Probable Maximum Precipitation (PMP) and Probable Maximum Flood (PMF) estimates

There are noted discrepancies in the EA application for the PMF analyses, as highlighted in comments by SSN (SSN-343 and SNN-344). KAM's responses to the SNN comments does not explain what constitutes the "more recent submissions" and does not provide references to the EA application. For example, the Jacko Lake PMF volume is stated in various sections of the EA as follows, based on the 24-hr Probable Maximum Precipitation (PMP):

- Chapter 11.7, Section 11.7.3.3, PMF volume = 580,000 m^3
- Appendix 3-F, PMF volume = 800,000 m^3
- Appendix 17.4-D, PMF volume = 9,650,000 m^3

MOE requests clarification on the PMP estimate and resulting PMF analysis for the Jacko Lake dams and the Peterson Creek Downstream Pond (PCDP) which are to be used moving forward for design and

assessment in the EA. Please include specific references from the EA application. **[EA Information Requirement]**

Peterson Creek Channel Alignment in Closure

As noted in the EA application (Appendix 3-F), a closure channel will be constructed downstream of Jacko Lake to re-establish the connection of Peterson Creek between Jacko Lake and the Peterson Creek Downstream Pond (PCDP). There are different alignments of this closure channel provided in the EA, namely Appendix 3-F, Drawing C135-KA39-5640-00-03 compared to Chapter 3, Figure 3.17-4 (refer to comment SSN-345). KAM's response to SSN-345 does not clarify which channel alignment is proposed for the EA (or permitting).

MOE has further concerns related to the closure channel alignment and its implications to the water quality model predictions, given the channel's proximity to an existing reclaimed waste rock pile. MOE requests a figure to clarify the proposed closure channel alignment for the EA; the figure should highlight the location of the existing waste rock pile relative to channel alignment. According, MOE requests clarification on how the influence of the existing waste rock in this area is being accounted for in the water quality modelling predictions. **[EA Information Requirement]**

Evaporative losses from the Peterson Creek Downstream Channel (PCDP)

MOE requests that the evaporative losses from the pond surface area of the PCDP be accounted for in the water quality model. As noted in the comment by FLNRO (FLNRO-185), evaporation does not appear to be included in the water quality model presented in the EA (Appendix 6.3-C). **[EA Information Requirement]**

Please contact me if you have any questions.

Yours truly,

Erin Rainey, P.Eng.
Regional Hydrologist
Environmental Protection Division – Mining Operations, MOE

Copy to:

Krysia Zurakowski, Project Assessment Officer, BC Environmental Assessment Office

File: Ajax Project - KAM

25 August 2016

Tracy James
Project Assessment Manager
Environmental Assessment Officer
2nd Floor 836 Yates St.
Victoria BC V8Q 1L8

Dear Ms. James,

RE: Ajax Mine Project – Ministry of Environment Review of Proponent Responses to Round 1 Comments

INTRODUCTION

I have reviewed the information as provided by KGHM Ajax Mining Inc. (KAM) in response to my Round 1 review comments related to surface water hydrology for the Ajax Mine Project (the project) Environmental Assessment (EA) Application.

The following documents formed the basis of my review:

- Comment tracking table entitled "WG Tracking Table (MASTER 27Jul2016)"
- ERM memo (Ajax Integrated Summary Memo – Groundwater and Surface Water) entitled "*Ajax Project – Summary of Round 1 Technical Working Group Comments and Responses – Groundwater and Surface Water*", dated July 27, 2016
- BGC memo (0412_KAM_Surface Water) entitled "*Ajax Project Environmental Assessment Certificate Application/Environmental Impact Statement for a Comprehensive Study – Responses to Information Requests from COK, MOE and SSN*" dated April 12, 2016
- BGC memo (0429_KAM_Surface_Water_3_BGC-013) entitled "*Ajax Project Environmental Assessment Certificate Application/Environmental Impact Statement for a*

Ministry of Environment Mining Operations
Environmental Protection Division
Mailing Address:
401-333 Victoria Street
Nelson, B.C.
V1L 1G2
Telephone: 250-354-6358
Facsimile: 250-354-6332
Website: www.gov.bc.ca/env

Comprehensive Study – Responses to Information Requests from DFO, FLNRO and MOE" dated April 28, 2016

- BGC memo (0609_KAM_WBM_BGC_015) entitled "*Ajax Project, 2016 Water Balance Update*" dated June 10, 2016
- Knight Piésold (KP) report (0706_KAM_KP Water Quality 2016 Update) entitled "*Ajax Project – Water Quality Predictions Updates and Information Request Responses*" dated June 28, 2016
- Norwest memo (0706_KAM_Peterson Creek Diversion System Update) entitled "*Peterson Creek Diversion System Alternatives Assessment Rev 2*" dated June 21, 2016

The first part of the memo provides a summary of the main issues related to surface water hydrology as result of the Round 1 proponent responses and ongoing review by MOE.

The second part of the memo includes my review of specific comment responses to outstanding Round 1 comments. My evaluation outlines where the response provided is adequate to resolve the identified issue and where additional information/clarification is required for the environmental assessment and/or permitting. Each response is identified by the comment Identification (ID) number as provided by KAM in the comment tracking table. New comments have also been included, referred to as Round 2 comments, as a result of outstanding issues and updated project information provided with the Round 1 responses.

SUMMARY OF MAIN ISSUES

The following are the main issues related to surface water hydrology:

- Updated Water Balance Model - the recalibration of the updated water balance model resulted in higher annual runoff for the project watersheds (up to 46% higher) and a poorer fit between the observed and simulated streamflow series compared to the original model submitted in the EA application. MOE is concerned that the recalibration of the water balance model has increased the uncertainty associated with predicted streamflow for the project area and biased the model results towards higher than average streamflow conditions than what would be expected in the long-term.
- Updated Water Quality Model – the review of the updated water quality model is still ongoing, so comments are pending on the implications (if any) of the updated water balance model on the updated water quality predictions.

KAM RESPONSES TO ROUND 1– JULY 27, 2016

MOE-003

As per the MOE letter dated May 16, 2016 to EAO, the proponent response provided to the original comment was not adequate. The follow up request by MOE on May 16, 2016 for additional information is as follows:

"The response does not address the comment and further information is requested. Error values presented in the response memo BGC-010 (Table SSN.318-3) appear to be out by an order of magnitude. In the follow up response, MOE requests that the "error" for each measured point on the rating curve for each station be defined based on the RISC hydrometric standards (2009), as follows:

$$\frac{Measured\ discharge - Rating\ Curve\ discharge}{Rating\ Curve\ discharge}\ x\ 100\%$$

The average of the error values is defined as the "average" error of the curve and the standard deviation of the error values is the "standard" error of the curve. This gives an indication of how well the rating curve(s) fit the measured discharge points. For example according to RISC (2009), a discharge rating accuracy (average error) of less than 7% is rated as a Grade A level of data quality."

This information will help MOE to understand the uncertainty associated with the baseline streamflow record based on the rating curve error estimates and the standard grade assignment according to the RISC standards (2009). **[EA Information Request Outstanding]**

MOE-007

Thank you for the clarification, no further action required. [EA Comment Closed]

MOE-009

MOE acknowledges that updated the water balance model and water quality model now include the updated potential evapotranspiration (PET) record (1897-2011). Thank you for the clarification, no further action required. [EA Comment Closed]

MOE-011

MOE acknowledges that climate change scenarios have been incorporated in the updated water balance model (BGC, June 2016), as well as the updated water quality model (KP, June 2016). KAM states in the Groundwater and Surface Water summary memo (ERM, July 2016) that the results of the updated water quality model based on the new climate change scenarios predict both increases and decreases compared to the Base Case water quality scenario, however "*…no new parameters are predicted to exceed water quality guidelines or water quality benchmarks at any of the downstream assessment nodes*." The MOE review of the updated water quality model is ongoing and comments related to the climate change effects will be finalized once that review has been completed. **[EA Comments Pending]**

MOE-012

No further action required. [EA Comment Closed]

MOE ROUND 2 COMMENTS – MAY 16, 2016

Additional review comments were submitted by MOE in a letter dated May 16, 2016 to EAO. These comments related to three main topic areas:

1. Probable Maximum Precipitation (PMP) and Probable Maximum Flood (PMF) estimates
2. Alignment of the Peterson Creek Channel in closure
3. Evaporative losses from the Peterson Creek Downstream Pond (PCDP)

Based on the latest comment tracking table provided by KAM on July 27, 2016, these comments have not been included nor responses provided. Subsequent to these comments being submitted by MOE, KAM provided an updated design for the Peterson Creek Diversion system (Norwest, 2016) making the above Round 2 comments #2 and #3 no longer a concern for MOE.

However, the above comment #1 related to the PMP and PMF assumptions for Jacko Lake are still applicable and MOE requests this comment be included in the tracking table as this information is still considered outstanding. The original comment #1 by MOE on May 16, 2016 is as follows:

"Probable Maximum Precipitation (PMP) and Probable Maximum Flood (PMF) estimates

There are noted discrepancies in the EA application for the PMF analyses, as highlighted in comments by SSN (SSN-343 and SNN-344). KAM's responses to the SNN comments does not explain what constitutes the "more recent submissions" and does not provide references to the EA application. For example, the Jacko Lake PMF volume is stated in various sections of the EA as follows, based on the 24-hr Probable Maximum Precipitation (PMP):

- *Chapter 11.7, Section 11.7.3.3, PMF volume = 580,000 m^3*
- *Appendix 3-F, PMF volume = 800,000 m^3*
- *Appendix 17.4-D, PMF volume = 9,650,000 m^3*

MOE requests clarification on the PMP estimate and resulting PMF analysis for the Jacko Lake dams and the Peterson Creek Downstream Pond (PCDP) which are to be used moving forward for design and assessment in the EA. Please include specific references from the EA application." **[EA Information Requirement]**

MOE ROUND 2 COMMENTS – AUGUST 25, 2016

Updated 2016 Water Balance Model

An updated water balance model was completed for the project and summarized in the supporting memo by BGC (June 2016). The updated model was recalibrated based on five years of measured streamflow at the JACINF hydrometric station for the open water months of April to October for 2008-2011 and 2014. The measured streamflow for JACINF was updated based on a new rating curve developed by BGC to include the 2014 measurements. The 2014 rating curve increased the resulting measured flows slightly compared to the previous rating curve, as shown in Table 2-1 (BGC, June 2016). As a result of the recalibration using the updated JACINF streamflow record, the updated water balance model predicted higher annual runoff for

the project watersheds compared to the water balance model submitted in the EA application, with the exception of the 950 m lower elevation band used for endorheic basins, as summarized below in Table 1.

Table 1 – Annual Runoff Depth Comparison (adapted from Table 2-7 (BGC, June 2016))

Model Version	Annual Runoff Depth (mm) by Elevation Band			
	950 m[1]	900 – 1200 m	1200 – 1500 m	>1500 m
2015 Water Balance (EA application)	23	28	45	62
2016 Updated Water Balance	12	41	58	71
% Difference	-48%	46%	29%	15%

1. The 950 m elevation band is used in the model to represent undisturbed areas in the Lower Peterson Creek catchment for endorheic basins.

The calibration statistics, Nash-Sutcliffe efficiency (NSE) and relative error (RE), were used to demonstrate the volumetric fit of the observed compared to the simulated streamflow for the water balance model. The NSE r^2 value for the updated model was 65% compared to 92% for the EA water balance, indicating a poorer calibration to measured streamflow, particularly in the freshet months as shown on Figure 2-2 in the BGC memo (2016). The relative error value for the updated model was -0.8% compared to 1.6% in the EA water balance, which demonstrates an improvement for the updated water balance model.

The original water balance submitted with the EA application used the 50-year synthetic flow series developed for JACINF by KP (2013), which provided a good representation of the expected long-term streamflow conditions, given the year-to-year and month-to-month variability available in the long-term record. Conversely, the five years of incomplete record for JACINF (open water months only) used to calibrate the updated model was a wetter than average period in the project area, as shown by comparing concurrent years from the 100-year streamflow record available for the nearby regional Water Survey of Canada (WSC) station at Deadman River above Criss Creek (08LF027). The streamflow at Deadman Criver above Criss Creek for 2008-2011 and 2014 indicates that those years, with the exception of 2009, was higher than average particularly in the freshet months, which represents 70% of the annual flow (KP, 2013).

MOE is concerned that as a result of the recalibration of the water balance model the uncertainty associated with predicted streamflow values has increased and also may have seemingly biased the model results towards higher than average streamflow conditions compared to what would be expected in the long-term. The key issue is what implication this will have on the updated water quality model predictions (KP, June 2016). MOE's review of the updated water quality model is

ongoing; therefore final comments on the effect of the updated water balance model on water quality predictions for the project are pending. **[EA Comments Pending]**

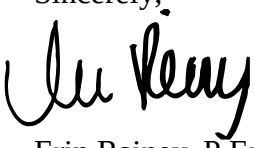
REFERENCES

Knight Piésold (KP), 2013. *Appendix 6.4-A – 2012 Hydrometeorology Report*. March 12, 2013

Resource Inventory Standards Committee (RISC), 2009. *Manual of Standard Operating Procedures for Hydrometric Surveys in British Columbia, Version 1.0*. Ministry of Environment, Science and Information Branch for the Resources Information Standards Committee. March 12, 2009

Should you have any questions about the above, please contact me at 250-354-6358 or Erin.Rainey@gov.bc.ca.

Sincerely,



Erin Rainey, P.Eng.
Regional Hydrologist
Environmental Protection Division – Mining Operations, MOE

cc: Krysia Zurakowski, Project Assessment Officer, Environmental Assessment Office

File: Ajax Mine Project - Environmental Assessment Act Review

September 12, 2016

To: Krysia Zurakowski, Project Assessment Officer, EAO

From: Gabriele Matscha, Environmental Impact Assessment Section Head – Mining, MOE

RE: Review of KGHM responses to MOE Round 1 comments MOE-015 to MOE-071 (Carmichael) for the Ajax Mine Proposal

INTRODUCTION

As per the Environmental Assessment Office (EAO) request dated July 28, 2016 from Krysia Zurakowski, reviewers are to assess KGHM responses and produce Round 2 comments, as follows:

The purpose of Round 2 comments is to:

- Review the Proponent's responses to Round 1 comments;
- Advise EAO on the adequacy of the Proponent's response to the original (Round 1) questions;
- Identify items that have been adequately addressed and can be "closed"; and
- As necessary, provide follow-up questions or comments to further clarify information requested in order to better understand the Project's effects.

This memo provides Round 2 comments based on the MOE contractor`s (Bruce Carmichael`s) review of KGHM responses to MOE-015 to MOE-071 in the tracking table, the Knight Piesold Memo "Ministry of Environment (MOE) Information Request MOE-028: Predicted Nitrogen to Phosphorus (N:P) Ratios for Peterson Creek" and the Memo "0706_KAM_Water Quality Downstream Cumulative Effects".

Due to the timing of the contract approval and contractor availability, the following response memos submitted by KGHM have not yet been reviewed in detail:

a) Related to MOE-019, memo "0706_KAM_ Historic Water Quality Data". Comments are pending on influence of historic water quality (pre-mine) on this assessment.

b) Related to MOE-026 and MOE-050, "Supplemental Response Memo 0706_KAM_KP Water Quality 2016 Update". Comments are pending on the methods by which updated water quality model results are determined.

Detailed review of these memos is still ongoing and additional comments will be forwarded (where applicable) in September.

The EAO requested the reviewers to include the following in their organization's Round 2 comments to EAO:

1. In a few bullet points, a high-level summary of the main issues that the organization believes are unresolved at this stage in the environmental assessment, and why.
2. Identification of any specific comments that, in the reviewer`s view, were not adequately addressed and that may require follow-up questions or clarifications.
3. If requesting any additional information from the Proponent we consider necessary to resolve the issue for the purposes of the EA, to provide EAO with the rationale/context for the request and the implications of not having this information for the assessment.

HIGH-LEVEL SUMMARY OF MAIN ISSUES

Following our review of KGHM's responses to the commentsMOE-015 to 071, MOE's Environmental Impact Assessment section has identified two main issues that require further resolution:

a) **Peterson Creek downstream cumulative effects:** Need for increased understanding of the sources of elevated levels of sulphate, selenium, chromium, arsenic and uranium in lower Peterson Creek, below the assessment node PC02. It is not clear if these levels are natural, affected by previous mining in the area or other land use activities. This information is necessary to inform MOE's assessment of how any incremental impacts of the Ajax Project may interact with past and present cumulative effects on water quality in Peterson Creek. (See MOE-033, 041 and 051).

b) **Dust fall and the Water Quality Model:** Lack of clarity with how dust fall has been included into the Water Quality Model (volume and geographic extent of dust fall deposition in water bodies) and how dust fall is predicted to influence water quality, including assumptions about the bioavailability of contaminants. (See MOE-046 and MOE-059) Pending this information, MOE has low certainty in the results of the Water Quality Model.

c) Related to MOE-035 and MOE-054, MOE wishes to stress that while SBEBs are usually formalized during the effluent permit pre-application phase, MOE would appreciate if the SBEB development plan and/or supporting science for preliminary SBEBs would be discussed with MOE as part of EA effects assessment.

Further to the overarching issues listed above, the following are MOE`s detailed comments on the Working Group Issue Tracking Table responses by KGHM of July 27, 2016, by issue number, in numerical order (not ordered as per the latest ITT version):

MOE-015: MOE notes that the July 27, 2016 memo Summary of Round 1 Technical Working Group Comments and Responses – Groundwater and Surface Water, page 5, does identfty "Kamloops Lake (augment flow in Peterson Creek)" as one of eight potential mitigation options to maintain or improve streamflow conditions in the Peterson Creek system. Given MOE's mandate for water quality protection, we request the opportunity to participate in discussions regarding possible use of these management options, particularly depending on the outcome of our pending water quality effects assessment. **EA comment closed.**

MOE-016: The response is not clear on which of the nine wetlands may be at risk of selenium contamination. MOE seeks information on which wetlands (with mapping) are thought to be at risk of elevated selenium concentrations and to what degree. We understand that at least the EMRSF and SMRSF residual ponds/wetlands are in this group. Please provide direction as to where in the Application this information can be located. Our interest is in assisting the development of effective baseline (for natural ponds) and operational selenium monitoring programs for these water bodies. Discussion on how enhanced wetlands may provide treatment may be of future interest. Please cross reference this comment to your statements on waterfowl and amphibian control in selenium contaminated environments. The explanation of habitat loss calculation is appreciated. **Unresolved issue; further clarification required.**

MOE-017: MOE further understands (response to MOE-018) that treatment to remove phosphorus is planned. **Issue resolved**

MOE-018: The KGHM response is acknowledged. The commitment to install phosphorus removal is specifically acknowledged. The actual need for this treatment should be further assessed at permitting. **EA level clarification resolved.**

MOE-019: The KGHM summary response is acknowledged. Refer to MOE-084 for MOE responses to 0706_KAM_ Historic Water Quality Data. Review ongoing. **MOE comments pending, unresolved issue.**

MOE-020: In reply to the first section of the response that has offered batch specific laboratory QA submission on request, MOE requests the CRM and matrix spike data for the newly provided baseline data (October 2014 to April 2016), as a partial check on overall project data QA for accuracy. **Outstanding issue; further clarification required.**

MOE-021: The possible use of Edith Lake as a water quality reference for Jacko Lake is a permitting level issue. MOE requests that the ITT record this issue as such. **Permitting information requirement.**

MOE-022: The potential for limitations to site establishment in lower Humphrey Creek is understood. This will be part of permit discussions. **Permitting information requirement.**

MOE-023: The KGHM response is supported. **Permitting information requirement.**

MOE-024: The information has been provided in a June 9, 2016 Lorax memo to KGHM, thank you. **Issue resolved.**

MOE-025: KGHM`s explanation of WR-Seep versus South Catchment is appreciated. **Issue resolved.**

MOE-026: The KGHM response is acknowledged. The Supplemental Response Memo 0706_KAM_KP Water Quality 2016 Update is under review. **MOE comments pending, unresolved issue.**

MOE-027: MOE requests a response to the first part of our comment. **Unresolved issue.**

MOE-028: MOE-028: MOE appreciates the KGHM response and has reviewed the May 24, 2016 Memo Predicted Nitrogen to Phosphorus (N:P) Ratios for Peterson Creek.

This issue links to MOE-038 (livestock as the suspected source of phosphorus in the Peterson Creek drainage). KGHM response to MOE-038 provides agreement that livestock is the likely main source of phosphorus in Peterson Creek. MOE-028 also links to MOE-030 (livestock management within the same drainage).

We offer the following comments/questions on the May 24th memo for consideration:

P2: MOE agrees that, at least seasonally, Peterson Creek exceeds guidelines for periphyton biomass and so currently contains potentially damaging concentrations of algal biomass for aquatic life (and recreation). Our interest is in seeing this not worsen as a result of mine development. We also note that KGHM confirms phosphorus concentrations in Peterson Creek to be in the eutrophic to hyper-eutrophic range.

P2: We note very low N:P ratios upstream of PC02. Importantly, PC02 also shows a strong nitrogen limitation during the summer/fall growing season. While Peterson Creek below PC02 was not assessed (P4), we expect similar conditions to exist there. Recent data for PC-EF-04 should be reviewed for this purpose.

P2: with regard to Jacko Lake, MOE believes that only the epi- and perhaps metalimnion phosphorus concentrations should have been included in N:P ratio development as the hypolimnion concentrations are below the photic zone and not seasonally relevant. Peterson Creek, not Jacko Lake, is our primary concern with this issue, however.

P6: We note that the predicted annual average N:P ratio for PC02.3 is well less than 5:1 for life of mine and (P9) that PC02 predicted summer/fall ratios are also <5:1.

P12: In summary, MOE agrees that on a seasonal basis, Peterson Creek sites PC02.3 and PC02 are nitrogen limited. We suspect lower Peterson Creek downstream of PC02 to be similar. We agree that the predictions indicate an ongoing seasonal nitrogen limitation, likely for operations and closure / post-closure. Nitrogen is thought to drive aquatic productivity now and is predicted to do so in future. The likely addition of available nitrogen (largely nitrate) from the mine has the potential to promote additional, perhaps very high densities of periphyton. Finally, MOE agrees this is a concern for recreational and aquatic life values in Peterson Creek.

MOE considers KAM's recommendation "to monitor nutrient levels and chlorophyll a concentration in the Project area during operations and post-closure and implement additional mitigation measures" to lack the detail necessary at the EA review stage for an issue of shared concern. **EA Information Request:** Provide a more detailed investigation into mitigation options that will effectively limit periphyton development, ideally to guideline levels. **Unresolved issue.**

MOE-029: This issue is under review by MOE. **MOE comments pending, unresolved issue.**

MOE-030: MOE has concerns with elevated nutrient concentrations in Peterson Creek, particularly phosphorus, and has not been provided with clear information that those concentrations are natural and not related to the presence of livestock. MOE seeks a fuller understanding of the source of phosphorus concentrations that we consider to be very high and capable of causing extensive attached algal growths in Peterson Creek. Refer also to MOE

comments on ammonia and nitrate concentrations made for report KP 0706 – Historic Surface Water Quality Data, where we question whether temporal and spatial trends in these nutrients may be related to livestock. **Issue unresolved.**

MOE-031: Comment can be considered **resolved**. Refer to related comment MOE-030, which remains unresolved.

MOE-032: MOE agrees with the KGHM response on the issue of hardness based guidelines for copper (first paragraph). With the review of report KP 0706 - Historical Surface Water Quality Data, MOE has improved confidence that current baseline generated for JC03-PC10 appears to fairly represent pre-mine total copper concentrations (i.e., close to true baseline conditions) (Figure D5). However, with reference to Appendix 6.3-A, P52 of 158, Figure 4.14, we acknowledge that application of a background concentration method to modify the hardness based copper guideline and using copper data from above Jacko Lake to sites downstream may not be appropriate when baseline concentrations appear very different between the two locations. An SBEB based on concentrations typically measured below Jacko Lake would be preferred.

Regarding the second paragraph and as a general comment, the inability to locate unimpacted sites in the project area should not imply the current water quality at those sites is baseline and acceptable to local aquatic life (i.e., that the current condition is not causing stress). This should be a purpose of reference sites located in adjacent drainages. **Issue resolvedMOE-033:** The KGHM responses are appreciated. **While the specific question can be considered resolved, it leads to a new and substantial issue** as part of effects assessment. With reference to report 0706 Water Quality Downstream Cumulative Effects, selenium plot (page 9), MOE believes the Application has suffered from previous lack of water quality data for lower Peterson Creek. With selenium concentrations exceeding water quality guidelines below PC02 MOE believes it is important to now consider the degree to which these elevated Se concentrations in lower Peterson Creek are natural occurrences or potentially induced by previous mining via subsurface movement. If latter is the case, this contaminant pathway needs to be considered in the water quality model for the lower Peterson Creek. In addition, cumulative effects of mine related effects (via surface or subsurface) and other sources need to be assessment. For a meaningful cumulative effects assessment, the water quality model, currently down to PC02, should be extended into the lower section of Peterson Creek.

MOE-034: The KGHM clarification response is appreciated. This specific comment can be considered as resolved. The Supplemental Response Memo 0706_KAM_KP Water Quality 2016 Update is currently under review by MOE. Numerous **MOE comments pending, unresolved issue.**

MOE-035: MOE acknowledges KGHM response, assuming that the need for a lentic based SBEB in Peterson Creek between WR-Seep and PC02.3 is accepted. **Issue resolved.** Importantly, while SBEBs are usually formalized during the permit application process, MOE would appreciate discussion of an SBEB development plan and/or supporting science for preliminary SBEBs prior to Certification and as part of the EA effects assessment.

MOE-036: As part of nutrient management planning within the Peterson drainage, MOE recommends the Jacko Lake water quality monitoring program include a requirement for TP, TDP and OP monitoring of at least three depths on a monthly frequency, which when combined with lake inflow/outflow measurements, will provide an indication of available phosphorus

loading to Peterson Creek below the lake. **This is a permitting level monitoring issue. Issue resolved.**

MOE-037: MOE questions whether the presence of total chromium might indicate an anoxic environment at WR-Seep and a trivalent chromium that is dissolving. We believe application of the hexavalent guideline is appropriate. Refer to MOE-062 for related discussion. **Issue resolved.**

MOE-038: MOE notes the KGHM acknowledgement that cattle ranching is the primary land use in the area and that the primary source of phosphorus loading to the surface waters in the immediate project area is likely to be livestock. We agree that other sources may include septic loading from residential properties. **Issue resolved.** To understand, what the more natural nutrient concentrations in the system are, MOE is seeking data for Peterson Creek that can be confidently identified as not influenced by livestock (either temporal or spatial baseline). **Unresolved issue.**

MOE-039: KGHM's response is appreciated. MOE also seeks information from FLNRO ground water hydrology on value of the suggested new site and on the possible groundwater contamination of points downstream (PC02, PC-Park, etc). **Issue resolved. This is a Permitting Information Requirement.**

MOE-040: The Supplemental Response Memo 0706_KAM_KP Water Quality 2016 Update is currently under review by MOE, with numerous **MOE comments pending**. As such, this **issue remains unresolved.**

MOE-041: Thank you for this response. MOE will assume that the search for additional, existing groundwater quality data or the collection of new data in the PC02 area and downstream is ongoing and that additional data will be available if requested in order to further the review of this project application. **Comment closed. See MOE-051 for further comment on downstream water quality cumulative effects.** Our review of page 7, memo 0706 Water Quality Downstream Cumulative Effects clearly indicates the benefit additional groundwater data would bring to this assessment, namely source identification for the increasing Se, SO4, Cr, As, U concentrations with progression downstream in Peterson Creek. It would be important to confirm, for example, that natural increases in Se downstream of PC02 far exceed current predictions caused by the proposed mine at PC02.3. Can additional groundwater quality data be provided at this time? Does the City of Kamloops collect well data from the lower drainage that may be of value here? Please also see comments under MOE-51. **Unresolved issue.**

MOE-042: The Proponent response is appreciated. MOE acknowledges that potential Operation, Decommissioning and Closure phase spills are discussed in Section 17.6 Accidents and Malfunctions of the Application/EIS. **Issue resolved**.

MOE-043: The KGHM response is appreciated. This issue remains a **Permitting Information Requirement. (EA resolved).**

MOE-044: Issue resolved.

MOE-045: The KGHM response is lacking the requested detail. To rephrase the issue, MOE requests that assumptions built into the water quality model be clearly identified for our reference. What model assumptions were applied to the model and what mitigations are necessary to meet these assumptions? How do these assumptions influence water quality

predictions? We are requesting the location of these assumptions in the Application for our review. **EA Information Requirement outstanding.**

MOE-046: The KGHM response is acknowledged. MOE requests that EAO coordinate a discussion as a priority between both the Air and Water Quality Sub-working groups and KGHM in order that we may better understand the method by which the dust fall component of the water quality model was determined. At this point, MOE Environmental Impact Assessment section has a limited understanding of this issue and a high uncertainty in the dust fall based contaminant loadings to Peterson Creek and Jacko Lake. **Unresolved issue.**

MOE-047: MOE recalls a verbal commitment made by KGHM at the initial working Group meeting (Kamloops, Feb 23, 2016) that an organic substitute for chloride would be used for road salting. Can KGHM provide an update to this verbal statement? Our concern is with the addition of chloride to Peterson Creek at points above where concentrations are now very elevated and are predicted to regularly exceed aquatic life guidelines (PC02). Given that chloride is identified at a Category 1 parameter at Ajax, if its use is being contemplated, its use should first be modelled and compared to baseline and current predictions at PC02.3 and that section of Peterson Creek. Note that the proposed water quality benchmark for chloride has not been accepted at this time (refer to MOE-048 Round 1 comment). **Unresolved issue.**

MOE-048: MOE's review of this issue is ongoing as part of effects assessment and SBEB development. No further work is required of KGHM at this time. **Issue unresolved.**

MOE-049: MOE supports the KGHM approach of assessing the total fractions of those metals where the particulate component is substantial and the current water quality guideline is developed for the total fraction. We look forward to reviewing any modified effects assessment that may be forthcoming. As such, review of both the metals selected for total fraction assessment (currently totals of chromium, cobalt, copper, and iron) and the effects assessment of each are ongoing at this time. MOE will provide comment at a later date. **Issue MOE-049 can be considered closed; it overlaps with MOE-050 which remains unresolved, pending MOE review.**

MOE-050: A priority issue for MOE that remains under review. **MOE comments pending, unresolved issue.**

MOE-051: MOE acknowledges the KGHM response and supports the monitoring of additional downstream sites. We agree that their long term status should be discussed at permitting. We are interested, for example, in the monitoring of both sites PC-Park and PC-EF-04 and suggest that data review will be useful in determining continuation of either site. MOE is also interested in the monitoring of City storm sewers during periods of discharge in order to determine surface water source loads.

MOE appreciates the KGHM response and has reviewed the Memo 0706_KAM_Water Quality Downstream Cumulative Effects and offers the following comments/questions for consideration:

- It is noted that KGHM predictions for PC02.3 are lower (for Se, sulphate, arsenic, molybdenum, and uranium) than the current measured concentrations downstream of PC02. **EA Clarification Request**: Please confirm that predictions are lower than measured concentrations, and provide rationale for these findings.
- P1: MOE advises EAO that we are seeking confirmation from FLNRO as to the accuracy of the statement that lower Peterson Creek is "where no new contact water is expected to

affect water quality". Is it likely that the existing mine development is influencing water quality downstream of PC02 by way of direct groundwater loading? This is important to confirming that increasing SO4, Se, Cr, As, U with progression downstream are natural increases or at least not related to existing mine development.

- P2: regarding the very small sample size from well RES-1, refer to MOE reply to MOE-041 and an updated request for additional groundwater quality data from lower Peterson Creek.
- P4: MOE recognizes that one of the limitations of CAE in lower Peterson Creek is that "long-term cumulative effects associated with consistent discharges from urban loading sources" may be rare events in the City of Kamloops due to limited precipitation, infrequent and short duration runoff events, and the relatively rapid flushing of sporadically loaded contaminants from lower Peterson Creek. MOE suggests that urban contaminant loading via shallow groundwater can be assessed by monthly monitoring at PC01. The potentially long list of urban parameters (page 5) can also be measured by way of regular monitoring. **Permitting/monitoring information requirement.**
- P5: It is reasonable that hydraulically based changes in urban runoff are not within the scope of this KGHM review as such changes in the lower drainage may be primarily a response to City of Kamloops development. **No further information required.**
- P5: MOE agrees with KGHM interpretations of water quality data collected from lower Peterson Creek (Figures 2 and 3). We are interested in the noted increases downstream of PC02, particularly for SO4 and Se where aquatic life guidelines are (naturally) exceeded, but also of As, Cr and U. **EA Information Request**: MOE recommends follow-up discussion with KGHM during Round 2 regarding natural conditions, parameter sources, implications to SBEB development, etc.
- P6: If the statement "Selenium exceeded relevant guidelines under the Base Case scenario and the Base Case water quality predictions rarely exceed the monthly baseline ranges measured for this parameter" applies on a site specific basis, a background concentration method should be investigated to develop a preliminary SBEB for effects assessment, instead of comparing to the guideline. This may not apply to Sensitivity Analyses, however. **EA level and Permitting Information Requirement.**
- Information Requested: P8 and 9: Those parameters found to be decreasing between PC02 and sites downstream (Ni, perhaps Cd) should be reviewed for possible sources in the LSA, as was done for chloride, assumed to be sourced at Hwy 5A. P10: KGHM is requested to provide Table 2 (missing from the memo).
- As a general statement on cumulative effects assessment in lower Peterson Creek, MOE acknowledges the practical difficulties in monitoring the very intermittent urban runoffs from an arid community such as Kamloops. We question how sustained the spring snow melt and summer storm flows from the City of Kamloops typically are. The flushing rate for contaminants loaded into lower Peterson Creek should be a matter of just hours prior to their discharge to the Thompson River, including from any storm sewers sourced in the upper residential area of Aberdeen. If the storm sewer source flow is of short duration, the potential for cumulative effects as measured by water quality exceedances should also be of short duration. Operationally, the best way to assess cumulative effects in lower

Peterson Creek may be through storm based, high frequency water quality monitoring and the application of acute rather than chronic water quality guidelines. This is offered as a point of discussion during future considerations of operational cumulative effects assessment in lower Peterson Creek. **Permitting Information Requirement.**

MOE-052: Given that MOE-052 overlaps with -051 which remains under review and unresolved, MOE-052 can be considered as closed.

MOE-053: The KGHM response is appreciated. Given the general nature of this MOE comment, we believe it still very much applies to this application, is an overarching goal, and remains relevant to the EA review. **Issue to be resolved through the proposed meeting.**

MOE-054: With the advancement of discussions on the suitability of water quality modelling for the Ajax Application and in consideration of EA review time constraints, MOE is increasing its focus on the review of effects and the development of related SBEBs. Review of updated Water Quality Model is ongoing by MOE. **Issue resolution pending. MOE-055:** The KGHM response is acknowledged. **MOE comments pending** following review of the updated water quality memo. Clarification Request: Has modelling been updated for re-established Peterson Creek channel south of the open pit ?

MOE-056: Thank you for the response. **Issue resolved.**

MOE-057: Thank you for the clarification. **Issue resolved.**

MOE-058: The KGHM response is appreciated. **Issue resolved.**

MOE-059: This issue of dustfall sourced metal loading to the water quality model is a priority and currently under review. **MOE comments pending, unresolved issue.**

MOE-060: Thank you for this explanation. MOE will review the updated baseline calibration model. **Issue resolved.**

MOE-061: The KGHM response is appreciated. **Issue resolved.**

MOE-062: Memo 0706_KAM_KP Water Quality 2016 Update is under review, with **MOE comments pending, unresolved issue.**

MOE-063: This issue is under MOE review. **MOE comments pending, unresolved issue.**

MOE-064: This issue is under MOE review. **MOE comments pending, unresolved issue.**

MOE-065: Memo 0706_KAM_Water Quality Downstream Cumulative Effects has been reviewed and comments provided under related issue MOE-051. **MOE-065 can be considered resolved.**

MOE-066: This issue is current under MOE review. **MOE comments pending, unresolved issue.**

MOE-067: The furthering of this issue is dependent on the ongoing review of selenium predictions and effects assessment. **MOE comments pending. Resolution pending.**

MOE-068: The Proponent is requested to ensure that sediment baseline has been collected at KC03 or will be scheduled as a condition of Certification (i.e., ensure that this issue and related sampling is part of the remaining baseline requirement). **Issue resolved.**

MOE-069: Thank you for the response. **EA level Issue resolved.**

MOE-070: This issue is under MOE consideration. **MOE comments pending, unresolved issue.**

MOE-071: The Proponent response is appreciated. MOE questions the ongoing need for several existing baseline sites and recommends that once the mine plan is finalized, a review of existing and required program sites be conducted at permitting. **Issue resolved.**

Please do not hesitate to contact me, should you have any questions about the above comments.

Sincerely,

Gabriele Matscha, R.P. Bio
Environmental Impact Assessment Section Head – Mining Operations
Ministry of Environment

cc. Brian Herbert, Senior Project Manager – Mining, MOE
Erin Rainey, Hydrologist – Mining Operations, MOE
Leslie Berkes, Environmental Protection Officer – Mining Operations, MOE
Ralph Adams, Meteorologist – Monitoring, Assessment and Stewardship, MOE
Lyudmila Merkulova, Environmental Protection Technician – Mining Operations, MOE

September 28, 2016

Memo to: Gabi Matscha, R.P. Bio,

Environmental Impact Assessment Section Head – Mining

BC Ministry of Environment

Re: **Draft Review of KGHM Ajax Project "*Historical Surface Water Quality Data Report*", June 30, 2016**

As per General Service Agreement, Contract No. GS17KAE302 and your related instructions, this memo provides my draft comments on the June 30, 2016 KGHM report "*Historical Surface Water Quality Data Report*" for your consideration. The review also includes my Round 2 comments related to this topic.

I have focused my review on the monthly data plots contained in Appendix D of the historical report, mainly those showing PC10/JC03, PC08, PC03, PC02 and PC-Park. I found this appendix contained useful data comparisons that appear not to be thoroughly discussed in the report.

For this review "pre-mine" (before the previous mining activity in this area) extends from 1986 to 1989, "post-mine" (during or after the previous mining activity in this area) from 1991 to 2000, and "baseline" from 2007 to current year. Also note that PC08 (just downstream from Jacko Lake) is assumed to be upstream from most mine influence. PC03 is the main site downstream from the existing mine. PC-Park is located below the Peterson Creek falls and had been excluded from discussion during the mine Application due to a lack of data at that time.

MOE agrees with the parameters selected for review in the report (i.e., that several pre-mine parameters lacked the historical detection levels necessary to allow comparison to current data). It should be noted that the Category 1 parameter arsenic existed in pre-mine data base as <MDL concentrations, so was not reviewed. This was not mentioned in the text.

From Appendix D, my comments are as follows:

Specific Conductance (SpC):
Appendix D page D-1 suggests the occurrence of increased specific conductance (SpC) from pre-mine to post-mine at PC03 (Mar-Jul) and PC08 (May-Jul). Given that three of the five monthly increases are also located at PC08 (above the main mine influence), the apparent increase may not be mine related. MOE's review will look for support from other parameters. We see no clear trending between post-mine and baseline at PC03 or PC08.

Spatial increases from PC08 to PC03 are apparent for both post mine and baseline, and may be mine related. These increases are generally maintained to below the falls at PC-Park during the baseline period.

The report does not discuss data collected for Peterson Creek below the falls (PC below Falls) and PC-Park, and fails to consider spatial trends in the pre-mine data. Those pre-mine data indicate that SpC increased spatially from the upper drainage to PC below Falls. SpC values of generally <1000 uS/cm at

PC08 and PC03 increased to generally <2000 uS/cm below the falls. This information implies that prior to mine development water chemistry increased, perhaps naturally, with distance downstream. MOE is not aware of when urban development occurred in this reach of Peterson Creek, nor of what effect this development may have had on water quality. The historic increase in downstream conductivity does suggest a need for cumulative effects assessment below the falls using an extension of water quality modelling to that area.

Sulphate (SO4):
MOE finds the historic report's discussion on sulphate limited. From page D-2 of Appendix D, MOE believes the current SO4 baseline at PC10/JC03, PC08 and PC02 provides a lower concentration and a more suitable baseline for SO4 for the Ajax Project than that measured during pre-mine. We believe the pre-mine data do not benefit impact prediction, with reference sites reporting higher concentrations than the current baseline.

SO4 was detectable in the pre-mine data and does provide useful information on conditions for that time. MOE disagrees that "the pre- and post- mine sulphate concentration at all sites are within similar ranges". Pre-mine SO4 concentrations spatially increased from PC08 and PC03 (generally <200 mg/L) to PC below falls (generally 600-900 mg/L) (Figure 4.3). This implies a natural (MOE agrees that the Davidson aquifer may be a SO4 source to lower Peterson) or at least non-mine increase with movement downstream, and one that is supported by SpC data. This major spatial pre-mine increase in downstream SO4 suggests a substantial cumulative effects potential from future mine loading of SO4, should SO4 loadings increase in the lower Peterson Creek due to the Ajax Mine. This has implications to SO4 management going forward.

The page D-2 plots suggest a strong decreasing SO4 trend from post-mine to current baseline during most months for site PC08. This decrease is apparent at site PC10/JC03, also located above the mine. The cause of this decrease is not known. Using the limited pre-mine data base, no clear trend over time is apparent for SO4 at PC03 with the pre-mine data similar to post-mine and baseline. Current baseline SO4 concentrations at PC03 (<600 mg/L) are increased over those at PC08 and PC10/JC03 (<120 mg/L). This spatial increase between adjacent sites can also be seen for post-mine, and it maybe due to the existing mine. These baseline concentrations appear to be increased further at PC-Park (<900 mg/L). Both pre-mine (discussed above) and baseline concentrations at PC-Park exceed both the current water quality guideline for SO4 and at some times the SBEB proposed by KGHM.

MOE request (EA level): Given that the current sulphate baseline may be influenced by previous mining activities, KGHM is requested to determine the impact of these increased concentrations at PC03 and points downstream on the water quality effects assessment.

MOE request (EA level): KGHM is requested to either conduct a sulphate focused cumulative effects assessment for the lower Peterson Creek or provide a clear rationale to show that the proposed mine will not have any effect on sulphate water quality downstream of PC02.

Molybdenum (Mo):
From page D-8 of Appendix D, MOE believes the current baseline at PC10/JC03, PC08 and PC02 provides a lower concentration and more concise baseline for Mo associated with the existing mine site than that measured during pre-mine. We believe the pre-mine data (with reference site Mo more

concentrated than the current baseline) do not benefit impact assessment. However, Mo was detectable in the pre-mine data and does provide useful information on conditions for that time.

Pre-mine Mo appears to have increased slightly with distance downstream from PC08 and PC03 to PC below falls. Based on the data provided, typical pre-mine Mo concentrations were less than 10 ug/L in the upper drainage (PC08), increasing generally to less than 15 ug/L below the Peterson Ck falls. The minor (likely natural) increases down drainage, suggest a limited cumulative effects potential from future Mo loadings.

Data from PC03 (downstream of the mine) suggest an increase in Mo caused by the existing mine and that the current baseline may be influenced by previous mining activities. The data from PC03 indicate an increase of Mo from pre-mine (<20 ug/L) to current baseline (<110 ug/L) for the months of March to July. The current baseline also shows a spatial increase in Mo between PC08 (2-4 ug/L) and PC03 (<110 ug/L), decreasing to <15 ug/L at PC02 and PC-Park.

MOE agrees with the mine being the likely source of noted Mo at PC03. From report section 4.4.9, the pre-mine data limitations are not overly relevant here. Nor is seasonality an issue. The simple spatial comparison between adjacent sites PC08 and PC03 using current data is enough to identify the mine as the likely Mo source. Other potential sources between PC08 and PC03 have not been suggested by KGHM. MOE disagrees that the limited pre-mine Mo dataset prevents a conclusion that the mine is responsible for the measured increases at PC03 versus PC08.

MOE request (EA level): Given that the current molybdenum baseline may be influenced by previous mining activities, KGHM is requested to determine the impact of these increased concentrations at PC03 and points downstream on the water quality effects assessment.

Copper (Cu):

Pre-mine copper data (D-5 & D-6 of Appendix D) offer some insights into the trending of this parameter. While MOE supports a focus on the current baseline's development and use (with lower and more concise data concentrations than pre-mine data), differences noted by MOE between pre-mine and current baseline should be considered during the EA review, and are referenced in the following MOE requests.

MOE notes no clear separation for either Cu-T or Cu-D over the three phases (pre-mine, post-mine and current baseline) at reference site PC10/JC03 or PC08 or at downstream of mine at PC03. Method detection limits (MDLs) and quality assurance near the MDL are likely issues with the pre-mine data and with the noted lack of trends. Plotting scales may also be too coarse and limiting to interpretation.

Importantly, current Cu-T and Cu-D concentrations at PC02 are above the pre-mine period concentrations measured at PC below falls (MOE recognizes that no pre-mine data exist for PC02). This suggests an increase of Cu concentrations for 7 of 10 months from pre-mine to current baseline levels and that modelling to date has made use of possibly elevated copper concentrations of unknown origin.

MOE request (EA level): Given that the current copper baseline may be elevated above pre-mine concentrations, KGMH is requested to determine the impact of increased copper concentrations at PC02 and points downstream on the water quality effects assessment.

Finally, both Cu-T and Cu-D data at PC below falls and PC-Park suggest a possible future issue with cumulative effects, if effects of the proposed mine can be expected into the lower Peterson Creek. While pre-mine data quality may be suspect, both total and dissolved monthly copper concentrations have usually shown minor increases in the lower creek from pre-mine to current baseline. Reason for the increase is unknown.

MOE request (EA level): KGHM is requested to either conduct a copper focused cumulative effects assessment for the lower Peterson Creek or provide a clear rationale to show that the proposed mine will not have any effect on copper water quality downstream of PC02. The review is to include the typical hardness based guidelines applied to Peterson Creek relative to the differences between pre-mine and baseline data and to be reported by KGHM to determine the actual significance of this finding.

Manganese (Mn):

Pre-mine manganese data (Appendix D-7) offer some insights into trending of this parameter. While MOE supports a focus on the current baseline's development and use (baseline data range includes that of pre-mine data at PC10/JC03 and PC08), noted differences between pre-mine and current baseline should be considered during the EA review, and are referenced in following MOE requests.

MOE notes no clear separation for Mn-T from pre-mine to baseline reference site PC10/JC03. An increase in baseline over pre-mine concentrations is suggested at PC08. While no clear temporal trend is seen at PC03, Mn concentrations appear to have increased spatially from PC08 to PC03 (plot scaling is an issue here), and are likely mine related.

More clearly than for copper or nitrate, Mn-T is currently elevated at PC02 above pre-mine data from PC below falls for 10 of 10 months. This increase from pre-mine concentrations suggests that modelling to date has made use of elevated Mn concentrations. Mn concentrations have also increased over time at PC-Park, but only to concentrations just 10% of those measured at PC02. The minor increases down drainage, suggest a limited cumulative effects potential from future Mn loadings.

MOE request (EA level): Given that the current manganese baseline may be influenced by previous mining activities, KGHM is requested to determine the impact of the increased concentrations at PC02 and points downstream on the water quality effects assessment.

MOE request (EA level): KGHM is requested to either conduct a manganese focused cumulative effects assessment for the lower Peterson Creek or provide a clear rationale to show that the proposed mine will not have any effect on manganese water quality downstream of PC02.

Ammonia:

Pre-mine ammonia data (D-3) do not offer much information to the Application review and MOE supports a focus on the current baseline's development and use. We offer the following comments:
- No obvious monthly trending exists at PC08 from pre-mine to post-mine to baseline.
- The plot scale for PC10/JC03 limits discussion.

- The apparent increases in ammonia at PC03 from pre-mine to baseline (Feb-Jul) may be the result of increased sample frequency and/or livestock near the watercourse. MOE would not expect the old mine to be a current ammonia source to Peterson Creek.
- The PC-Park plot suggests aerobic conditions both during pre-mine and current baseline and oxidation of ammonia from upstream sources at upstream locations.
- The decrease in ammonia from PC08 and PC03 to PC-Park, at least for the current baseline, may suggest that any ammonia sources are located above the falls.

Nitrate (NO3):
Pre-mine nitrate data (D-4) offer only limited information to the Application review and MOE supports a focus on the current baseline's development and use. MOE has the following comments:
- Temporal nitrate increases are suggested at the reference site PC10/JC03 from pre-mine to current baseline. The increase seems to remain below 0.2 mg/L, all well below the aquatic life guideline of 3 mg/L and not likely of concern.
- No temporal trending is suggested at PC08.
- The existing mine appears not to be a major current source of nitrate, based on PC03 data. No clear trends exist; most concentrations are <0.4 mg/L.
- Nitrate concentrations have increased since pre-mine in the middle creek section (PC02 vs PC below the falls) for 9 of 10 months.
- Nitrate at PC-Park also shows increasing concentrations from pre-mine to baseline (10 of 10 months). Given data for PC03, this is not likely mine related, unless via long range groundwater flow. These temporal increases of down drainage NO3 suggest a cumulative effects potential related to future loadings from the mine, if the proposed mine will affect water quality below PC-02.

MOE request (EA level): KGHM is requested to either conduct a nitrate focused cumulative effects assessment for the lower Peterson Creek or provide a clear rationale to show that the proposed mine will not have any effect on nitrate water quality downstream of PC02.

Iron (Fe):
Pre-mine iron data (D-9 & D-10) offer some insights into trending of this parameter. MOE supports a focus on the current baseline's development and use for most sites. Data from PC10/JC03 indicate no clear temporal trends. At PC08, a temporal increase is suggested for Fe-T, but not Fe-D from pre-mine to post-mine. Scaling limitation in the PC03 plot limits the review of Fe-T. Fe-D temporal trends at PC03 are not clear but suggest increases from pre-mine during summer (no winter pre-mine measures exist). Similar to Mn, Fe at PC02 seems to increase over time, but at concentrations well below the 0.35 mg/L Fe-D water quality guideline. The same can be said for Fe-T and its 1 mg/L water quality guideline. Again as with Mn, Fe measured at PC below falls and PC-Park suggest a concentration increase over time, but at lower concentrations than noted for PC02. The minor (likely natural) increases down drainage, suggest a limited cumulative effects potential from future iron loadings.

MOE request (EA level): Given that the current iron baseline may be elevated above pre-mine concentrations, KGMH is requested to determine the impact of increased iron concentrations at PC02 and points downstream on the water quality effects assessment.

Report Conclusions:
MOE does not feel the report effectively meets its stated purpose, to "provide a comparison of historical water quality to baseline conditions (2007 to present) in the Project area". MOE generally disagrees with the KGHM assessment of historical (pre-mine) data, and believes that useful information can be gleaned through their review. It is agreed that, particularly for PC03, pre-mine data are limited. However, "PC below falls" does provide almost a complete year of pre-mine data. Even for PC03, data were consistently collected for half a year. Information can be gained by comparing sites for that period. MOE also disagrees that "none of the parameters appear to be influenced by previous mining features" and believe that specific conductance, sulphate, molybdenum and manganese do show changes from PC08 to PC03, very likely attributable to the existing mine, and often simply determined by spatial comparison (i.e., not determined through review of pre-mine data). MOE also disagrees with the last paragraph of the Conclusions, that "given the limitations in the historical data previously discussed, updates to the baseline assessment, water quality model, and effects assessment with the inclusion of historical water quality data are not warranted.

MOE request (EA level): MOE requests that KGHM respond to comments raised in this memo and determine through a more detailed review of available data, methods detection levels and aquatic life guidelines whether the concentration increases suggested here are significant in terms of effects assessment at points in Peterson Creek downstream from the mine site. We also request that the potential for future cumulative effects, particularly for S04, be recognized and assessed as part of updated water quality modelling.

KGHM indicates in Section 4.1 that "other parameters show an increase in concentration between sites further downstream of the historic mine features, indicating that these parameters are not being influenced by the historical mine features."

MOE request (EA level): To eliminate the mine as a potential source for metals and sulphate concentration increases in Peterson Creek at and below PC-02, MOE requests that KGHM clearly show that no groundwater loading occurs from the mine area to Peterson Creek, from PC02.3 to PC02 and via groundwater to Peterson Creek below the waterfall (PC-EF-04 and PC-Park).

Thank you for the opportunity to continue with the assessment of aquatic impact assessment of the Ajax Mine proposal.

Respectfully submitted,

N.B. Carmichael, R.P. Bio

Contract Impact Assessment Biologist

September 28, 2016

Memo to: Gabi Matscha, R.P. Bio,

Environmental Impact Assessment Section Head – Mining

BC Ministry of Environment

Re: **Draft Review of KGHM Ajax Project "*Water Quality 2016 Update*" June 28, 2016**

As per General Service Agreement, Contract No. GS17KAE302 and your related instructions, this memo provides my draft comments on the June 28, 2016 KGHM report "*Water Quality Predictions Updates and Information Request Responses*" for your consideration. The review also includes my Round 2 comments related to this topic.

MOE finds that many of the questions we might raise in our review of this "*Water Quality 2016 Update*" (e.g. dustfall loading to Peterson Creek (MOE-046), road salt use at the mine site (MOE-047), ground water loading from the mine to PC02, etc.) are outstanding issues already raised in related correspondences (e.g. September 12, 2016 to EAO, responses to the Working Group Issue Tracking Table). With these issues still outstanding, MOE believes the same specific comments do not require repeating here. New comments raised in this current review are few. MOE will continue with the Effects Assessment following advancement of these information requirements.

My comments are as follows:

P9: Having indicated, with respect to PC02.5 and PC02.3, that "it was determined that there were significant differences in the water chemistry at each of the sites and that they should be used separately in the model to effectively under the understanding of background loading in this area of Peterson Creek", why was discussion of PC02.5 versus PC02.3 omitted from this update report (from Appendix D1 and D2)? **Clarification request (EA level).**

Page 10: Field QA data for the recent water quality update were provided for review by MOE. They have been reviewed, with no comments found necessary. Given generally low percent QA failures in field QA, MOE will retract our recent request to review the associated laboratory QA data (MOE-020 of September 12, 2016, Review of KGHM responses…. MOE-015 to MOE-071". **Issue closed.**

Page 13: MOE assumes the WMRSF is a rename of the Tailings Embankment MRSF and that related ponds 1 and 2 have also be renamed. **Clarification request.**

Page 29: MOE understands that chloride is largely from Hwy 5A. Pie chart Figure D2.2 appears to still show a very low percent of salt being produced by the mine (though these charts are very difficult to read). With KGHM's recent statement that salt would be used at the site (rather than an organic vegetable based alternative), the use of salt on the mine site should be modelled into Peterson Creek. **MOE request (EA level):** to account for mine site salting in the water quality model.

Page 68: Residual effects should also be determined for Peterson Creek below the falls, at PC-EF-04 and PC-Park as a minimum. The high levels of sulphate and selenium in the creek below PC-02 are some of the justifications for this request.
P93: KGHM states that "*The cumulative effects of urban runoff were assessed based on literature review and on all available surface water quality data for the reach of Peterson Creek below assessment node PC02 to the mouth of Peterson Creek*." MOE questions this statement. Plot D-2 of Appendix D of the Historic Water Quality Data Report clearly indicates increasing pre-mine and baseline SO4 from the mine area through PC02 and down to at least "PC below falls" and PC-Park. Concentrations downstream of the falls have historically and are today well above the BCWQGL of 429 mg/L, with some also exceeding the KGHM proposed SBEB of 730 mg/L. The Historic report understandably mentions (p15) that "This change is likely due to local groundwater discharge from the Davidson aquifer." Regardless, MOE questions whether the residual effect or cumulative effect potential of these recently reviewed historic data (PC below falls) and newly collected baseline data (PC-Park) have been considered for this section of Peterson Creek. We don't believe that all available data have been assessed and request this be completed during EA review. KGHM may be able to support a position that the potentially natural SO4 exceedences at PC below falls (pre-mine) and PC-Park (current) indicate that a higher SO4 benchmark is appropriate.
MOE request (EA level): KGHM is requested to determine whether there will be any residual effects of the mine in lower Peterson Creek at or below PC-02.

Page 68: Regarding mention of the PCDP, will the PCDP be cancelled from the project and if so, what are the implications to this WQ 2016 Update? **Clarification request.**

Page 71: Regarding the development of water quality benchmarks being required where guideline exceedances were observed under baseline conditions, MOE will consider the increase of baseline above pre-mine concentrations during our effects assessment. The natural exceedence of WQGLs by baseline should prompt application of the background concentration method. **For information.**

P93: While "Ranching activities in the LSA (Peterson Creek watershed) and the effects on surface water quality…… have thus been included in the effects assessment….", management planning that would effectively limit livestock based nutrient loading in the face of nitrogen loading from the mine, potentially address the acknowledged nitrogen limitation in Peterson Creek, and limit excessive attached algal growth in the creek is lacking. Refer to MOE comments submitted to EAO on September 12, 2016 on the KGHM May 24 memo Predicted Nitrogen to Phosphorus Ratios for Peterson Creek.
MOE comment (for permitting level)

Page 94: MOE does agree that the "cumulative residual effect of the Project on the larger Thompson River system" is likely to be negligible, at least outside the Peterson Creek mixing zone. **No further action required.**

P97: Regarding the statement "There are no residual cumulative effects on surface water quality.", MOE points to Figures 2 and 3 of the KGHM Downstream Cumulative Effects memo where we note increases downstream of PC02, particularly of SO4 and Se, but also of As, Cr and U. The Historic Water Quality report suggests that Cu, Mn and NO3 may also be parameters of interest below PC02. We believe potential residual cumulative effects to date include nitrate (cumulative with livestock), and SO4 (cumulative or at least residual to elevated baseline).
MOE request (EA level): KGHM is requested to determine whether there will be any residual effects of the mine in lower Peterson Creek at or below PC-02.

Thank you for the opportunity to continue with the assessment of aquatic impact assessment of the Ajax Mine proposal.

Respectfully submitted,

N.B. Carmichael, R.P. Bio

Contract Impact Assessment Biologist

Zurakowski, Krysia EAO:EX

From: Herbert, Brian ENV:EX
Sent: Friday, January 13, 2017 3:51 PM
To: James, Tracy A EAO:EX; Zurakowski, Krysia EAO:EX
Cc: Matscha, Gabriele ENV:EX
Subject: FW: Ajax January 2017 EA Level Red Flag Issues

Follow Up Flag: Follow up
Flag Status: Flagged

Hello,

MOE does not feel there are any real “Red Flags” or show stoppers at this time. We feel most of the issues presented below can be accomplished with clarifications or the provision of already existing data/information.

This email addresses the request for water quality issues that are necessary for MOE to undertake our effects assessment. To develop this list of critical issues, MOE has reviewed the following documents that I provided to him on December 23, 2016:

- WG ITT (MASTER)_2016-12-14_For Dist to WG_Batch 3
- 2016-12-12 1207_KAM_KP WQ Predictions Update for Changes to Conceptual Fish Offsetting Plan
- 2016-12-15 1205_KAM_KP Responses to MOE Review of Historical WQ Data Assessment
- 2016-12-06 1207_KAM_KP Round 2 NP Response
- "WG Tracking Table (MASTER 27Jul2016)" for any outstanding critical EA Level issues.

The EA Level issues are as follows. All are related to the updated water quality predictions document.

- MOE notes from Figure 3.1 of "2016-12-12 1207_KAM_KP WQ Predictions Update for Changes to Conceptual Fish Offsetting Plan" that a new "Peterson Creek Diversion Facility (PCDF)" will transfer water from Jacko Lake to Peterson Creek site PC03, along the south side of the Ajax pit. We request additional detail on why this plan was developed, whether the facility is channeled or piped, whether it has caused the pit perimeter to be changed, and most importantly, whether the loads associated with channelizing through old waste been included/updated in the water quality predictions for Peterson Creek.

- Cancelling development of the Peterson Creek Downstream Pond (PCDP) raises the question of why the approximately 1.5 km of Peterson Creek from PC03 to the confluence with Humphrey (originally planned as mine works, now fish habitat) have not been included in the water quality predictions. MOE seeks clarification as to how ground and surface water loadings, the previously identified PCDF, or other factors may cause future water quality in this section of Peterson Creek to vary from that predicted for the nearest model node, PC02.5. What is MOE to assume to be the water quality of this long section of Peterson Creek fish habitat? In order to assess the impact on aquatic life within this section, MOE may request that this section of Peterson Creek be modelled for water quality if the water quality is not shown to be reflected conservatively at another modelling node.

- MOE notes that updated predicted water quality at PC02.3 may impact aquatic life, particularly due to sulphate and selenium. Their predicted concentrations exceed not only BC water quality guidelines, but also KGHM's proposed SBEBs. If habitat focused mitigation to pump compensation water from Kamloops Lake is being seriously considered, the related dilution effects to Peterson water quality should be modelled as part of EA review. This will allow our assessment of the efficiency of this mitigation for water quality protection. Without

this modelling, MOE will use the newly predicted concentrations in Peterson Creek without augmentation which would result in potential concentrations that are unacceptable for the protection of aquatic life.

- MOE notes that in "2016-12-12 1207_KAM_KP WQ Predictions Update for Changes to Conceptual Fish Offsetting Plan" only the Base Case water quality predictions have been updated and reported. While the water quality model Sensitivity Analyses are discussed, predicted concentrations are missing for either Catergory 1 or 2 parameters under the SA conditions. MOE believes those conditions that justified an update of the Base Case model should also apply to the SA scenarios. Reporting of Catergory 2 parameters in Table 4.1, suggests that the SA predictions were also updated, but not reported. We request that SA predictions for Category 1 and 2 parameters be provided for our upcoming effects assessment review (digital format).

MOE has noted inconsistencies in the water balance and water quality iterations, so want to make sure that this is not the case here.

As stated in Knight Piésold (KP) memo entitled “Ajax Project – Water Quality Predictions Update Based on Changes to the Conceptual Fish Offsetting Plan” dated December 7, 2016 (1207_KAM_KP WQ Predictions Update for Changes to Conceptual Fish Offsetting Plan), a number of water balance updates were implemented to reflect design changes specific to the updated conceptual fish offsetting plan (0706_KAM_Fish Habitat and Fishery Offsetting Plan). However, additional changes to the Tailing Storage Facility (TSF) operating pond volume (3 Mm^3 from 11 Mm^3) and water management pond volumes (1000 m^3) were also implemented. In terms of the updated water balance model, MOE has reviewed the version described in BGC’s memo entitled “Ajax Project, 2016 Water Balance Model Update” dated June 10, 2016 (0609_KAM_WBM_BGC_015) . None of the changes described in KP (2016) were mentioned in the BGC (2016) updated water balance model memo. It is understood that the streamflow mitigation option of flow augmentation in Lower Peterson Creek pumped from Kamloops Lake has not been incorporated in the updated water balance or water quality models.

Based on the above, MOE would like to clarify the following:

- What version of the water balance was used for the water quality predictions in the KP memo (2016)? Is it consistent with the version described in the above-mentioned BGC memo (2016)?
- What was the reasoning behind the reduction in the TSF operating pond volume by over 70%?
- In terms of the Peterson Creek diversion channel updated design, how has this been incorporated in the water balance or water quality model?
- A concise summary of water management updates that *have* been incorporated in the latest water balance model should be provided in order to ensure consistency in the updated water quality predictions.

We believe that most of these should not be a great deal of work for the proponent to complete and we are open to having a discussion with them on the points.

Please let me know if you have any questions on these.

Have a great day.

As always,
Brian
Reduce, Reuse & Recycle