Attachment B – Sensitivity Analysis for Hydraulic Conductivity of Shallow Bedrock

The groundwater flow model described in TSD 4 was used to perform a sensitivity study to evaluate the effect of shallow bedrock hydraulic conductivity on seepage by-pass. Table 1 below summarizes predicted seepage by-pass (in m^3/day) for different reaches along the perimeter of the TSF/WRSF (see attached figure for numbering of perimeter reaches). Seepage by-pass is the portion of seepage from the TMF and MRMF that is not collected by the seepage collection system. The first column shows the predicted fluxes for the last time step of the transient base case (reported in the earlier modeling report submitted to the agencies). The total seepage by-pass computed using the zone budget is about 3,700 m^3/day.

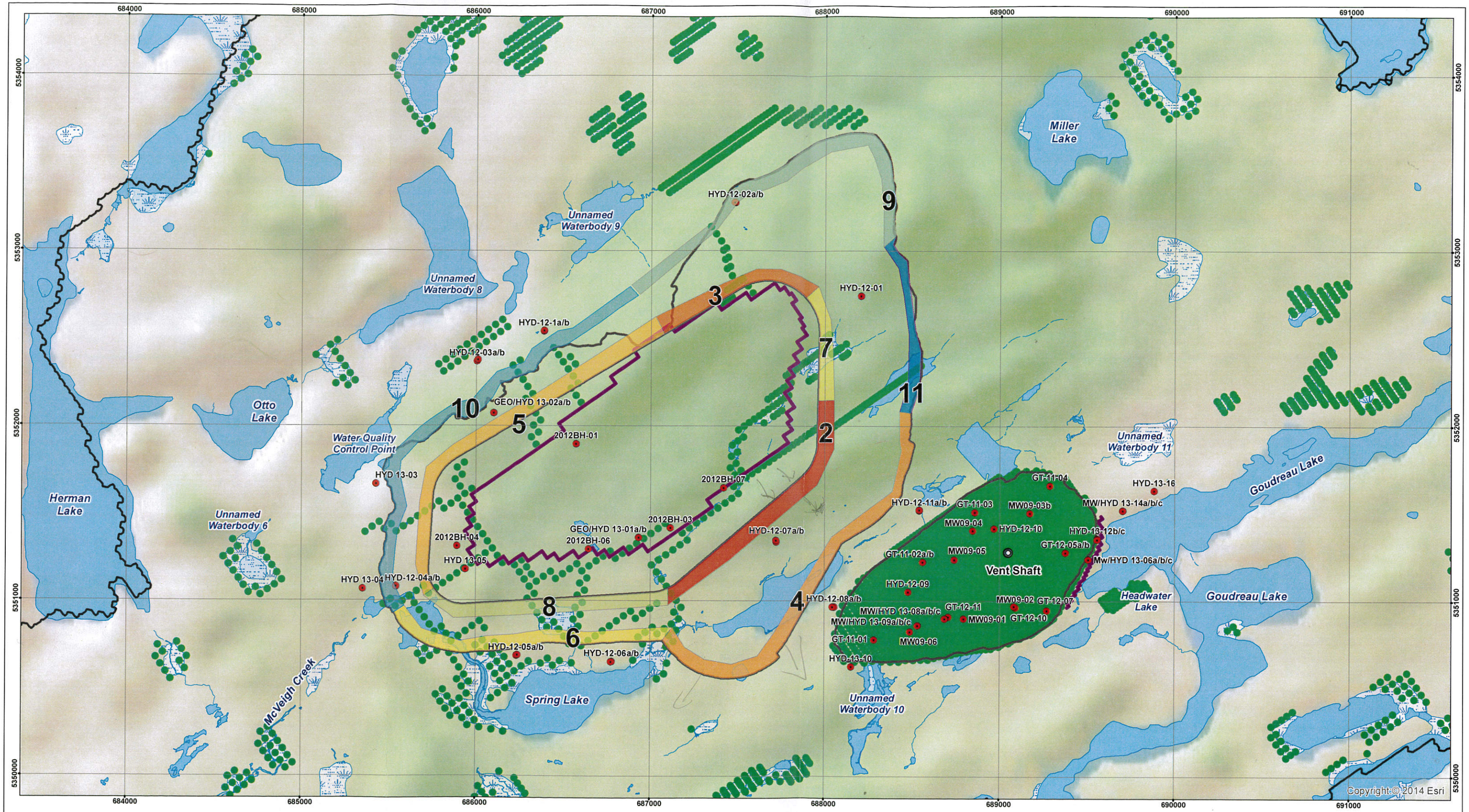
The second column shows the base case scenario run assuming steady-state at the end of mining, i.e. the same flow field used to complete particle tracking presented in TSD 4. Note that the total seepage by-pass for this steady-state scenario using the calibrated K (base case scenario) is slightly lower (3,324 m^3/day) than for the transient base case.

The other columns show the computed fluxes for different scenarios of bedrock K (assuming steady-state flow). As expected, increasing K for model layers 2-4 (0-60m below top of bedrock [bToBr]) results in the greatest increase in seepage by-pass. Adjusting Bedrock K only in layer 2 (0-20m bToBr) results in less seepage by-pass. Assuming an increase in K in the top 10m of bedrock has very little effect on seepage by-pass. For example, even with a very high K of $2x10^{-5}$ m/s for the upper 10m of bedrock the predicted seepage by-pass increases only by 2% to 8%.

In other words, this sensitivity analysis suggests that uncertainty in bedrock K in the upper 10m (highlighted in the comments from CEAA) is NOT a very sensitive parameter for estimation of seepage by-pass. This is because the upper 10m are under the influence of the shallow drains and the thickness of the higher K zone for potential by-pass is relatively small (max 10m). Note that we have much better K data to constrain K in model layers 2-4 than in the top 10m so the reported sensitivity runs assuming $K=2x10^{-5}$ m/s for layers 2-4 are highly unlikely and are only included here for comparison.

Table 1 – Results of Sensitivity Analysis

FROM ZONE X TO ZONE 1: Flow rates m^3/d (Zone X is the corresponding zone shown in the attached figure)											
	Base Transient	**Base Steady-State**	**Layers 2 to 4**			**Only Layer 2**			**Only 10 m shallow bedrock**		
Zone	K = 1.4e-6 (m/s)	K = 1.4e-6 (m/s)	K = 3.0e-6 (m/s)	K = 6.0e-6 (m/s)	K = 2.0e-5 (m/s)	K = 3.0e-6 (m/s)	K = 6.0e-6 (m/s)	K = 2.0e-5 (m/s)	K = 3.0e-6 (m/s)	K = 6.0e-6 (m/s)	K = 2.0e-5 (m/s)
4	1944	1559	2145	3121	7026	1644	1760	2230	1562	1591	1685
6	568	245	348	511	1106	243	264	404	222	220	262
9	466	619	655	725	1100	633	648	738	630	637	661
10	586	661	985	1420	2764	733	830	1142	671	688	749
11	187	239	301	363	476	248	259	290	239	240	247
TOTAL	**3751**	**3324**	**4434**	**6139**	**12473**	**3501**	**3761**	**4803**	**3323**	**3376**	**3604**



Legend

- Well Location
- Proposed Outline of Open Pit, TMF, MRMF
- Domain Boundary
- Cutoff Wall
- TMF, MRMF Drain

ZONE BUDGET	
2	7
3	8
4	9
5	10
6	11

Zonation for Flux Calculation

Magino Gold Project, Ontario

Scale 1:20,000

0 0.125 0.25 0.5 0.75 1 1.25 Km

NAD 83/UTM Zone16N

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Client: ARGONAUT GOLD	**Figure: 1**
Project: Magino Gold Project	Project No:211003
Report: RGC 211003/1	Last Update: May 15, 2018
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