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BGC Project Memorandum

To:	**Mount Polley Mining Corporation**	**Doc. No.:**	
Attention:	**Luke Moger, Katie McMahen (MPMC)**	**cc:**	**Tom Harper, Todd Martin**
From:	**Daryl Dufault**	**Date:**	**May 15, 2014**
Subject:	**Mount Polley Mine Water Balance Model: Review Comments**		
Project No.:	**1197001**		

1.0 INTRODUCTION

Mount Polley Mining Corporation (MPMC) has developed an Excel-based site-wide monthly water balance model. The model indicates that, consistent with MPMC's operating experience in recent years, the site operates under a net annual water balance surplus. The surplus is aggravated by the expansion of the runoff collection system around the mine site that has increased the overall catchment area contributing to the site-wide water balance. This accumulating surplus is stored within the tailings storage facility (TSF).

The accumulating surplus has the following short and longer term effects:

- Annual dam raise requirements are accelerated.
- Wide above-water tailings beaches, separating the dam from the reclaim water pond, which is a fundamental structural element of the dam, cannot be maintained.
- MPMC's longer term plans for mine expansion, and commensurate expansion of the TSF storage capacity, are inhibited as tailings storage capacity is displaced by the accumulating surplus water.

Over the past year, MPMC has undertaken work to quantify the site water balance, and to develop strategies for elimination of the accumulating water balance surplus, and for gradual draw down of the surplus water volume already stored within the TSF. Those efforts included consultation with the B.C. Ministry of Environment (MOE), which is understood to have approved, in principle, MPMC's plans for water treatment and discharge of up to 3 Mm^3 per year of treated water to Polley Lake. MPMC has an existing permit for discharge of surplus water to Hazeltine Creek, but limitations in terms of rate and seasonality of discharge, and the actual versus dischargeable water quality, are such that minimal surplus water is discharged from the site relative to the remaining surplus.

The Excel-based monthly water balance model developed by MPMC considers average, dry, and wet year scenarios. MPMC has used this model to evaluate scenarios to guide TSF dam crest raising requirements for the next year (i.e. the 2014 crest raise), and for five years, by which time the accumulated surplus would be expected to be eliminated, and wide above-water tailings beaches established and consistently maintained. The variables considered in the one year and five year projections were as follows:

- One year projections (required 2014 TSF dam crest raise):
  - timing of the start of water treatment and discharge to Polley Lake
  - volume of water discharged to Polley Lake
  - volume of water discharged to Hazeltine Creek (per existing permit)
  - average, and 1 in 200 year return period wet and dry year conditions
- Five year projections, considering average year conditions over 5 years:
  - timing of the start of water treatment and discharge to Polley Lake
  - volume of water discharged to Hazeltine Creek

With the water balance model constructed and now being used for short and long term planning, this represented an opportune time to conduct a review of the model and of the assumptions and parameters underlying it. BGC Engineering Inc. (BGC) engaged Dr. Peter McCreath of Clearwater Consultants Inc. (Clearwater) to undertake the review. Comments provided by Clearwater are provided in Section 2, and recommendations in Section 3.

2.0 CLEARWATER CONSULTANTS INC. REVIEW OF WATER BALANCE

2.1. Information Provided for Review

The information provided by BGC to Clearwater to form the basis of the review is listed in Table 2-1. Following.

Table 2-1. Information provided for Clearwater Review.

Document/File	Description
File: MPMC – Site Water Balance 2014_predictive.xls	Monthly water balance model.
File: MPMC – Site Water Balance 2014_predictive with 1 and 5 year scenarios.xls	Monthly water balance model developed by MPMC, with additional tabs summarizing one and five year scenarios.
BGC memorandum "Mount Polley Mine Site Visit – Trip summary and path forward", dated June 18, 2013.	Provides general project background and a discussion of the water balance issues and concerns.
MOE letter to MPMC entitled "Confirmation of terms of reference for the technical assessment report for the discharge of treated mine water to Polley Lake", dated March 26, 2014.	MOE approval in principle for water treatment concept involving annual discharge of 3 Mm^3 of treated water to Polley Lake.
Aerial photograph of the site (2012)	General site information.
Site facilities map, comprising an aerial photograph with key water balance elements overlain.	General site information.
Appendix A from the Knight Piesold 1995 TSF design report. Appendix entitled "Report on Project Water Management".	Includes site hydrometeorology, and water balance projections.
Appendix D from 2005 Knight Piesold updated design report. Appendix entitled "Mount Polley Water Balance".	Includes updated site hydrometeorology and water balance projections.

2.2. Review Comments

Review comments provided Clearwater are as listed below, and refer to specific worksheets (tabs) within the Excel files. These comments are also embedded in the file "*7_MPMC – Site Water Balance 2014_Predictive With 1 and 5 Year Scenarios_PM.xlsx*", which has been forwarded to MPMC in a separate email. Comments generally apply also to file "*6_MPMC – Site Water Balance 2014_Predictive _PM.xlsx*" although the numbers differ a little between the two files (calculated annual average surpluses of 2.28 Mm^3 and 2.03 Mm^3 for the two files respectively.

1. Tab \Summary\ (only in file "*6_MPMC – Site Water Balance 2014_Predictive _PM.xlsx*") – the calculation in cell C7 is incorrect - should subtract 3,000,000 not 30,000. This means the "Total Volumes" shown in cells D22 to J22 are all incorrect (too high) for the Five Year Annual Accumulation Projections.
2. Tab \Constants\ (both files)

a. Runoff coefficients (E4, E5) of 0.0 for "Disturbed Areas" and "RSDS Areas" for July to October are not realistic, especially for wet years. Net result with more realistic coefficients would be overall higher runoff volumes, especially for wet years.
b. Groundwater/seepage infiltration rates to the open pits (E24 to E26, especially Cariboo & Springer) appear to be very conservatively based on the maximum values at the completion of mining for each pit.
    - Are all pits at maximum and being pumped out at the same time?
    - These volumes contribute about half of the average annual surplus.
    - The KP 2004 report indicates that some perimeter runoff water would be directed to a pit after mining to accelerate pit filling.
    - Rates should be adjusted for each year to more realistically represent actual projected conditions.
c. Water shown as "Geology input" and "Freshwater well" (E15, E16) – if this is potable and treated as sewage, it could be disposed of separate from the TSF. If this is part of the process then the reclaim from the TSF (point 4e below) should be decreased accordingly.
d. Other input constants appear reasonable

3. Tab \Enter Site Data – AVERAGE\ (both files)
    a. The water balance model does not appear to have been calibrated against previous years using actual values of parameters such as precipitation, runoff and pond volumes. Calibration would allow better assessment of appropriate runoff coefficients.
    b. Annual precipitation used (668 mm) is less than used in the earlier Knight Piesold studies (740 mm). Site precipitation analysis should be redone using all up to date and concurrent site data and regional AES data.
    c. No allowance appears to be made for winter sublimation losses from the snowpack. Net result would be less runoff if sublimation was included.
    d. It is unclear how the average, wet and dry monthly precipitation (rain and snow) values were derived. The earlier Knight Piesold study used precipitation from the Horsefly station to scale for Mt. Polley, whereas the MPMC model apparently uses Likely station (1974 to 1993) plus "available site records". The MPMC model assumes a 200 year return period for wet and dry years. It is probably worthwhile to update the site precipitation analysis using all available site data plus Horsefly data up to 2013.
    e. The total evaporation values used are reportedly based on site values but it is not clear if these are site-measured Pan Evaporation values or calculated Lake Evaporation values. If these are Pan Evaporation values, then the model estimates more evaporation losses than actual. Lake Evaporation values would typically be about 70% of Pan Evaporation values.
    f. The equations in cells E19-G19 are incorrect – correct equations would yield more flow from Joe's Creek Pipe in November through January and hence more inflow to the TSF.

4. Tab \Water Balance – AVERAGE\ (both files)
    a. Groundwater infiltration rates to the pits are maximums (point 2b above) and are perhaps too high. The net result may be too much apparent inflow to the system.
    b. Water consumed by dust control & sprinklers for the Cariboo Pit is greater than the total of all the inflows to the Cariboo Pit. Is the difference in reality to be made up by pumping from elsewhere?
    c. Row 17 ("From Geology/Mill Potable Water") – could the potable water (point 2c above) be treated as sewage and released rather than being pumped into the TSF? If it is process water, then the "Recycled Supernatant" (i.e. reclaim) should be decreased (point 4e below).
    d. Row 21 cells D22.F22 Joe's Creek Pipe values are too low per point 3f above
    e. Row 46 "Recycled Supernatant" assumes 100% reclaim, i.e. zero freshwater process and ore moisture inputs. This seems optimistic. The net result of accounting for any freshwater process and ore moisture inputs should be less reclaim and more net inflow to the TSF. Ore moisture is not accounted for anywhere in the model.
    f. Row 47 "Seepage from Toe Drains" appears to be treated as a net loss from the system. Is this correct, i.e. is all of this water constantly released from the system, or should these volumes be assumed collected in the perimeter ditches and pumped back into the TSF? The volume is significant (2.6 Mm^3/year) and more than the apparent calculated annual average surplus (2.28 Mm^3). The water balance schematic indicates that all of the South Toe Drain flow is recycled to the TSF, however flows from the Main Toe Drain and the Perimeter Toe Drain may be either recycled to the TSF or discharged to Hazeltine Creek (at a maximum rate of only 82,000 m^3/year?). This needs to be checked.

2.3. Recommendations

Overall the model appears reasonable, subject to the comments and issues raised above, and in particular point 4f regarding the Toe Drain Seepage. The following recommendations are provided on the basis of the review:

1. Attempt to calibrate the model (such as runoff coefficients) using actual past performance including measured precipitation, rainfall, snowfall, pond volumes etc.
2. Re-work the site precipitation analysis including all site data and concurrent Horsefly data up to 2013. Correlations should be developed between site and Horsefly for common years/months and between Horsefly and Likely. The Likely station is closest to the site but has no concurrent data with the site.
3. Check evaporation values – are they pan evaporation or lake evaporation in the water balance model?
4. Develop a linked continuous water balance model covering the entire mine operating period and into closure into which could be input actual values including precipitation, tonnage, pond volume. as mining proceeds.
5. Develop reasonable variations over the operating mine life for the rates of groundwater infiltration into the pits. Revise the model to allow for pit filling after each pit is mined out.
6. Confirm what actually is happening with the Toe Drain Seepage. How much is actually returned to the TSF and how much is released from the system. Revise the model accordingly. This item may potentially have the most significant impact on the model conclusions.

3.0 CLOSURE

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Yours sincerely,

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