

APPENDIX N-1: Post Closure Nondegradation Evaluation



MEMORANDUM

DATE: June 10, 2016

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FROM: Greg Bryce, Project Manager
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SUBJECT: Post Closure Nondegradation Evaluation, Black Butte Copper Project

Hydrometric has conducted an evaluation of nondegradation criteria for Post Closure water quality flowing through the mine working of the Upper Copper Zone (UCZ) at the Black Butte Copper Project. The UCZ mine workings are proposed to be developed in four hydro-stratigraphic units: Upper Newland Shales (Ynl A), Upper Sulfide Zone (USZ), Upper Copper Zone (UCZ) and the Lower Newland Shales (Ynl B). The nondegradation analysis was conducted from wells completed within these hydro-stratigraphic units in the vicinity of the UCZ as discussed below and listed in Table 1. The nondegradation criteria were evaluated based on the following elements listed below:

- Ambient groundwater conditions are based on wells completed in the Ynl A, USZ, UCZ, and Ynl B. Water quality data from wells MW-1B, MW-2A, MW-2B, MW-3, MW-9, PW-2, PW-3, PW-4, PW-8, PW-9, and PW-10 were combined; statistics were generated for the 25th, mean and 75th percentiles values. In most cases the 75th percentile value was used to represent ambient water quality.
- Only those parameters that have groundwater standards were evaluated. No additional human health advisories were incorporated into the analysis, however this may occur during the MEPA process.
- The development of the nondegradation criteria used the procedures found in ARM17.30.715. Based on the parameter category the criteria were developed as:
 - No increase allowed in the receiving water for carcinogens and toxics with a BCF>300.
 - An increase (in the receiving water) of 15% of the most stringent water quality standard for toxic parameters.
 - An increase (in the receiving water) of 10% of the most stringent water quality standard for harmful parameters.

- When water quality standards were not promulgated, yet a trigger value was available, the ambient water quality and trigger value were used to set the nondegradation criteria.

Compliance with the nondegradation nonsignificant policy is evaluated by comparing the resulting water quality at closure to the nondegradation criteria calculated by summing the preexisting water quality and the nondegradation criteria. The statistic of the groundwater data and nondegradation evaluation is summarized in Table 1.

To meet the non-significance criteria at closure the following water management option are available:

- Request a regulatory mixing zone (standard or source specific) for ambient mixing of groundwater and waters generated in the mine void. Care should be taken to exclude any influences to surface waters prior to achieving the nondegradation criteria.
- Additives could be included in the paste backfill to limit the leaching of constituents (if any).

Table 1. Estimated Groundwater Non-Degradation Criteria for Underground Workings at Closure

Constituent	Groundwater Wells (MW-1B, MW-2A, MW-2B, MW-3, MW-9, PW-2, PW-3, PW-4, PW-8, PW-9, and PW-10)			Groundwater Human Health Standard	Category	Non Deg Trigger Level	Ambient + Trigger	Applicable Nonsignificance Factor ARM 17.30.715	Non Deg Threshold	Required Reporting Limit (RRL)	Estimated Non-Degradation Criteria
	25%ile	75%ile	Average								
ALUMINUM (Al)	<0.009	0.028	0.015	--	Toxic	0.03	0.0580	--	--	0.009	--
ANTIMONY (Sb)	<0.0005	0.0011	0.0012	0.006	Toxic	0.0004	0.0015	0.15	0.0009	0.0005	0.002
ARSENIC (As)	0.003	0.064	0.034	0.010	Carcinogen	NAI	NAI	NAI	NAI	0.001	0.064
BARIUM (Ba)	0.013	0.043	0.035	1.0	Toxic	0.002	0.0448	0.15	0.1500	0.005	0.193
BERYLLIUM (Be)	<0.0008	0.0010	0.0009	0.004	Carcinogen	NAI	NAI	NAI	NAI	0.001	0.0010
CADMIUM (Cd)	<0.00003	0.00007	0.00004	0.005	Toxic	0.0001	0.0002	0.15	0.0008	0.00008	0.00082
CHROMIUM (Cr)	<0.001	0.010	0.006	0.1	Toxic	0.001	0.0110	0.15	0.0150	0.001	0.025
COBALT (Co)	<0.01	0.01	0.01	--	--	--	--	--	--	0.01	--
COPPER (Cu)	<0.001	0.002	0.002	1.3	Toxic	0.0005	0.0025	0.15	0.1950	0.001	0.197
FLUORIDE (F)	0.30	0.60	0.43	4.0	Toxic	0.005	0.6050	0.15	0.6000	0.001	1.20
IRON (Fe)	0.068	2.140	5.513	--	Harmful	--	--	--	--	0.05	--
LEAD (Pb)	<0.0003	0.0005	0.0015	0.015	Toxic	0.0001	0.0006	0.15	0.00225	0.00050	0.0028
MANGANESE (Mn)	0.012	0.085	0.052	--	--	--	--	--	--	0.005	--
MERCURY (Hg)	<0.000005	0.000010	0.000007	0.002	Toxic w/ BCF >300	NAI	NAI	NAI	NAI	0.00001	0.000010
MOLYBDENUM (Mo)	<0.002	0.005	0.003	--	--	--	--	--	--	0.002	--
NICKEL (Ni)	0.001	0.010	0.005	0.1	Toxic	0.0005	0.0105	0.15	0.0150	0.010	0.025
SELENIUM (Se)	0.0002	0.0010	0.0006	0.05	Toxic	0.0006	0.0016	0.15	0.0075	0.0010	0.009
SILVER (Ag)	<0.0005	0.0200	0.0106	0.1	Toxic	0.0002	0.0202	0.15	0.0150	0.001	0.0350
STRONTIUM (Sr)	0.10	6.48	3.84	4.0	Toxic	0.1	6.5800	0.15	0.6000	0.0002	6.48
THALLIUM (Tl)	0.0004	0.0039	0.0040	0.002	Toxic	0.0003	0.0042	0.15	0.0003	0.0002	0.0039
URANIUM (U)	0.0010	0.0080	0.0047	0.03	Carcinogen	NAI	NAI	NAI	NAI	0.008	0.0080
ZINC (Zn)	0.002	0.01675	0.01573	2.0	Toxic	0.005	0.0218	0.15	0.3000	0.01	0.32
NITRATE + NITRITE AS N	0.0100	0.0450	0.0637	10	Toxic	7.5	7.5	0.15	7.5	0.01	7.5
NITROGEN (N) TOT	0.5	0.5	0.5	--	Nutrient	--	--	--	--	0.01	--
PHOSPHORUS (P) TOT	0.0	0.0	0.0	--	Nutrient	0.001	--	--	--	0.001	--
PH FLD (S.U.)	6.5	7.3	6.9	6.5-8.5	Harmful	0.5 s.u.	--	--	--	--	6.0 -7.8
SPECIFIC CONDUCTIVITY (UMHOS/CM)	451.0	751.0	592.7	<1000	Class I GW	--	--	--	--	1	<1000
SULFATE (SO4)	39	230	146	250*	SMCL	--	--	--	--	1	250*
CHLORIDE (Cl)	1	2	1	250*	SMCL	--	--	--	--	1	250*
CALCIUM (Ca)	52	79	63	--	--	--	--	--	--	1	--
SODIUM (Na)	3	10	6	--	--	--	--	--	--	1	--
MAGNESIUM (Mg)	28	49	36	--	--	--	--	--	--	1	--
TOTAL ALKALINITY AS CaCO3	190.0	220.0	185.8	--	--	--	--	--	--	4	--
TOTAL SUSPENDED SOLIDS (TSS)	10.0	10.0	20.0	--	--	--	--	--	--	10	--
TOTAL HARDNESS AS CaCO3	244	405	306	--	--	--	--	--	--	--	--

Units in mg/L unless otherwise noted

NAI = No Allowable Increase (applies to all Carcinogen and Toxics with BCF >300); -- = Not Applicable

Statistics calculated using the value of detection limit when less than detection results. Average value assigned < when 50% or more of samples below detect.

* Based on EPA Secondary Standard (SMCL)

BCF = bio-concentration factor