



Memo

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Subject: Water Balance and Water Chemistry Results for Revised Water Management Scenario

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cc: Mark Humbert

AMEC Environment & Infrastructure, a division of AMEC Americas Limited (AMEC) has prepared the following deliverable to present a summary of the results derived from a revised water management scenario for the Star-Orion South Diamond Project.

1.0 REVISED WATER BALANCE

1.1 Background

The previously developed water balance was revised to reflect changes requested by Shore Gold on 03 October 2013. The essential changes summarized by Shore Gold are:

1. *All coarse PK water (runoff, seepage, and water content) will be collected and sent to PKCF, using a conveyance efficiency of 80%.*
2. *The 20% of coarse PK water not conveyed to PKCF will be allocated as follows:*
 - *40% will flow into Duke Ravine (8% of total Coarse PK water).*
 - *60% will be collected in the Runoff Pond (12% of total Coarse PK water).*

The updated water balance schematic is illustrated on **Figure 1.1** and the changes are discussed below.



Figure 1.1 Updated Water Balance Schematic



1.2 Primary Changes to the Water Balance

1.2.1 Coarse PK Water

At the request of Shore Gold, all Coarse PK Water has been routed to PKCF in the updated water balance model, assuming a conveyance efficiency of 80%. The updated inflows to PKCF are shown below in **Figure 1.2**.

Figure 1.2 Inflows to PKCF with Coarse PK Water Collection

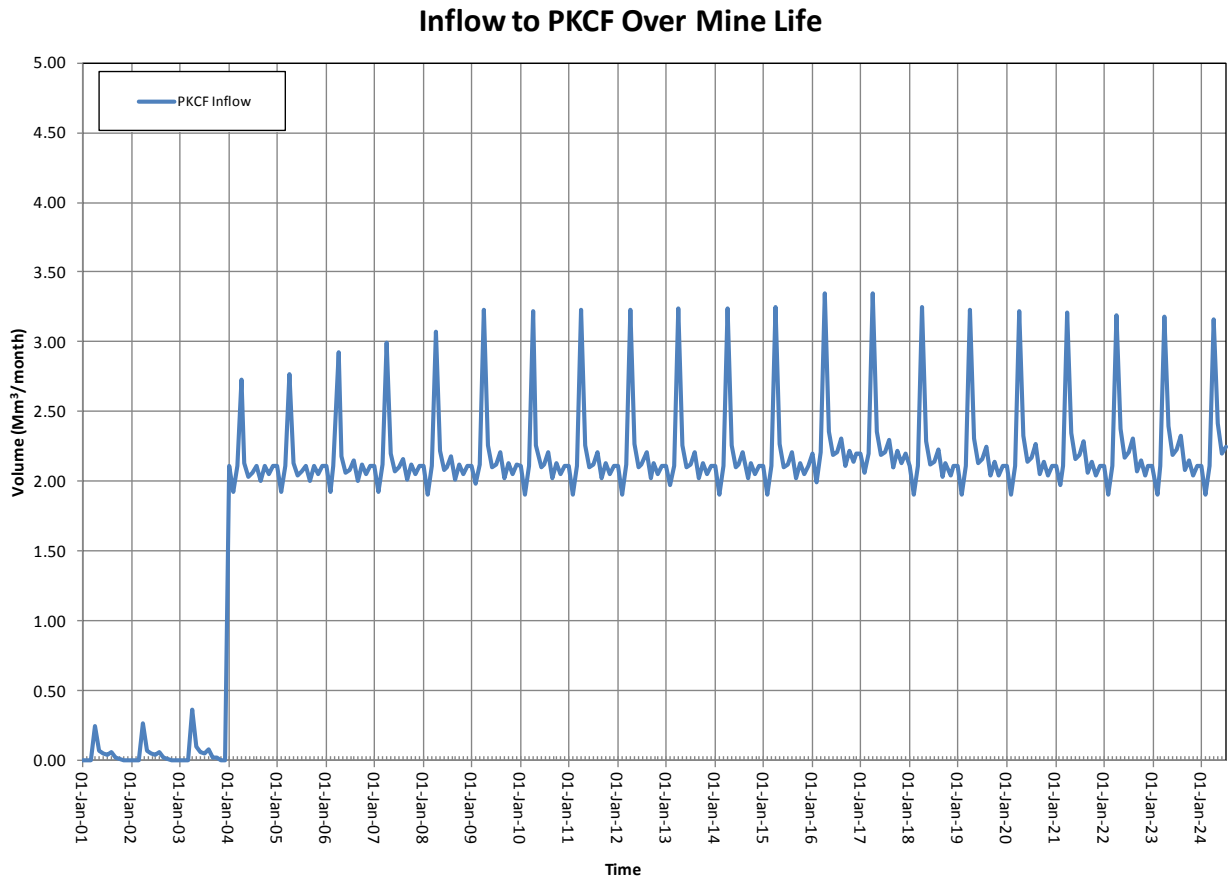


Figure 1.2 indicates that there is no accumulation of water in the PKCF over time. The water decant from the PKCF to the mixing facility is sufficient to keep the water in the PKCF in an approximate balance. Leap years have been removed from this plot; (i.e., all years have 365.25-days).



2.0 WATER QUANTITY AND QUALITY FINDINGS

2.1 Discharge to the Saskatchewan River

2.1.1 Volume

The following points summarize changes to flow discharges to the Saskatchewan River during the life of the Star Pit Mine:

- No discharge in first 3 years. This is unchanged from the previous model.
- In Year 4, discharge to the Saskatchewan River is purely decant water from PKCF (1.61 Mm³ to 1.78 Mm³ per month depending on number of days in the month). These volumes are greater than the volumes from the previous water balance model where the discharge volumes ranged between 0.00 Mm³ and 0.34 Mm³ in Year 4.
- Year 5 through Year 7, the discharge to the Saskatchewan River is decant water from PKCF and Star Pit Manville Pumping Wells (range from 4.36 Mm³ to 4.82 Mm³ per month). These volumes are greater than the volumes from the previous water balance model where the discharge volumes ranged between 2.85 Mm³ to 3.32 Mm³ per month in Years 5 through Year 7.

2.1.2 Concentration at End of Pipe

Characteristics of water quality are presented in **Table 2.1** for PKCF decant water discharge and seepage from the facility collected in a perimeter ditch and directed to wetlands; for co-management facility in comparison with pure Manville formation water going to the Saskatchewan River.

Water quality parameters leaving wetlands after seepage is collected and mixed with external PKCF slopes runoff along with resultant concentrations in lower reaches of receiving streams are presented in **Table 2.2**.

Table 2.1
Water Quality Parameters Based On Water Balance

Parameter	Units	Saskatchewan River	PKCF Decant Water / Seepage Water				Option 2013 - Manville Formation and PKCF Decant Water Discharge from Co-management Facility				Option 2012 - Manville Formation Water Discharge from Dewatering Wells Only			
		Background	Mean	Median	95th Percentile	Maximum	Mean	Median	95th Percentile	Maximum	Mean	Median	95th Percentile	Maximum
Conventional Parameters														
Specific conductivity	µS/cm	443	842	858	979	995	4232	4216	4412	4419	4618	5430	5808	5916
Total alkalinity	mg/L	159	183	183	189	190	314	313	321	321	337	360	379	384
Total dissolved solids	mg/L	262	492	502	578	589	2688	2678	2805	2809	2865	3398	3702	3781
Total hardness	mg/L	188	214	214	222	223	408	406	418	418	421	464	500	506
Major Ions														
Bicarbonate	mg/L	187	210	210	216	218	378	377	387	387	390	425	458	464
Calcium	mg/L	48	54	54	56	57	105	105	108	108	108	120	129	131
Carbonate	mg/L	4	3	3	3	3	1.3	1.3	1.4	1.4	0.5	0.5	0.5	0.5
Chloride	mg/L	7	110	115	149	155	1120	1116	1173	1176	1212	1454	1588	1623
Fluoride	mg/L	0.1	0.3	0.3	0.3	0.3	1.7	1.7	1.8	1.8	2	2	2	2
Hydroxide	mg/L	1	0.7	0.7	0.8	0.8	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.5
Magnesium	mg/L	17	19	19	19	19	35	35	36	36	35	40	43	44
Potassium	mg/L	3	7	7	8	8	38	38	40	40	40	48	52	53
Sodium	mg/L	20	94	97	122	125	809	806	847	849	876	1050	1140	1165
Sulfate	mg/L	67	107	108	122	124	509	507	530	531	537	641	692	707
Nutrients														
Ammonia as nitrogen	mg/L	0.05	0.2	0.2	0.3	0.3	1.3	1.3	1.4	1.4	1.4	1.7	1.8	1.9
Nitrate	mg/L	0.4	0.4	0.4	0.4	0.4	0.2	0.2	0.2	0.2	0.02	0.02	0.04	0.04
Total Phosphorus	mg/L	0.1	0.1	0.1	0.1	0.1	0.06	0.06	0.06	0.06	0.04	0.04	0.05	0.05

Parameter	Units	Saskatchewan River	PKCF Decant Water / Seepage Water				Option 2013 - Manville Formation and PKCF Decant Water Discharge from Co-management Facility				Option 2012 - Manville Formation Water Discharge from Dewatering Wells Only			
		Background	Mean	Median	95th Percentile	Maximum	Mean	Median	95th Percentile	Maximum	Mean	Median	95th Percentile	Maximum
Metals														
Aluminum	mg/L	0.4	0.4	0.4	0.4	0.4	0.2	0.2	0.2	0.2	0.003	0.002	0.005	0.006
Antimony	mg/L	0.0004	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0002
Arsenic	mg/L	0.0007	0.8	0.8	0.8	0.8	0.4	0.4	0.4	0.4	0.0003	0.0002	0.0005	0.0007
Barium	mg/L	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.08	0.04	0.3	0.3
Beryllium	mg/L	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.00005	0.00005	0.00005	0.00005
Boron	mg/L	0.03	0.1	0.2	0.2	0.2	1.3	1.3	1.3	1.3	1.4	1.7	1.8	1.8
Cadmium	mg/L	0.00008	0.00008	0.00008	0.00009	0.00009	0.00004	0.00004	0.00004	0.00004	0.00006	0.00003	0.0003	0.0003
Chromium	mg/L	0.002	0.002	0.002	0.002	0.002	0.0007	0.0007	0.0008	0.0008	0.0008	0.0006	0.003	0.003
Cobalt	mg/L	0.0005	0.0006	0.0006	0.0006	0.0006	0.0003	0.0003	0.0003	0.0003	0.0001	0.0001	0.0001	0.0001
Copper	mg/L	0.002	0.003	0.003	0.003	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Iron	mg/L	0.6	0.8	0.8	0.8	0.8	0.4	0.4	0.4	0.5	0.2	0.2	0.2	0.2
Lead	mg/L	0.0006	0.0008	0.0008	0.0009	0.0009	0.0005	0.0005	0.0005	0.0005	0.0002	0.0003	0.0003	0.0003
Manganese	mg/L	<i>0.05</i>	<i>1.9</i>	<i>1.9</i>	<i>1.9</i>	<i>2.0</i>	<i>0.7</i>	<i>0.7</i>	<i>0.8</i>	<i>0.8</i>	<i>0.06</i>	<i>0.07</i>	<i>0.08</i>	<i>0.08</i>
Molybdenum	mg/L	0.001	0.001	0.001	0.001	0.001	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.004	0.01
Nickel	mg/L	0.002	0.002	0.002	0.003	0.003	0.001	0.001	0.001	0.001	0.0005	0.0005	0.0007	0.001
Selenium	mg/L	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003	0.0003	0.0003	0.0003	0.0002	0.0002	0.0004	0.0007
Silver	mg/L	0.0002	0.0001	0.0001	0.0001	0.0001	0.00005	0.00005	0.00005	0.00005	0.00002	0.000009	0.00005	0.00005
Strontium	mg/L	0.4	0.5	0.5	0.5	0.5	1.8	1.7	1.8	1.8	1.8	2	2	2
Thallium	mg/L	0.00009	0.00009	0.00009	0.00009	0.00009	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Tin	mg/L	0.0002	0.0003	0.0002	0.0003	0.0003	0.0001	0.0001	0.0001	0.0002	0.003	0.002	0.005	0.006
Titanium	mg/L	0.008	0.008	0.008	0.009	0.009	0.003	0.003	0.003	0.003	0.0002	0.0002	0.0003	0.0005
Vanadium	mg/L	0.002	0.002	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.0006	0.003	0.005
Zinc	mg/L	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.07	0.07

Note: **Bolded** and shaded cells indicate an aquatic life guideline exceedance.
Italicized and shaded cells indicate a drinking water exceedance.

Note: Guidelines are summarized in **Table A-1** in **Appendix A**.

Table 2.2
Water Quality Parameters in Wetlands and Lower Reaches of Streams

Parameter	Unit	Minimum	Mean	Median	95th Percentile	Maximum	Minimum	Mean	Median	95th Percentile	Maximum
English Creek Wetland						English Creek Lower Reach					
Conventional Parameters											
Specific conductivity	µS/cm	861.40	1775.11	1774.03	2492.85	2639.70	451.10	502.28	500.37	548.54	559.00
Total alkalinity	mg/L	109.50	236.21	240.54	297.26	307.46	395.16	397.56	397.79	398.85	400.00
Total dissolved solids	mg/L	197.93	437.63	451.31	537.59	581.03	263.48	272.59	273.25	278.72	281.42
Total hardness	mg/L	89.05	208.03	221.74	245.24	250.60	240.81	243.34	243.43	244.54	244.82
Major Ions											
Bicarbonate	mg/L	77.61	187.83	203.59	214.28	218.62	295.20	296.19	296.10	297.00	297.85
Calcium	mg/L	20.52	49.15	53.04	56.50	57.78	68.82	69.22	69.25	69.34	69.43
Carbonate	mg/L	0.96	2.47	2.65	2.88	2.91	4.40	4.42	4.42	4.44	4.46
Chloride	mg/L	45.51	96.96	100.38	129.84	149.74	1.89	5.00	5.05	7.69	8.73
Fluoride	mg/L	0.11	0.25	0.26	0.31	0.34	0.15	0.15	0.15	0.16	0.16
Hydroxide	mg/L	0.26	0.66	0.72	0.76	0.76	0.49	0.51	0.51	0.51	0.51
Magnesium	mg/L	9.01	20.30	20.95	24.62	25.31	16.81	17.17	17.18	17.39	17.43
Potassium	mg/L	4.58	9.36	9.43	12.68	13.55	2.00	2.27	2.27	2.50	2.55
Sodium	mg/L	69.00	138.68	139.08	195.10	212.25	4.97	9.64	9.69	13.65	14.77
Sulphate	mg/L	82.76	168.19	168.09	228.07	241.29	4.25	10.01	10.03	14.42	15.38
Nutrients											
Ammonia	mg/L	0.099	0.214	0.222	0.268	0.290	0.044	0.050	0.050	0.054	0.055
Nitrate	mg/L	0.14	0.36	0.39	0.43	0.43	0.05	0.06	0.06	0.07	0.07
Phosphorus	mg/L	0.0231	0.0584	0.0627	0.0673	0.0678	0.0542	0.0552	0.0553	0.0556	0.0556

Parameter	Unit	Minimum	Mean	Median	95th Percentile	Maximum	Minimum	Mean	Median	95th Percentile	Maximum
English Creek Wetland						English Creek Lower Reach					
Metals											
Aluminum	mg/L	0.15	0.38	0.40	0.44	0.45	0.09	0.10	0.10	0.10	0.10
Antimony	mg/L	0.00006	0.00014	0.00015	0.00016	0.00017	0.00010	0.00010	0.00010	0.00010	0.00010
Arsenic	µg/L	0.27	0.70	0.76	0.82	0.84	2.83	2.86	2.85	2.90	2.91
Barium	mg/L	0.039	0.098	0.105	0.112	0.112	0.353	0.356	0.355	0.360	0.362
Beryllium	mg/L	0.000043	0.000110	0.000118	0.000127	0.000128	0.000050	0.000053	0.000053	0.000054	0.000054
Boron	mg/L	0.050	0.109	0.112	0.142	0.161	0.035	0.038	0.038	0.041	0.042
Cadmium	mg/L	0.000062	0.0000157	0.0000169	0.0000180	0.0000181	0.0000483	0.0000486	0.0000486	0.0000491	0.0000494
Chromium	mg/L	0.000181	0.000462	0.000498	0.000529	0.000531	0.000370	0.000379	0.000380	0.000383	0.000383
Cobalt	mg/L	0.00020	0.00050	0.00054	0.00059	0.00059	0.00015	0.00017	0.00017	0.00017	0.00017
Copper	mg/L	0.00090	0.00227	0.00244	0.00259	0.00262	0.00100	0.00106	0.00106	0.00108	0.00108
Iron	mg/L	0.28	0.71	0.76	0.83	0.84	0.76	0.77	0.77	0.78	0.78
Lead	mg/L	0.00030	0.00076	0.00082	0.00088	0.00089	0.00025	0.00027	0.00027	0.00028	0.00028
Manganese	mg/L	0.65	1.68	1.80	1.96	1.99	0.16	0.21	0.22	0.24	0.24
Molybdenum	mg/L	0.00038	0.00097	0.00105	0.00113	0.00115	0.00128	0.00129	0.00129	0.00129	0.00129
Nickel	mg/L	0.00087	0.00223	0.00239	0.00261	0.00264	0.00144	0.00149	0.00149	0.00151	0.00151
Selenium	mg/L	0.00009	0.00024	0.00026	0.00028	0.00028	0.00020	0.00020	0.00020	0.00020	0.00020
Silver	mg/L	0.000042	0.000108	0.000115	0.000125	0.000127	0.000050	0.000053	0.000053	0.000054	0.000054
Strontium	mg/L	0.19	0.43	0.45	0.51	0.53	0.20	0.21	0.21	0.22	0.22
Thallium	mg/L	0.0000337	0.0000841	0.0000907	0.0000950	0.0000952	0.0000984	0.0000995	0.0000996	0.0000998	0.0000998
Tin	mg/L	0.000081	0.000231	0.000237	0.000307	0.000330	0.000051	0.000058	0.000058	0.000063	0.000064
Titanium	mg/L	0.00294	0.00761	0.00814	0.00892	0.00907	0.00280	0.00301	0.00304	0.00310	0.00311
Uranium	µg/L	0.23	0.60	0.65	0.71	0.71	0.30	0.31	0.32	0.32	0.32
Vanadium	mg/L	0.00065	0.00167	0.00179	0.00195	0.00199	0.00060	0.00065	0.00065	0.00067	0.00067
Zinc	mg/L	0.00197	0.00489	0.00529	0.00559	0.00564	0.00507	0.00515	0.00516	0.00517	0.00517

Parameter	Unit	Minimum	Mean	Median	95th Percentile	Maximum	Minimum	Mean	Median	95th Percentile	Maximum
Wapiti Ravine Wetland						Wapiti Ravine Lower Reach					
Conventional Parameters											
Specific conductivity	µS/cm	861.40	1775.11	1774.03	2492.85	2639.70	558.88	674.81	670.93	778.77	789.36
Total alkalinity	mg/L	109.50	236.21	240.54	297.26	307.46	240.52	271.85	273.23	280.48	281.88
Total dissolved solids	mg/L	197.93	437.63	451.31	537.59	581.03	295.69	336.43	338.47	350.37	356.08
Total hardness	mg/L	89.05	208.03	221.74	245.24	250.60	239.08	271.56	274.66	277.02	277.87
Major Ions											
Bicarbonate	mg/L	77.61	187.83	203.59	214.28	218.62	271.53	307.89	311.56	312.90	313.05
Calcium	mg/L	20.52	49.15	53.04	56.50	57.78	66.77	75.74	76.62	76.99	77.08
Carbonate	mg/L	0.96	2.47	2.65	2.88	2.91	4.88	5.52	5.57	5.62	5.63
Chloride	mg/L	45.51	96.96	100.38	129.84	149.74	6.74	13.66	13.90	19.06	20.65
Fluoride	mg/L	0.11	0.25	0.26	0.31	0.34	0.14	0.16	0.16	0.17	0.17
Hydroxide	mg/L	0.26	0.66	0.72	0.76	0.76	0.45	0.52	0.53	0.53	0.53
Magnesium	mg/L	9.01	20.30	20.95	24.62	25.31	17.55	19.99	20.12	20.60	20.70
Potassium	mg/L	4.58	9.36	9.43	12.68	13.55	2.52	3.05	3.04	3.51	3.61
Sodium	mg/L	69.00	138.68	139.08	195.10	212.25	14.80	22.70	22.35	30.50	32.36
Sulphate	mg/L	82.76	168.19	168.09	228.07	241.29	27.09	36.85	36.46	45.27	46.51
Nutrients											
Ammonia	mg/L	0.099	0.214	0.222	0.268	0.290	0.036	0.045	0.046	0.053	0.055
Nitrate	mg/L	0.14	0.36	0.39	0.43	0.43	0.41	0.47	0.48	0.48	0.48
Phosphorus	mg/L	0.0231	0.0584	0.0627	0.0673	0.0678	0.0440	0.0509	0.0516	0.0521	0.0521

Parameter	Unit	Minimum	Mean	Median	95th Percentile	Maximum	Minimum	Mean	Median	95th Percentile	Maximum
Wapiti Ravine Wetland						Wapiti Ravine Lower Reach					
Metals											
Aluminum	mg/L	0.15	0.38	0.40	0.44	0.45	0.11	0.14	0.14	0.14	0.14
Antimony	mg/L	0.00006	0.00014	0.00015	0.00016	0.00017	0.00009	0.00011	0.00011	0.00011	0.00011
Arsenic	µg/L	0.27	0.70	0.76	0.82	0.84	1.85	2.08	2.10	2.12	2.13
Barium	mg/L	0.039	0.098	0.105	0.112	0.112	0.172	0.195	0.197	0.198	0.198
Beryllium	mg/L	0.000043	0.000110	0.000118	0.000127	0.000128	0.000048	0.000058	0.000059	0.000059	0.000060
Boron	mg/L	0.050	0.109	0.112	0.142	0.161	0.026	0.032	0.032	0.036	0.039
Cadmium	mg/L	0.000062	0.0000157	0.0000169	0.0000180	0.0000181	0.0000403	0.0000454	0.0000458	0.0000461	0.0000462
Chromium	mg/L	0.000181	0.000462	0.000498	0.000529	0.000531	0.001829	0.002053	0.002070	0.002087	0.002093
Cobalt	mg/L	0.00020	0.00050	0.00054	0.00059	0.00059	0.00028	0.00033	0.00033	0.00033	0.00034
Copper	mg/L	0.00090	0.00227	0.00244	0.00259	0.00262	0.00245	0.00281	0.00284	0.00286	0.00287
Iron	mg/L	0.28	0.71	0.76	0.83	0.84	0.92	1.05	1.06	1.07	1.07
Lead	mg/L	0.00030	0.00076	0.00082	0.00088	0.00089	0.00084	0.00097	0.00098	0.00099	0.00099
Manganese	mg/L	0.65	1.68	1.80	1.96	1.99	0.22	0.31	0.31	0.33	0.34
Molybdenum	mg/L	0.00038	0.00097	0.00105	0.00113	0.00115	0.00078	0.00091	0.00092	0.00093	0.00093
Nickel	mg/L	0.00087	0.00223	0.00239	0.00261	0.00264	0.00245	0.00280	0.00284	0.00286	0.00287
Selenium	mg/L	0.00009	0.00024	0.00026	0.00028	0.00028	0.00033	0.00038	0.00038	0.00039	0.00039
Silver	mg/L	0.000042	0.000108	0.000115	0.000125	0.000127	0.000048	0.000057	0.000058	0.000059	0.000059
Strontium	mg/L	0.19	0.43	0.45	0.51	0.53	0.20	0.23	0.23	0.24	0.24
Thallium	mg/L	0.0000337	0.0000841	0.0000907	0.0000950	0.0000952	0.0000853	0.0000976	0.0000988	0.0000994	0.0000994
Tin	mg/L	0.000081	0.000231	0.000237	0.000307	0.000330	0.000057	0.000073	0.000074	0.000081	0.000084
Titanium	mg/L	0.00294	0.00761	0.00814	0.00892	0.00907	0.00252	0.00307	0.00313	0.00319	0.00321
Uranium	µg/L	0.23	0.60	0.65	0.71	0.71	1.14	1.29	1.30	1.32	1.32
Vanadium	mg/L	0.00065	0.00167	0.00179	0.00195	0.00199	0.00248	0.00282	0.00285	0.00287	0.00288
Zinc	mg/L	0.00197	0.00489	0.00529	0.00559	0.00564	0.01288	0.01450	0.01464	0.01474	0.01475

Parameter	Unit	Minimum	Mean	Median	95th Percentile	Maximum	Minimum	Mean	Median	95th Percentile	Maximum
Duke Ravine Wetland						Duke Ravine Lower Reach					
Conventional Parameters											
Specific conductivity	µS/cm	861.40	1775.11	1774.03	2492.85	2639.70	662.29	1247.90	1278.53	1561.45	1624.82
Total alkalinity	mg/L	109.50	236.21	240.54	297.26	307.46	188.08	243.32	246.75	267.10	270.67
Total dissolved solids	mg/L	197.93	437.63	451.31	537.59	581.03	227.96	307.96	314.35	345.09	357.57
Total hardness	mg/L	89.05	208.03	221.74	245.24	250.60	174.49	214.42	219.32	227.11	228.84
Major Ions											
Bicarbonate	mg/L	77.61	187.83	203.59	214.28	218.62	189.31	219.69	223.43	226.04	227.19
Calcium	mg/L	20.52	49.15	53.04	56.50	57.78	47.00	55.18	56.22	57.12	57.49
Carbonate	mg/L	0.96	2.47	2.65	2.88	2.91	2.38	2.82	2.87	2.94	2.95
Chloride	mg/L	45.51	96.96	100.38	129.84	149.74	13.98	32.75	33.55	45.29	50.93
Fluoride	mg/L	0.11	0.25	0.26	0.31	0.34	0.12	0.16	0.16	0.18	0.19
Hydroxide	mg/L	0.26	0.66	0.72	0.76	0.76	0.44	0.57	0.59	0.61	0.61
Magnesium	mg/L	9.01	20.30	20.95	24.62	25.31	13.82	18.45	18.97	20.23	20.49
Potassium	mg/L	4.58	9.36	9.43	12.68	13.55	2.91	5.61	5.76	7.05	7.39
Sodium	mg/L	69.00	138.68	139.08	195.10	212.25	29.35	71.27	73.23	95.08	101.30
Sulfate	mg/L	82.76	168.19	168.09	228.07	241.29	39.42	93.00	96.32	120.20	125.92
Nutrients											
Ammonia	mg/L	0.099	0.214	0.222	0.268	0.290	0.037	0.078	0.081	0.101	0.107
Nitrate	mg/L	0.14	0.36	0.39	0.43	0.43	0.13	0.24	0.26	0.28	0.29
Phosphorus	mg/L	0.0231	0.0584	0.0627	0.0673	0.0678	0.0291	0.0420	0.0437	0.0456	0.0459

Parameter	Unit	Minimum	Mean	Median	95th Percentile	Maximum	Minimum	Mean	Median	95th Percentile	Maximum
Duke Ravine Wetland						Duke Ravine Lower Reach					
<i>Metals</i>											
Aluminum	mg/L	0.15	0.38	0.40	0.44	0.45	0.09	0.19	0.20	0.22	0.22
Antimony	mg/L	0.00006	0.00014	0.00015	0.00016	0.00017	0.00009	0.00012	0.00012	0.00013	0.00013
Arsenic	µg/L	0.27	0.70	0.76	0.82	0.84	1.78	1.86	1.85	1.94	2.04
Barium	mg/L	0.039	0.098	0.105	0.112	0.112	0.152	0.164	0.165	0.167	0.168
Beryllium	mg/L	0.000043	0.000110	0.000118	0.000127	0.000128	0.000050	0.000075	0.000078	0.000082	0.000083
Boron	mg/L	0.050	0.109	0.112	0.142	0.161	0.037	0.057	0.058	0.070	0.075
Cadmium	mg/L	0.000062	0.0000157	0.0000169	0.0000180	0.0000181	0.0000394	0.0000460	0.0000468	0.0000476	0.0000477
Chromium	mg/L	0.000181	0.000462	0.000498	0.000529	0.000531	0.000401	0.000618	0.000649	0.000685	0.000696
Cobalt	mg/L	0.00020	0.00050	0.00054	0.00059	0.00059	0.00015	0.00029	0.00031	0.00033	0.00034
Copper	mg/L	0.00090	0.00227	0.00244	0.00259	0.00262	0.00070	0.00125	0.00133	0.00142	0.00145
Iron	mg/L	0.28	0.71	0.76	0.83	0.84	0.31	0.47	0.49	0.52	0.52
Lead	mg/L	0.00030	0.00076	0.00082	0.00088	0.00089	0.00018	0.00037	0.00040	0.00042	0.00043
Manganese	mg/L	0.65	1.68	1.80	1.96	1.99	0.28	0.71	0.77	0.84	0.86
Molybdenum	mg/L	0.00038	0.00097	0.00105	0.00113	0.00115	0.00080	0.00101	0.00104	0.00107	0.00108
Nickel	mg/L	0.00087	0.00223	0.00239	0.00261	0.00264	0.00102	0.00185	0.00197	0.00212	0.00218
Selenium	mg/L	0.00009	0.00024	0.00026	0.00028	0.00028	0.00018	0.00024	0.00025	0.00026	0.00026
Silver	mg/L	0.000042	0.000108	0.000115	0.000125	0.000127	0.000050	0.000074	0.000078	0.000081	0.000082
Strontium	mg/L	0.19	0.43	0.45	0.51	0.53	0.17	0.26	0.27	0.29	0.30
Thallium	mg/L	0.0000337	0.0000841	0.0000907	0.0000950	0.0000952	0.0000806	0.0000968	0.0000988	0.0001004	0.0001005
Tin	mg/L	0.000081	0.000231	0.000237	0.000307	0.000330	0.000065	0.000123	0.000128	0.000154	0.000164
Titanium	mg/L	0.00294	0.00761	0.00814	0.00892	0.00907	0.00281	0.00467	0.00493	0.00522	0.00528
Uranium	µg/L	0.23	0.60	0.65	0.71	0.71	0.46	0.58	0.59	0.61	0.62
Vanadium	mg/L	0.00065	0.00167	0.00179	0.00195	0.00199	0.00046	0.00087	0.00093	0.00100	0.00101
Zinc	mg/L	0.00197	0.00489	0.00529	0.00559	0.00564	0.00391	0.00562	0.00586	0.00616	0.00621

Parameter	Unit	Minimum	Mean	Median	95th Percentile	Maximum	Minimum	Mean	Median	95th Percentile	Maximum
		101 Ravine					Caution Creek				
<i>Conventional Parameters</i>											
Specific conductivity	µS/cm	487.50	525.46	526.44	577.98	578.33	357.00	373.23	374.82	393.80	394.01
Total alkalinity	mg/L	263.50	281.93	282.41	307.44	307.60	202.00	208.08	208.68	215.78	215.86
Total dissolved solids	mg/L	318.50	328.81	329.08	343.08	343.17	225.00	230.69	231.25	237.89	237.97
Total hardness	mg/L	266.50	269.31	269.38	273.20	273.23	200.25	200.67	200.64	201.00	201.00
<i>Major Ions</i>											
Bicarbonate	mg/L	305.50	326.90	327.45	356.51	356.71	246.00	250.77	251.24	256.81	256.88
Calcium	mg/L	74.00	74.31	74.32	74.74	74.75	56.90	58.08	57.99	59.00	59.00
Carbonate	mg/L	8.50	8.81	8.82	9.24	9.25	2.50	3.35	3.43	4.43	4.44
Chloride	mg/L	1.00	1.31	1.32	1.74	1.75	1.00	1.09	1.10	1.20	1.20
Fluoride	mg/L	0.17	0.22	0.22	0.29	0.29	0.15	0.17	0.17	0.19	0.19
Hydroxide	mg/L	0.50	0.50	0.50	0.50	0.50	0.44	0.47	0.47	0.50	0.50
Magnesium	mg/L	20.50	20.81	20.82	21.24	21.25	13.00	13.50	13.54	14.12	14.13
Potassium	mg/L	2.15	2.87	2.89	3.86	3.87	1.50	1.83	1.87	2.26	2.26
Sodium	mg/L	5.45	12.96	13.16	23.36	23.43	3.50	6.96	7.31	11.36	11.40
Sulphate	mg/L	14.00	17.97	18.07	23.46	23.49	3.80	6.81	7.11	10.63	10.67
<i>Nutrients</i>											
Ammonia	mg/L	0.040	0.224	0.229	0.479	0.481	0.025	0.109	0.117	0.215	0.216
Nitrate	mg/L	0.03	0.05	0.05	0.07	0.07	0.03	0.04	0.04	0.05	0.05
Phosphorus	mg/L	0.0109	0.0249	0.0247	0.0350	0.0350	0.0343	0.0487	0.0476	0.0600	0.0600

Parameter	Unit	Minimum	Mean	Median	95th Percentile	Maximum	Minimum	Mean	Median	95th Percentile	Maximum
		101 Ravine					Caution Creek				
<i>Metals</i>											
Aluminum	mg/L	0.10	0.35	0.36	0.70	0.70	0.04	0.16	0.17	0.31	0.31
Antimony	mg/L	0.00010	0.00010	0.00010	0.00010	0.00010	0.00009	0.00009	0.00009	0.00010	0.00010
Arsenic	µg/L	1.75	3.45	3.50	5.81	5.82	3.20	3.59	3.63	4.08	4.09
Barium	mg/L	0.161	0.163	0.163	0.164	0.164	0.218	0.264	0.261	0.300	0.300
Beryllium	mg/L	0.000050	0.000050	0.000050	0.000050	0.000050	0.000044	0.000047	0.000047	0.000050	0.000050
Boron	mg/L	0.035	0.072	0.073	0.124	0.125	0.020	0.038	0.040	0.061	0.061
Cadmium	mg/L	0.0000500	0.0001125	0.0001141	0.0001989	0.0001995	0.0000500	0.0000754	0.0000779	0.0001076	0.0001080
Chromium	mg/L	0.000250	0.002046	0.002093	0.004532	0.004548	0.000250	0.001044	0.001123	0.002051	0.002062
Cobalt	mg/L	0.00013	0.00017	0.00017	0.00020	0.00020	0.00014	0.00018	0.00017	0.00020	0.00020
Copper	mg/L	0.00080	0.00217	0.00221	0.00408	0.00409	0.00070	0.00129	0.00135	0.00205	0.00206
Iron	mg/L	0.63	1.73	1.75	3.25	3.26	0.84	1.26	1.30	1.79	1.80
Lead	mg/L	0.00023	0.00186	0.00190	0.00412	0.00413	0.00030	0.00101	0.00108	0.00190	0.00191
Manganese	mg/L	<i>0.06</i>	<i>0.09</i>	<i>0.09</i>	<i>0.13</i>	<i>0.13</i>	<i>0.10</i>	<i>0.10</i>	<i>0.10</i>	<i>0.10</i>	<i>0.10</i>
Molybdenum	mg/L	0.00080	0.00086	0.00086	0.00095	0.00095	0.00099	0.00111	0.00110	0.00120	0.00120
Nickel	mg/L	0.00035	0.00088	0.00087	0.00125	0.00125	0.00052	0.00073	0.00072	0.00090	0.00090
Selenium	mg/L	0.00020	0.00026	0.00026	0.00035	0.00035	0.00020	0.00022	0.00022	0.00024	0.00024
Silver	mg/L	0.000050	0.000050	0.000050	0.000050	0.000050	0.000044	0.000047	0.000047	0.000050	0.000050
Strontium	mg/L	0.13	0.21	0.21	0.27	0.27	0.11	0.14	0.14	0.16	0.16
Thallium	mg/L	0.0001000	0.0001000	0.0001000	0.0001000	0.0001000	0.0000877	0.0000946	0.0000941	0.0001000	0.0001000
Tin	mg/L	0.000050	0.000050	0.000050	0.000050	0.000050	0.000044	0.000047	0.000047	0.000050	0.000050
Titanium	mg/L	0.00120	0.00300	0.00297	0.00430	0.00430	0.00116	0.00163	0.00160	0.00200	0.00200
Uranium	µg/L	0.85	1.77	1.80	3.05	3.06	0.20	0.69	0.74	1.32	1.33
Vanadium	mg/L	0.00026	0.00063	0.00063	0.00090	0.00090	0.00029	0.00041	0.00040	0.00050	0.00050
Zinc	mg/L	0.00500	0.16246	0.16653	0.38034	0.38176	0.00500	0.07553	0.08249	0.16496	0.16590

Bolded and shaded cells indicate an aquatic life guideline exceedance.

Italicized and shaded cells indicate a drinking water exceedance.

Cadmium guideline (mg/L)= (10[0.86 [log(hardness)] - 3.2])*1000. Calculated exceedance is based on a water hardness of 214 mg/L.

Guideline is for hexavalent chromium (CrVI) because its guideline is more stringent than the trivalent chromium (CrIII) guideline of 0.009 mg/L.s



2.1.3 Co-management Facility

Table 2.3 highlights the breakdown of the component inflows to the co-management facility (i.e., the component outflows to the Saskatchewan River).

Table 2.3
Co-management Facility Inflows

Year	Total Inflow (Mm ³)	PKCF Decant		Manville Pumping Wells	
		(Mm ³)	% of Total	(Mm ³)	% of Total
1	0	0	N/A	0	N/A
2	0	0	N/A	0	N/A
3	0	0	N/A	0	N/A
4	20.99	20.99	100%	0	0%
5	56.83	20.99	37%	35.84	63%
6	56.83	20.99	37%	35.84	63%
7	56.83	20.99	37%	35.84	63%

The percentage contributions from each of the inflow sources are stable from year 5 until mining is completed at Star in year 7. Note that leap years have been removed from this table; (i.e., all years have 365.25 days).

2.2 Water Withdrawal from the Saskatchewan River

2.2.1 Annual Volumes

The updated water balance indicates volumes ranging from 23.7 to 24.2 Mm³ annually being withdrawn from the Saskatchewan River in years 4 to 7. Considering the outflow volumes from the mixing facility to the river (**Table 2.3**) there is a net inflow to the river in during mining at Star.



2.2.2 Monthly Variability

Monthly variability of water taken from the Saskatchewan River is driven by runoff from East Ravine into the runoff pond. Directing 80% of Coarse PK Water to PKCF means a slight reduction in the volume of water collected by the Runoff Pond each month to meet the plant demand (25.2 Mm³/a). The percentage of plant demand met by water from the runoff pond per month is presented in **Table 2.4**.

Table 2.4
Plant Demand Met by Runoff Pond

Month	% Plant Demand Met by Runoff Pond
January	1
February	1
March	1
April	24
May	6
June	3
July	3
August	5
September	1
October	1
November	1
December	1
Annual	4

Overall, the runoff pond provides approximately 4% of the plant demand. Thus, the Saskatchewan River provides approximately 96% of the plant water demand. The variability is illustrated on **Figure 2.1**.

2.3 Hydrology Summary

Table 2.5 summarizes the salient changes to the hydrological water balance compared to the 2012 model.

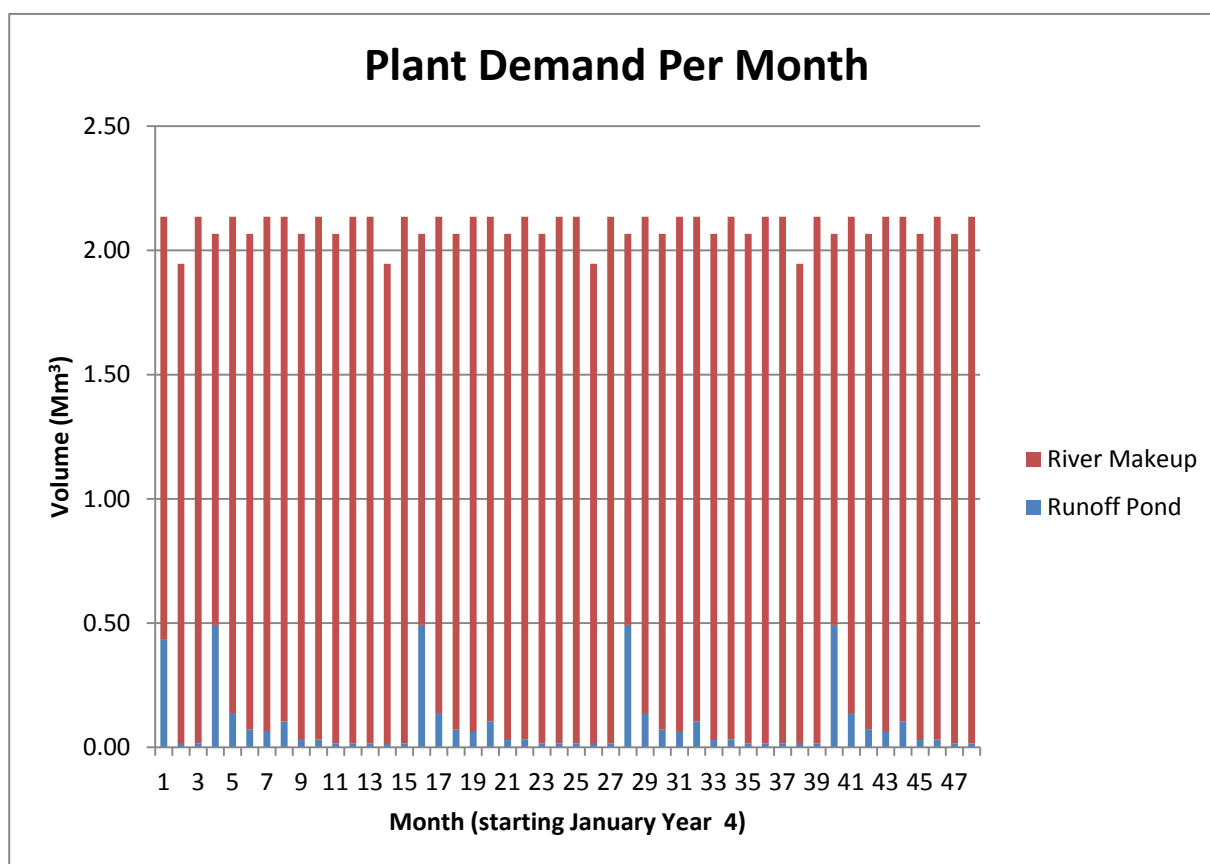


Table 2.5
Summary of Changes to Water Balance compared to 2012 Model

Hydrology Component	2012	November 2013
Withdrawal from Saskatchewan River	0	23.73 to 24.15
Inflow to PKCF	23.85	25.49
Runoff pond contribution to plant	0	1.00 to 1.42
Release directly to Saskatchewan River	36.24 to 36.49	20.99 to 56.83

Other than the components listed in **Table 2.5**, all other hydrological components in the water balance remained unchanged from the 2012 model.

Figure 2.1 **Variability in Makeup Water Volume from Saskatchewan River in Years 4 to Year 7**



3.0 CLOSURE

This report has been prepared for the exclusive use of Shore Gold Inc. This report is based on, and limited by, the interpretation of data, circumstances, and conditions available at the time of completion of the work as referenced throughout the report. It has been prepared in accordance with generally accepted engineering practices. No other warranty, express or implied, is made.

We look forward to the opportunity to discuss these results further and to prepare any documents required by Shore Gold Inc. to present the findings to regulatory authorities.

Yours truly,

AMEC Environment & Infrastructure

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GREB/jp/elf

Appendix A
Water Quality Guidelines

**TABLE A-1
Water Quality Guidelines Applicable During the Study**

Parameter	Units	Guidelines			
		Liquid Effluent	Aquatic Life		Drinking Water
		Mineral Industry (1996)	CCME (2012)	SK MOE (2006)	Health Canada (2012)
Field Measured		-	-	-	-
pH	pH units	-	6.5 to 9.0	-	6.5 to 8.5 ^{d1}
Dissolved Oxygen (DO)	mg/L	-	6.5 or 9.5 ^{a1}	-	-
Temperature	°C	-	-	-	≤15 ^{d1}
Conventional Parameters and Major Ions					
pH	pH Units	-	6.5 to 9.0	-	6.5 to 8.5 ^{d1}
Total Dissolved Solids (TDS)	mg/L	-	-	-	≤500 ^{d1}
Total Suspended Solids (TSS)	mg/L	-	^{a2}	-	-
Turbidity	NTU	-	-	-	1 ^{d2}
Sodium	mg/L	-	-	-	≤200 ^{d1}
Chloride	mg/L	-	120	-	≤250 ^{d1}
Sulphate	mg/L	-	-	-	≤500 ^{d1}
Nutrients and Organics					
Ammonia	mg/L	-	0.02 - 190 ^{a3}	-	-
Nitrate-Nitrogen	mg/L	-	2.9 ^{a4}	-	10 ^{d3}
Nitrite-Nitrogen	mg/L	-	0.06 ^{a5}	-	1 ^{d3}
Phosphorus, Total	mg/L	-	^{a6}	-	-
Phenols	mg/L	-	0.004	-	-
Total Metals					
Aluminum	mg/L	-	0.005 or 0.1 ^{a7}	-	0.1 ^{d4}
Antimony	mg/L	-	-	-	0.006 ^{d2}
Arsenic	mg/L	0.5 ^{b1}	0.005	-	0.01 ^{d2}
Barium	mg/L	-	-	-	1 ^{d2}
Boron	mg/L	-	1.5	-	5 ^{d2}
Cadmium	mg/L	-	^{a8}	^{c1}	0.005 ^{d2}
Chromium	mg/L	-	0.0001 ^{a9}	-	0.05 ^{d2}
Copper	mg/L	0.3 ^{b1}	^{a10}	-	≤1 ^{d1}
Iron	mg/L	-	0.3	-	≤0.3 ^{d1}
Lead	mg/L	0.2 ^{b1}	^{a11}	-	0.01
Manganese	mg/L	-	-	-	≤0.05 ^{d1}
Mercury	mg/L	-	0.00003	0.00003	0.001 ^{d2}
Molybdenum	mg/L	-	0.073	-	-
Nickel	mg/L	0.5 ^{b1}	^{a12}	-	-
Selenium	mg/L	-	0.001	-	0.01 ^{d2}
Silver	mg/L	-	0.0001	-	-
Thallium	mg/L	-	0.0008	-	-
Uranium	mg/L	2.5 ^{b1}	0.015	0.015 ^{c2}	0.02 ^{d2}
Zinc	mg/L	0.5 ^{b1}	0.03	-	≤5 ^{d1}

Part 1. Water Quality Guidelines for the Protection of Aquatic Life

CEQG (CCME - Federal)

a1 = Guideline is based on temperature preferences of biota. In this case, the cold water biota guidelines for both early life and other life stages are shown.

short-term exposure (e.g., 24-h period).

levels when background is >250 mg/L (TSS) or >80 NTU (turbidity).

a3 = Guideline is dependent on temperature and pH, and is expressed as Ammonia-N. The value ranges between 0.02 mg/L (pH= 10.0, temperature= 30°C) and 190 mg/L (pH= 6, temperature= 0°C).

a4 = Guideline is expressed as nitrate-N.

a5 = Guideline is expressed as nitrite-N.

a6 = The trophic status of lakes is assessed using the total phosphorus concentrations. The Canadian Trigger Ranges are as follows: ultra-oligotrophic - <0.004 mg/L; oligotrophic - 0.004 to 0.01 mg/L; mesotrophic - 0.01 to 0.02 mg/L; meso-eutrophic - 0.02 to 0.035 mg/L; eutrophic - 0.035 to 0.1 mg/L; and hyper-eutrophic - >0.1 mg/L.

a7 = Guideline = 5 µg/L at pH < 6.5, [Ca2+] < 4 mg/L and DOC < 2 mg/L;

Guideline = 100 µg/L at pH ≥ 6.5, [Ca2+] ≥ 4 mg/L and DOC ≥ 2 mg/L.

The Ministry Environmental Protection Agency 1996

b1 = The Maximum Mean Monthly Arithmetic Concentration

SK MOE (Saskatchewan Water Quality Objectives)

0.000058 mg/L where the water hardness is 97 to 194 mg/L, and 0.0001 mg/L where the water hardness is >194 mg/L.

c2 = The objective was developed by the Industrial, Uranium and Hardrock Mining Unit of Saskatchewan Environment.

Part 2. Water Quality Guidelines for Human Consumption

GCDWQ (Health Canada - Federal)

d1 = Aesthetic objective.

d2 = Maximum allowable concentration (MAC).

d3 = Guideline corresponds to nitrate-N and nitrite-N.

d4 = A health-based guideline for aluminum in drinking water has not been established.

Operational guidance values of less than 100 µg/L total aluminum for conventional treatment plants and less than 200 µg/L total aluminum for other types of treatment systems are recommended.