Additional Information Request # 8

Groundwater Seepage from the PSMF and MRSA

Related Comments:

CEAR #550 (Natural Resources Canada)

In its review of SCI's response to IR 24.15, Natural Resources Canada noted that additional information is needed to assess the accuracy of the values presented in Tables B and C (IR 24.15), which it considers important in the technical review of the information related to groundwater, particularly as the values in these tables provide the basis for determining estimates for COPCs in surface water receptors.

Provide the following information:

Per Table B, IR 24.15, "Maximum Loadings from MRSA":

- Specify the rate of seepage used in the calculation of MRSA seepage loadings (Table B); and
- Discuss the appropriateness of the seepage rate used, including reference to specific sections and page numbers of the EIS.

Per Table C, IR 24.15, "Maximum Loadings from PSMF Seepage to Receiving Surface Waters":

- Specify the rate of seepage from the PSMF used in the calculation of values in Table C; and
- Discuss the appropriateness of the seepage rate used, including reference to specific sections and page numbers of the EIS.

SCI Response:

Seepage Rates Related to the MRSA

Figure AiR 8-1 illustrates the components of the water balance for the MRSA that includes seepage of contact water from the rock stockpile that flows along the natural ground to the catch basins and the seepage into the natural ground below the MRSA that becomes groundwater. The values on schematic in Figure AiR 8-1 show that the components of flow of contact water as surface runoff represents about 1,700 m^3/day (897 runoff + 803 seepage) while the groundwater component representing contact water is only about one-eighth of the surface component or 204 m^3/day. The surface water flow component was developed using reasonable and conservative representations of components for a mine rock pile. The groundwater seepage component was developed from the MODFLOW groundwater model for the appropriate hydrogeologic conditions at the site and the respective flow conditions represented by the open pit to the west and Pic River to the east as discussed in SID 15 (TGLC, 2012).

Seepage Rates Related to the PSMF

The seepage rates from the PSMF used to calculate the mass loadings presented in Table C of IR 24.15 were derived from the results presented in the Knight Piesold memorandum NB13-00080; entitled "Process Solids Management Facility Seepage Analysis" (dated June 10, 2013, attached). The majority of seepage from the PSMF will occur to the base of the perimeter embankments (refer to Figure AiR 8-2), and the above-noted memorandum outlines the modelling approach and assumptions used to estimate these rates. The values presented in Table C of IR24.15 are from Year 12 of operations and are conservative representations of conditions post-closure. The seepage values used in the response to IR 24.15 are as follows:

- Cell 1 Seepage Flow to Stream 1: 0.03 L/s (Year 12)

- Cell 1 Seepage Flow to Stream 6: 0.57 L/s (Year 12)
- Cell 2 Seepage Flow to Stream 6: 1.06 L/s (Year 12)
- Cell 2 Seepage Flow to Stream 5 (Hare Creek): 1.1 L/s (Year 12)

The estimated seepage rates account for seepage through the bedrock to the base of the perimeter embankments, as well as potential defects in the HDPE geomembrane that will be installed on the upstream face of the embankment. The HDPE geomembrane will be connected to the prepared bedrock foundation via a concrete plinth. The seepage model accounts for foundation grouting, the proposed embankment construction method and process solids material parameter values from laboratory test work. The material parameter values used in the model are summarized in the seepage analysis memorandum noted above (KP Memorandum NB13-00080).

During operations, virtually all seepage from the PSMF will be collected and managed within the downstream collection basins, as required. A small percentage of seepage may occur in the deeper groundwater flow paths that will not be intercepted by the collection basins. However, as shown below, the effect of this deeper seepage on downstream water quality will be negligible. Collected seepage can be pumped back to the closed-circuit operations of the PSMF, if necessary. Following closure, the above seepage rates and their potential impact on the receiving environment have been assessed within the EIS and the responses to the information requests to the JRP. The seepage rates are considered reasonable given the design basis for the PSMF, and the indicated low permeability bedrock foundation. However, it is recognized that there may be some uncertainty in the long term performance of the engineered elements and the hydraulic conductivity of the foundation materials beneath the PSMF, and that seepage rates could be greater than the values above. For example, hydraulic conductivities in the upper bedrock may be locally higher beneath parts of the PSMF, reducing the effective width of the lower hydraulic conductivity achieved by the grouting program. In addition, while small in relation to the seepage at the embankment locations, there would be a relatively minor component of seepage in the deeper bedrock beneath the PSMF to discharge locations beyond the toe of the perimeter embankments. These factors, combined, are reflected in the conclusions of the KP Memorandum NB13-00080 which notes that the "*seepage analysis provides an order of magnitude seepage estimate from the PSMF during the 12 year mine life and at closure*". Therefore, a sensitivity analysis was completed to determine the effects of increased seepage flow on the quality of water in the receiving streams (1, 5 and 6).

Should seepage rates be greater than those assumed, Stillwater remains confident that the resulting concentrations in the receiving environment will remain within acceptable ranges given that concentrations of COPCs in the PSMF seepage will remain relatively low. Screening level calculations (refer to Tables AiR 8-1 through AiR 8-3) indicate that at three times the seepage rates forecast above, concentrations in the receiving streams would remain at, or below, benchmark concentrations in the receiving environment. Even with a 10 times increase in the seepage rates above those calculated, most COPCs would not exceed benchmark values in the receiving streams, and there would be only marginal exceedances in Stream 6 for a few constituents (Al, Cd, Fe, Se and U). Given the conservative approach used to predict the porewater concentrations in the process solids and no that consideration has been given to attenuation along the groundwater flow path, Stillwater is fully confident in the performance of the PSMF during operations, and post-closure. Through ongoing site characterization of the PSMF foundation and refinements in the engineering design (and through feedback from the monitoring programs during operations), Stillwater will continue to refine the design (implementing mitigation measures as required) to ensure acceptable downstream environmental performance of the facility both during operations, and post-closure.

Table AiR 8-1: Sensitivity Analysis of PSMF Seepage on Water Quality in Stream 5

COPC	Units	Stream 5 Benchmark	Stream 5 Background	Predicted Stream 5 Water Quality		
				Base Case	3X Seepage	10X Seepage
Sulphate (SO_4^{2-})	mg/L	-	3.6	4.4	6.0	11.7
Aluminum (Al)	mg/L	0.14	0.14	0.14	0.14	0.14
Arsenic (As)	mg/L	0.0050	<0.0010	0.001	0.001	0.001
Cadmium (Cd)	mg/L	0.00009	<0.00009	0.00009	0.00009	0.00009
Cobalt (Co)	mg/L	0.00090	<0.00050	0.0005	0.0005	0.0005
Copper (Cu)	mg/L	0.0020	0.0010	0.001	0.001	0.001
Iron (Fe)	mg/L	0.97	0.97	0.97	0.97	0.97
Molybdenum (Mo)	mg/L	0.040	<0.0010	0.001	0.002	0.006
Nickel (Ni)	mg/L	0.025	<0.0020	0.002	0.002	0.002
Lead (Pb)	mg/L	0.0010	<0.0010	0.0010	0.0010	0.0010
Selenium (Se)	mg/L	0.0010	<0.00040	0.0004	0.0004	0.0005
Uranium (U)	mg/L	0.0050	<0.0050	0.005	0.005	0.005
Vanadium (V)	mg/L	0.0060	<0.0010	0.001	0.001	0.001
Zinc (Zn)	mg/L	0.020	0.0060	0.006	0.006	0.006

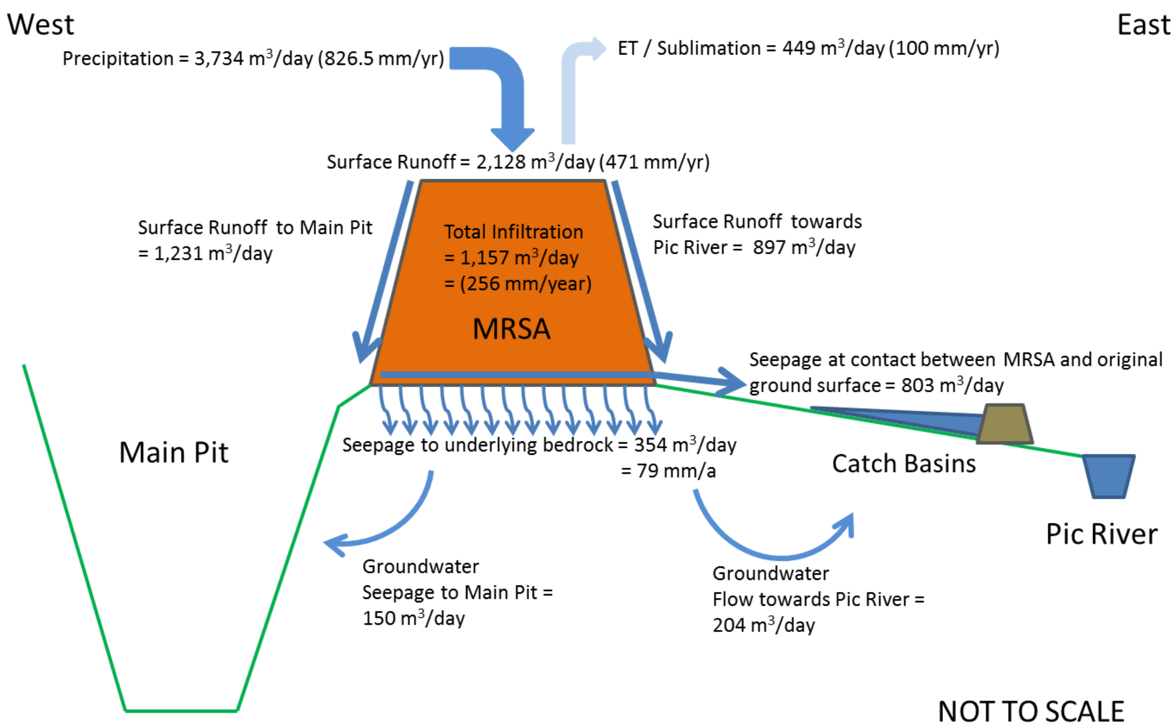
Table AiR 8-2: Sensitivity Analysis of PSMF Seepage on Water Quality in Stream 6

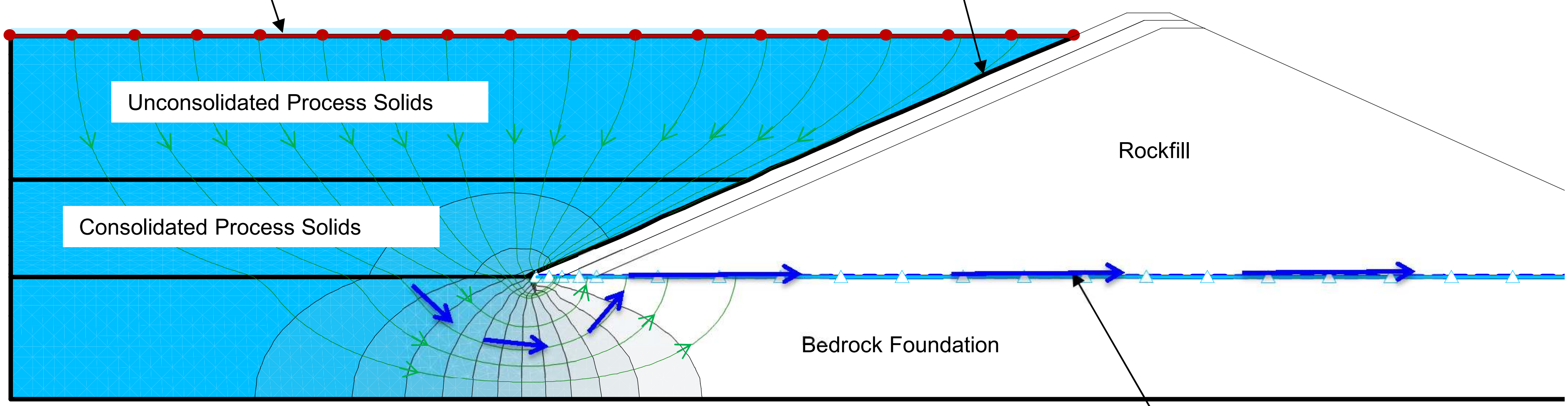
COPC	Units	Stream 6 Benchmark	Stream 6 Background	Predicted Stream 6 Water Quality		
				Base Case	3X Seepage	10X Seepage
Sulphate (SO_4^{2-})	mg/L	-	3.6	8.3	17.8	50.9
Aluminum (Al)	mg/L	0.14	0.14	0.14	0.14	0.16
Arsenic (As)	mg/L	0.0050	<0.0010	0.001	0.001	0.002
Cadmium (Cd)	mg/L	0.00009	<0.00009	0.00009	0.00009	0.00010
Cobalt (Co)	mg/L	0.00090	<0.00050	0.0005	0.0005	0.0006
Copper (Cu)	mg/L	0.0020	0.0010	0.001	0.001	0.001
Iron (Fe)	mg/L	0.97	0.97	0.97	0.97	0.98
Molybdenum (Mo)	mg/L	0.040	<0.0010	0.004	0.010	0.031
Nickel (Ni)	mg/L	0.025	<0.0020	0.002	0.002	0.002
Lead (Pb)	mg/L	0.0010	<0.0010	0.001	0.001	0.001
Selenium (Se)	mg/L	0.0010	<0.00040	0.0005	0.0006	0.0011
Uranium (U)	mg/L	0.0050	<0.0050	0.005	0.005	0.006
Vanadium (V)	mg/L	0.0060	<0.0010	0.001	0.002	0.004
Zinc (Zn)	mg/L	0.020	0.0060	0.006	0.007	0.008

Table Air 8-3: Sensitivity Analysis of PSMF Seepage on Water Quality in Stream 1

COPC	Units	Stream 1 Benchmark	Stream 1 Background	Predicted Stream 1 Water Quality		
				Base Case	3X Seepage	10X Seepage
Sulphate (SO_4^{2-})	mg/L	-	2.6	2.7	3.1	4.1
Aluminum (Al)	mg/L	0.075	0.040	0.040	0.040	0.040
Arsenic (As)	mg/L	0.0050	<0.0010	0.001	0.001	0.001
Cadmium (Cd)	mg/L	0.00009	<0.00009	0.00009	0.00009	0.00009
Cobalt (Co)	mg/L	0.0012	0.0012	0.001	0.001	0.001
Copper (Cu)	mg/L	0.0040	0.0040	0.004	0.004	0.004
Iron (Fe)	mg/L	2.7	2.7	2.7	2.7	2.7
Molybdenum (Mo)	mg/L	0.040	<0.0010	0.001	0.001	0.002
Nickel (Ni)	mg/L	0.025	0.0050	0.005	0.005	0.005
Lead (Pb)	mg/L	0.0014	0.0014	0.001	0.001	0.001
Selenium (Se)	mg/L	0.0010	<0.00040	0.0004	0.0004	0.0004
Uranium (U)	mg/L	0.0050	<0.0050	0.005	0.005	0.005
Vanadium (V)	mg/L	0.0060	0.0050	0.005	0.005	0.005
Zinc (Zn)	mg/L	0.020	0.011	0.011	0.011	0.011

Figure AiR 8-1: Schematic illustrating the overall water balance for the MRSA and flows to the open pit and Catch Basins.





Seepage from the PSMF reports to the original ground surface within the rockfill embankment foot print and flows towards the downstream toe of the embankment

LEGEND:

- SEEPAGE PATH LINES
- HYDRAULIC HEAD CONTOUR LINES
- PROCESS WATER POND
- SEEPAGE FACE

STILLWATER CANADA INC.

MARATHON PGM-Cu PROJECT

PROCESS SOLIDS MANAGEMENT FACILITY
SEEPAGE CONDITIONS FOR TYPICAL EMBANKMENT CROSS-SECTION

Knight Piésold CONSULTING

P/A NO. NB101-446/5

REF. NO. NB14-10

FIGURE AIR 8-2

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	20JAN'14	ISSUED WITH TRANSMITTAL FOR AIR #8	JAM	CNH	CNH