



Parent Company of Canadian Zinc

Memorandum

To: MVLWB

Pages: 2

Date: August 22, 2021

Re: Percentiles and their effect on EQC, MV2021L2-0004

In their comments on the application, the GNWT recommended (comment #44) that:

“CZN update the downstream predicted water quality using the 95th percentile of upstream water quality (seasonally specific) to derive a more conservative estimate of the minimum creek to effluent ratio. This information should be presented for discussion during the technical sessions. While the GNWT appreciates the 65th percentile of upstream water quality is in line with the 2013 Board's direction, it is suggested that a more conservative estimate of upstream water quality and resulting creek to effluent ratio may be more appropriate for the initial years of the project while the feasibility of CZN's preferred effluent management approach is validated.”

CZN determined 75th, 90th and 95th percentiles of upstream water quality. These percentiles were used to evaluate final effluent EQC using the conservative mixing model based on the 1983-83 dry winter, and 65 L/s average annual mine water flows. For the calculation of dissolved lead and zinc, we used 5th, 10th and 25th percentiles for hardness and DOC. We paired the 75th percentiles with the 25th hardness and DOC percentiles, the 90th percentiles with the 10th percentiles, and the 95th percentiles with the 5th percentiles, representing increasing conservatism.

In the simulations conducted using the different percentiles, we varied the assumed concentrations in final effluent in order to meet WQO. We did not vary the creek to effluent flow ratio. Our rationale is that increasing this ratio would mean a greater restraint on the volume of discharge, which may lead to concerns regarding adequate storage for extreme events. Also, the ability to lower metal concentrations in effluent by treating water provides flexibility as opposed to a higher flow ratio which is inflexible.

To meet WQO, concentrations of total arsenic, dissolved and lead and zinc, and nitrite in final effluent had to be progressively lowered with increased percentile conservatism. The resulting concentrations of these parameters are given in Table 1. The source concentrations and predictions for each simulation are attached.

Table 1: Selected Effluent Concentrations for Various Upstream Water Quality Percentiles

Upstream Percentile	Total As mg/L	Diss. Pb mg/L	Diss. Zn mg/L	NO₂ mg/L
65 th	0.035	0.057	0.3	0.2
75 th	0.034	0.053	0.24	0.19
90 th	0.033	0.052	0.223	0.19
95 th	0.032	0.0515	0.21	0.001

The different percentiles affect the required effluent concentration for dissolved zinc significantly, but not the other parameters. The exception is the 95th percentile for nitrite, which is unrealistic because the upstream percentile concentration (0.043 mg/L) is more than double the WQO. In general, the higher the percentile, the higher the influence of relatively few samples. The 95th nitrite percentile is skewed by a single sample. For this reason, 95th percentile concentrations are not considered to be an appropriate indication of upstream water quality. 90th percentile concentrations may also be prone to undue influence from relatively few samples. As the GNWT notes, the 65th percentile of upstream water quality is in line with the 2013 Board decision. 75th percentile concentrations would be more conservative, but likely not prone to undue influence from relatively few samples.

SOURCE WATER QUALITY, 75TH UPSTREAM PERCENTILES

Source Quality µg/L	Metals*									
	Ag	As	Cd	Cu	Fe	Hg ng/L	Pb	Sb	Se	Zn
Non-Contact Mine Water DS-7	0.05	34	1.1	9	220	110	53	33	4	240
Treated Mine Water	0.05	34	1.1	9	220	110	53	33	4	240
Mill Ditch	0.05	34	1.1	9	220	110	53	33	4	240
Upstream Prairie Creek Under-Ice Median	0.003	0.143	0.03	0.25	15	0.66	0.025	0.165	1.86	6.95
Upstream Prairie Creek Open Water High Median	0.023	0.32	0.06	1.16	568.5	10	0.1	0.131	1.06	3.26
Upstream Prairie Creek Open Water Low Median	0.01	0.192	0.03	0.29	16.5	10	0.025	0.14	1.505	5.13
Open water bypass seepage	0.06	0.21	0.16	0.44	30.7	0.03	3.66	1.36	1.52	555
Under ice bypass seepage	0.02	0.23	0.2	0.48	31.6	0.04	7.27	1.8	1.27	607
Source Quality mg/L	NH ³ N	NO ³ N	NO ² N	Tot. P	SO ⁴	TDS	DOC	Hardness	pH	
Non-Contact Mine Water	1.5	6	0.19	0.15	600	1000	0	834	7.95	
Treated Mine Water	1.5	6	0.19	0.15	600	1000	0	535	9	
Mill Ditch	1.5	6	0.19	0.15	600	1000	0	400	8.1	
Upstream Prairie Creek Under-Ice Median	0.0038	0.29	0.005	0.0063	113.75	357.01	0.81	315	8.09	
Upstream Prairie Creek Open Water High Median	0.005	0.17	0.005	0.02	61	234.6	1.3	183	8.2	
Upstream Prairie Creek Open Water Low Median	0.0044	0.25	0.005	0.005	98.4	298.7	0.81	257	8.3	

RECEIVING WATER CONCENTRATIONS - 65 L/s SCENARIO, 75TH UPSTREAM PERCENTILES

Total	Open Water High		Open Water Low			Under Ice					Open Water High		SSWQO's
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Ag	0.0232	0.0234	0.0240	0.0125	0.0134	0.0065	0.0061	0.0028	0.0030	0.0058	0.0230	0.0232	0.07
As	0.99	1.25	1.99	2.28	2.97	2.95	2.60	0.14	0.15	2.30	0.83	1.06	3
Cd	0.08	0.09	0.11	0.10	0.12	0.12	0.11	0.03	0.04	0.10	0.07	0.08	0.3
Cu	1.31	1.37	1.54	0.83	1.01	0.98	0.89	0.25	0.26	0.81	1.28	1.33	3
Fe	561.3	558.4	550.6	29.1	33.2	32.0	30.0	15.3	15.5	28.3	562.9	560.5	500
Hg	12.0	12.8	14.9	16.2	18.2	9.7	8.6	0.6	0.6	7.6	11.5	12.2	24
Pb	1.15	1.57	2.72	3.30	4.38	4.43	3.92	0.15	0.24	3.50	0.91	1.26	
Sb	0.78	1.04	1.76	2.17	2.84	2.89	2.56	0.19	0.21	2.28	0.63	0.85	15
Se	1.12	1.14	1.21	1.66	1.71	2.04	2.01	1.85	1.84	1.99	1.11	1.12	2
Zn	8.24	10.25	15.62	20.04	25.81	27.68	27.35	17.02	25.12	30.49	7.18	8.78	
NH ₄	0.035	0.046	0.079	0.097	0.127	0.128	0.112	0.004	0.004	0.099	0.028	0.038	0.2
NO ₃	0.29	0.33	0.46	0.60	0.72	0.76	0.70	0.29	0.28	0.65	0.26	0.30	2
NO ₂	0.009	0.010	0.014	0.016	0.0202	0.020	0.018	0.005	0.005	0.017	0.008	0.009	0.02
P	0.023	0.024	0.026	0.014	0.017	0.018	0.017	0.006	0.006	0.015	0.022	0.023	
SO ₄	71.8	76.1	87.8	129.5	139.8	154.2	149.6	115.2	116.3	145.9	69.3	72.9	200
TDS	250	256	273	342	357	411	405	361	364	401	246	252	500
DOC	1.27	1.26	1.23	0.76	0.74	0.74	0.75	0.80	0.79	0.75	1.28	1.27	
Hardness	195	199	212	286	292	346	340	318	321	323	192	196	
pH	8.20	8.19	8.19	8.29	8.32	8.12	8.13	8.09	8.09	8.09	8.20	8.20	
Pb guide	5.30	5.30	5.31	4.40	4.37	4.54	4.54	4.63	4.60	4.49	5.30	5.30	
Zn guide	21.92	22.35	23.48	25.67	25.90	30.42	30.04	28.97	29.03	28.66	21.70	22.02	

Creek to
Effluent

Ratio 74.00 51.07 26.52 18.40 16.10 13.27 14.22 - - 15.48 101.93 75.78

Metals ug/L Major ions mg/L

SOURCE WATER QUALITY, 90TH UPSTREAM PERCENTILES

Source Quality µg/L	Metals*									
	Ag	As	Cd	Cu	Fe	Hg ng/L	Pb	Sb	Se	Zn
Non-Contact Mine Water DS-7	0.05	33	1.1	9	220	110	52	33	4	223
Treated Mine Water	0.05	33	1.1	9	220	110	52	33	4	223
Mill Ditch	0.05	33	1.1	9	220	110	52	33	4	223
Upstream Prairie Creek Under-Ice Median	0.003	0.16	0.04	0.432	15	1.418	0.03	0.19	1.93	8.29
Upstream Prairie Creek Open Water High Median	0.050	1.32	0.22	3.25	2705	17.2	0.13	0.24	1.19	3.74
Upstream Prairie Creek Open Water Low Median	0.05	0.28	0.03	0.58	22	10	0.03	0.15	1.65	5.65
Open water bypass seepage	0.06	0.21	0.16	0.44	30.7	0.03	3.66	1.36	1.52	555
Under ice bypass seepage	0.02	0.23	0.2	0.48	31.6	0.04	7.27	1.8	1.27	607
Source Quality mg/L	NH ³ N	NO ³ N	NO ² N	Tot. P	SO ⁴	TDS	DOC	Hardness	pH	
Non-Contact Mine Water	1.5	6	0.19	0.15	600	1000	0	834	7.95	
Treated Mine Water	1.5	6	0.19	0.15	600	1000	0	535	9	
Mill Ditch	1.5	6	0.19	0.15	600	1000	0	400	8.1	
Upstream Prairie Creek Under-Ice Median	0.005	0.38	0.005	0.010	119	358	0.7	252	7.8	
Upstream Prairie Creek Open Water High Median	0.014	0.21	0.012	0.105	70	243	1.1	160	8.1	
Upstream Prairie Creek Open Water Low Median	0.008	0.38	0.005	0.009	105	303	0.8	246	8.2	

RECEIVING WATER CONCENTRATIONS - 65 L/s SCENARIO, 90TH UPSTREAM PERCENTILES

Total	Open Water High		Open Water Low			Under Ice					Open Water High		SSWQO's
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Ag	0.0500	0.0500	0.0500	0.0500	0.0500	0.0065	0.0061	0.0028	0.0030	0.0058	0.0500	0.0500	0.07
As	1.95	2.20	2.89	2.30	2.96	2.88	2.55	0.16	0.17	2.25	1.80	2.01	3
Cd	0.24	0.25	0.27	0.10	0.12	0.12	0.11	0.04	0.04	0.11	0.24	0.24	0.3
Cu	3.36	3.41	3.53	1.10	1.27	1.14	1.06	0.43	0.43	0.98	3.34	3.37	3
Fe	2654.3	2634.0	2578.9	34.2	38.3	32.3	30.3	15.6	15.8	28.6	2665.6	2649.0	500
Hg	19.0	19.8	21.8	16.2	18.2	10.4	9.3	1.4	1.4	8.3	18.6	19.2	24
Pb	1.16	1.57	2.70	3.24	4.30	4.35	3.85	0.15	0.25	3.44	0.92	1.27	
Sb	0.89	1.15	1.86	2.18	2.84	2.91	2.59	0.22	0.24	2.30	0.74	0.96	15
Se	1.24	1.27	1.33	1.80	1.84	2.10	2.08	1.92	1.91	2.05	1.23	1.25	2
Zn	8.37	10.25	15.24	19.48	24.89	27.49	27.34	18.33	26.41	30.64	7.40	8.89	
NH ₄	0.044	0.055	0.088	0.100	0.130	0.129	0.114	0.005	0.005	0.100	0.037	0.047	0.2
NO ₃	0.32	0.37	0.50	0.73	0.84	0.84	0.79	0.37	0.37	0.73	0.30	0.34	2
NO ₂	0.016	0.017	0.021	0.016	0.0202	0.020	0.018	0.005	0.005	0.017	0.015	0.016	0.02
P	0.105	0.106	0.107	0.018	0.021	0.022	0.020	0.010	0.010	0.019	0.105	0.106	
SO ₄	80.1	84.3	95.9	135.6	145.9	159.0	154.4	120.3	121.4	150.8	77.7	81.2	200
TDS	259	265	281	347	361	412	406	362	366	403	255	260	500
DOC	1.07	1.06	1.03	0.75	0.73	0.64	0.65	0.69	0.68	0.65	1.07	1.06	
Hardness	172	177	190	276	282	288	282	256	260	265	170	173	
pH	8.08	8.08	8.08	8.23	8.26	7.90	7.90	7.85	7.85	7.86	8.08	8.08	
Pb guide	4.71	4.72	4.74	4.35	4.32	4.05	4.04	4.10	4.08	3.99	4.71	4.71	
Zn guide	18.17	18.61	19.74	24.68	24.94	24.14	23.73	22.27	22.42	22.41	17.95	18.27	

Creek to
Effluent

Ratio 74.00 51.07 26.52 18.40 16.10 13.27 14.22 - - 15.48 101.93 75.78

Metals ug/L Major ions mg/L

SOURCE WATER QUALITY, 95TH UPSTREAM PERCENTILES

Source Quality µg/L	Metals*									
	Ag	As	Cd	Cu	Fe	Hg ng/L	Pb	Sb	Se	Zn
Non-Contact Mine Water DS-7	0.05	32	1.1	9	220	110	51.5	33	4	210
Treated Mine Water	0.05	32	1.1	9	220	110	51.5	33	4	210
Mill Ditch	0.05	32	1.1	9	220	110	51.5	33	4	210
Upstream Prairie Creek Under-Ice Median	0.00	0.28	0.04	0.6185	36	2.0	0.04	0.21	1.97	8.7
Upstream Prairie Creek Open Water High Median	0.08	3.02	0.25	3.98	6406	23.8	0.20	0.42	1.21	4.3
Upstream Prairie Creek Open Water Low Median	0.05	0.35	0.06	1.67	56	20	0.03	0.24	1.74	5.8
Open water bypass seepage	0.06	0.21	0.16	0.44	30.7	0.03	3.66	1.36	1.52	555
Under ice bypass seepage	0.02	0.23	0.2	0.48	31.6	0.04	7.27	1.8	1.27	607
Source Quality mg/L	NH ³ N	NO ³ N	NO ² N	Tot. P	SO ⁴	TDS	DOC	Hardness	pH	
Non-Contact Mine Water	1.5	6	0.001	0.15	600	1000	0	834	7.95	
Treated Mine Water	1.5	6	0.001	0.15	600	1000	0	535	9	
Mill Ditch	1.5	6	0.001	0.15	600	1000	0	400	8.1	
Upstream Prairie Creek Under-Ice Median	0.01	0.43	0.005	0.08	121	359	0.6	231	7.7	
Upstream Prairie Creek Open Water High Median	0.02	0.28	0.017	0.16	81	263	1.0	158	8.1	
Upstream Prairie Creek Open Water Low Median	0.02	0.41	0.043	0.01	110	305	0.8	234	8.2	

RECEIVING WATER CONCENTRATIONS - 65 L/s SCENARIO, 95TH PERCENTILES

Total	Open Water High		Open Water Low			Under Ice					Open Water High		SSWQO's
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Ag	0.0792	0.0790	0.0783	0.0500	0.0500	0.0073	0.0069	0.0037	0.0039	0.0066	0.0794	0.0792	0.07
As	3.59	3.82	4.45	2.30	2.95	2.91	2.58	0.28	0.28	2.30	3.46	3.65	3
Cd	0.26	0.27	0.29	0.12	0.15	0.13	0.12	0.04	0.05	0.11	0.26	0.27	0.3
Cu	4.08	4.12	4.23	2.12	2.27	1.31	1.23	0.62	0.61	1.15	4.06	4.09	3
Fe	6280.5	6230.0	6092.9	65.7	69.0	50.9	49.0	35.6	35.5	47.3	6308.6	6267.2	500
Hg	25.5	26.2	28.0	25.5	27.3	10.9	9.8	1.9	1.9	8.8	25.1	25.7	24
Pb	1.22	1.63	2.74	3.21	4.26	4.32	3.83	0.16	0.26	3.42	0.98	1.32	
Sb	1.07	1.33	2.04	2.26	2.93	2.93	2.60	0.24	0.26	2.32	0.92	1.14	15
Se	1.26	1.28	1.35	1.88	1.93	2.13	2.11	1.96	1.95	2.09	1.25	1.27	2
Zn	8.63	10.40	15.09	18.81	23.96	26.78	26.76	18.72	26.80	30.18	7.71	9.11	
NH ₄	0.052	0.063	0.095	0.116	0.146	0.136	0.121	0.012	0.012	0.107	0.045	0.055	0.2
NO ₃	0.39	0.44	0.56	0.75	0.86	0.89	0.83	0.42	0.41	0.77	0.37	0.40	2
NO ₂	0.017	0.017	0.016	0.040	0.039	0.005	0.005	0.005	0.005	0.005	0.017	0.017	0.02
P	0.160	0.160	0.160	0.019	0.022	0.084	0.083	0.077	0.076	0.081	0.160	0.160	
SO ₄	91.0	95.1	106.5	139.9	150.0	160.7	156.1	122.1	123.1	152.4	88.6	92.0	200
TDS	278	284	300	348	363	413	407	363	366	403	275	280	500
DOC	0.94	0.93	0.91	0.75	0.73	0.56	0.57	0.60	0.60	0.57	0.94	0.94	
Hardness	170	175	188	264	270	268	262	235	239	245	168	171	
pH	8.05	8.05	8.05	8.20	8.23	7.76	7.76	7.70	7.71	7.72	8.05	8.05	
Pb guide	4.41	4.41	4.43	4.31	4.28	3.73	3.72	3.76	3.75	3.67	4.40	4.41	
Zn guide	17.10	17.52	18.60	23.68	23.98	21.44	21.03	19.49	19.66	19.77	16.89	17.20	

Creek to
Effluent

Ratio	74.00	51.07	26.52	18.40	16.10	13.27	14.22	-	-	15.48	101.93	75.78
-------	-------	-------	-------	-------	-------	-------	-------	---	---	-------	--------	-------

Metals ug/L Major ions mg/L