APPENDIX J

Comments Provided by CNSC on Serpent River Watershed State of the Environment Report

1- Assess watershed conditions relative to TMA sources through water and sediment quality and benthic invertebrate community composition.

<u>Water quality</u>

Uranium levels still regularly exceed PWQO only at M-01 (Inlet Elliot Lake) and Q-09 (Inlet Quirke Lake). In general, Ra-226, sulphate and uranium levels are either stable or decreasing in the SRW. The pH remain stables with the exception of SR-06 (McCabe Lake) where pH has decreased. Cobalt regularly exceeded the threshold at SC-01 (Towards Elliot Lake), Q-20 (Dunlop Lake), Q-09 (Quirke Inlet) and M-01 (Elliot Lake inlet) and only decreased at Quirke and Elliot Lake inlets. The licensee has not compared the current uranium levels to the new CCME guidelines. With few exceptions, mean surface water concentrations of mine related substances are less than the SRWMP benchmark and where concentrations exceed the benchmark they do not exceed the new CCME guideline.

Table 5.1: Percent of samples exceeding selected benchmarks (shaded values) at SRWMP stations, 2005-2009.

Station	# of Samples	Barium	Cobalt	Iron	Manganese	pH	Radium	Sulphate[b]	Uranium
		mg/L	mg/L	mg/L	mg/L	pH units	Bq/L	mg/L	mg/L
Upper limit of Background		0.047	0.0007	0.47	0.098	6.3	0.006	6.3	0.0006
PWQO[a]		-	0.0009	0.30	-	6.5	1.0	100	0.005
D-5	60	48%	0%	0%	0%	0%	0%	0%	5%
D-6	57	0%	5%	14%	65%	2%	0%	12%	0%
DS-18	60	0%	0%	15%	0%	0%	0%	20%	0%
M-01	50	0%	22%	56%	na	4%	0%	0%	24%
Q-09	60	52%	15%	na	na	0%	0%	17%	25%
Q-20	5	0%	20%	na	na	0%	0%	0%	0%
SC-01	16	0%	69%	0%	na	18%	0%	0%	0%
SR-01	5	0%	0%	na	na	0%	0%	0%	0%
SR-06	10	100%	0%	na	na	0%	0%	60%	0%
SR-08	60	0%	0%	na	na	2%	0%	97%	0%

[a] Provincial Water Quality Objectives (OMOEE 1994)
[b] Sulphate criterion based on BCMOE
na - Parameter not sampled at respective station.

Table 5.2: Summary of water quality trends[a] for Serpent River monitoring stations, 2000 to 2009.

Station ID	Number of Seasons Used in Common Trend[b]	Barium	Cobalt[c]	Iron[d,e]	Manganese[d]	pH[e]	Radium-226[c]	Sulphate	Uranium[c,e]
Reference Stations									
D-4	2	0.165	ND	0.645	0.621	-0.069	ND	-0.593	ND
P-22	2	0.435	ND	-	-	-0.038	ND	-0.515	ND
SR-05	10	-0.012	ND	-	-	0.070	ND	-0.786	ND
SR-14	1	-0.215	ND	-	-	0.0243	ND	-0.608	ND
SR-18	2	-0.099	ND	-	-	0.289	ND	-0.721	ND
SR-19	12	-0.191	ND	-	-	0.087	ND	-0.579	ND
Exposed Stations									
D-5	12	-0.124	ND	*-0.134*	-0.367	-0.011	-0.405	-0.412	*-0.276*
D-6	12	-0.093	ND	0.244	-0.046	*0.010*	-0.290	-0.258	ND
DS-18	12	-0.121	ND	0.368	-0.321	-0.084	-0.668	-0.442	-0.254
M01	10	-0.229	-0.219	-0.004	-	0.414	-0.660	-0.619	0.162
Q09	12	0.038	-0.292	-	-	-0.095	-0.374	-0.244	-0.379
Q20	1	0.622	ND	-	-	0.582	-0.834	-0.264	ND
SC-01	1 or 2	-0.360	ND	0.446	-	0.655	-0.739	-0.053	ND
SR-01	1	0.422	ND	-	-	0.387	-0.887	-0.967	-0.845
SR-06	2	0.984	ND	-	-	-0.572	0.394	-0.935	-0.977
SR08	12	0.172	ND	-	-	-0.076	-0.416	-0.539	-0.740

(blue) decreasing trend, significant at p<0.05
(green) increasing trend, significant at p<0.05
[a] Based on rank correlation coefficients (rho) shown in table for common (combined) seasonal trends.
[b] Seasons used varied for substances based on suitability of data for trend analysis.
[c] ND denotes that this parameter was not included in the trend analysis for that particular station due to >50% non-detectable concentrations in the samples available for the analysis.
[d] "-" denotes that this parameter was not included in the trend analysis for that particular station due to the absence of data (e.g. there were <5 years worth of data for that parameter)
[e] Italic text mean monthly correlations were significantly different, but common trend value provided was not necessarily significant.

<u>Sediment Quality</u>

While surface water quality has dramatically improved since decommissioning and the inception of the SRWMP, sediment is changing slowly with few statistical differences found between 1999 and 2009. This is not surprising because the first centimeter of surface sediments was analysed which represents likely a decade or more of historical contaminant loading. In addition, samples taken at 15m deep may have important benthos activity that can contribute to homogenize the sedimentary profile. Therefore, a fine sedimentary core profile at the deepest part of the lakes where anoxic conditions would limit benthic activity, would provide better evidence of sediment recovery.

Sediment toxicity results (Fig.5.4 & 5.5) were not consistent with sediment chemistry showing reduced survival in lakes with some of the lowest sediment concentrations. Pecors, McCarthy and Nordic Lake had reduced survival and growth in test with *Hyalella azetca*. However, results of *Chironomus dilutus* test showed no difference between exposure and reference lakes measures for growth or survival.

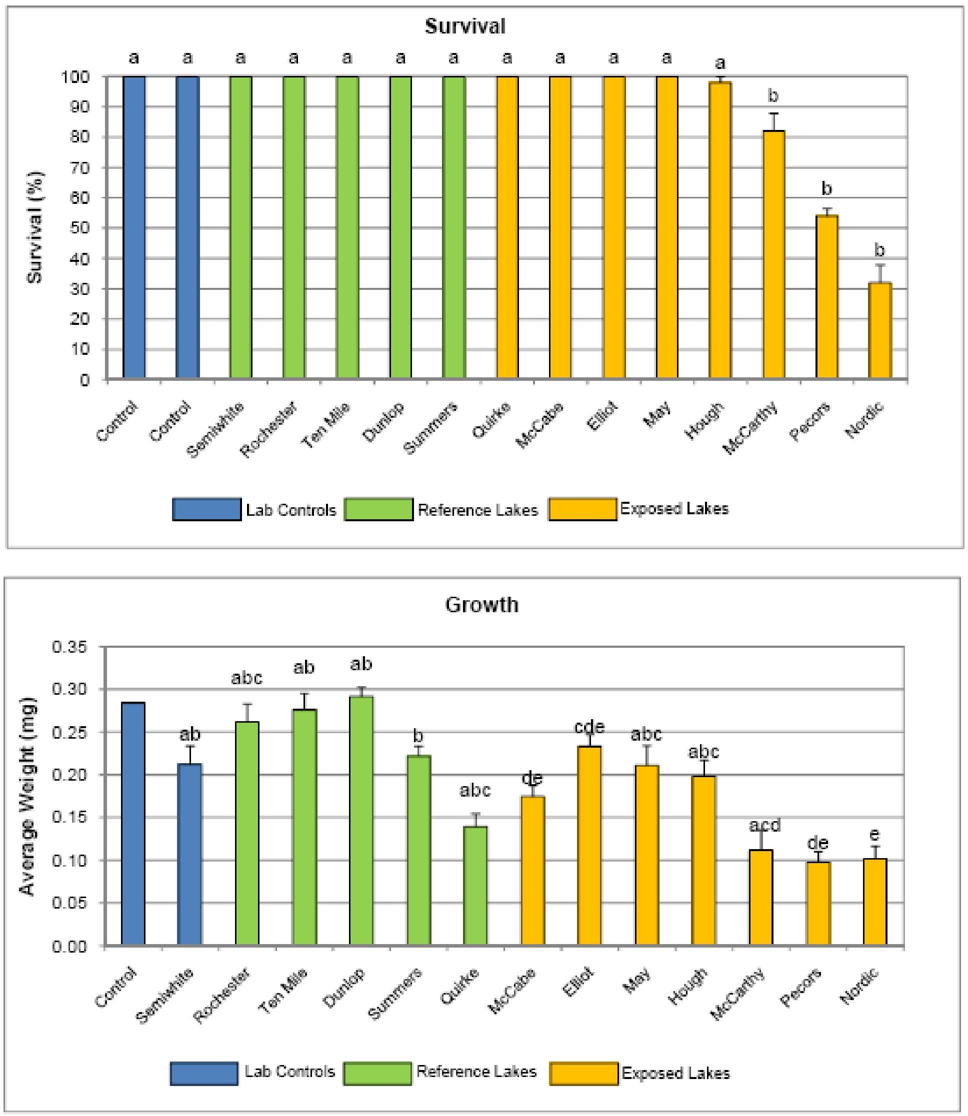


Figure 5.4: **Survival and growth (+ SE) of *Hyalella azteca* exposed to sediment samples, SRWMP 2009. Lakes with similar letters above bars were not significantly different ($p<0.05$).**

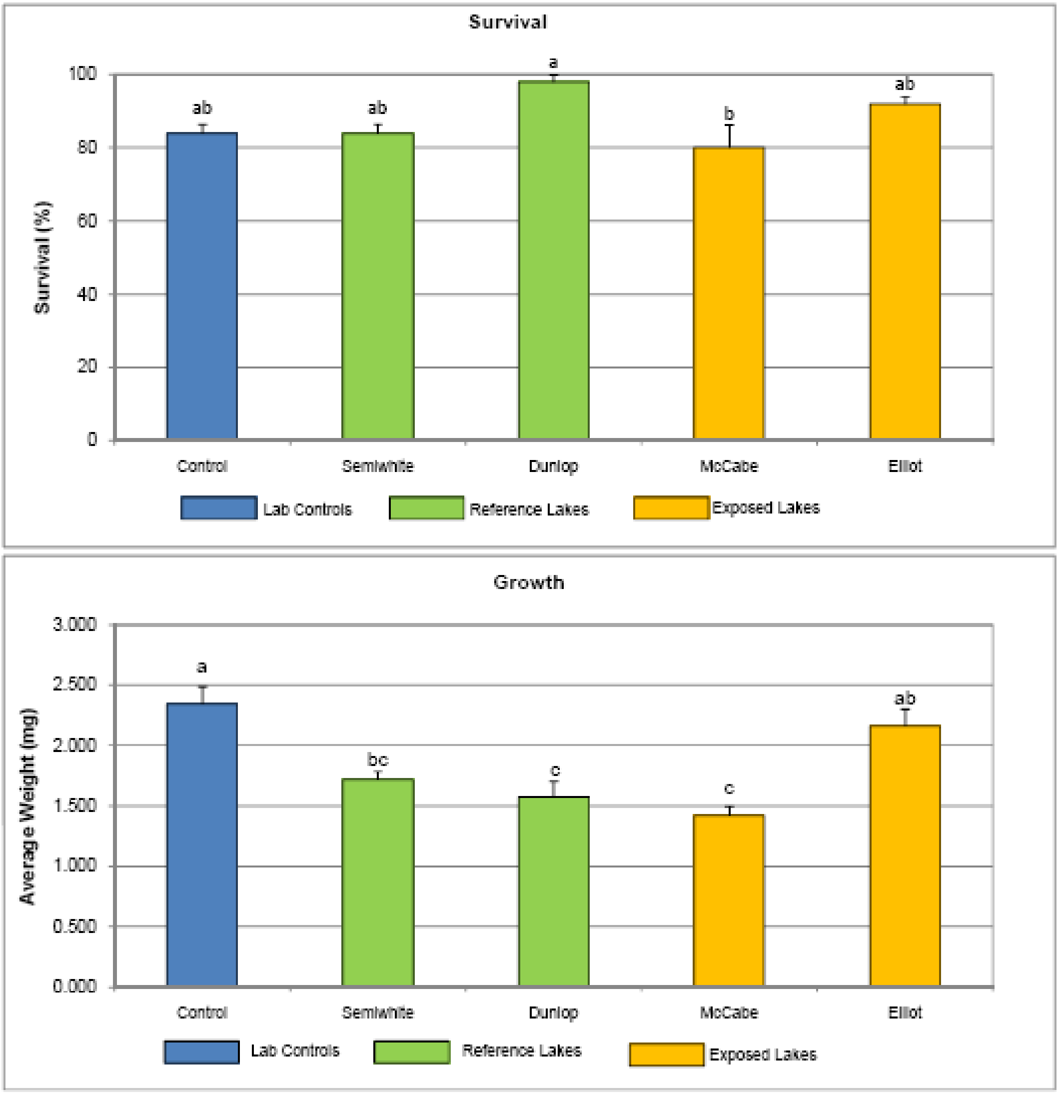


Figure 5.5: Survival and growth (+ SE) of *Chironomus dilutus* exposed to sediment samples, SRWMP 2009. Lakes with similar letters above bars were not significantly different ($p<0.05$).

<u>Impacts to aquatic environment</u>

Impacts on stream benthic communities (erosional habitats)

Erosional and depositional stream stations were discontinued in the Cycle 3 design based on water quality and habitat standardization (CNSC 2009). These stations were retired with the focus retained on lake depositional environments.

Impacts on benthic communities in depositional habitat

The communities in Quirke, McCabe, and May lakes showed more significant differences from the mean reference community than the other lakes (i.e., more metrics differed; Fig. 5.7).

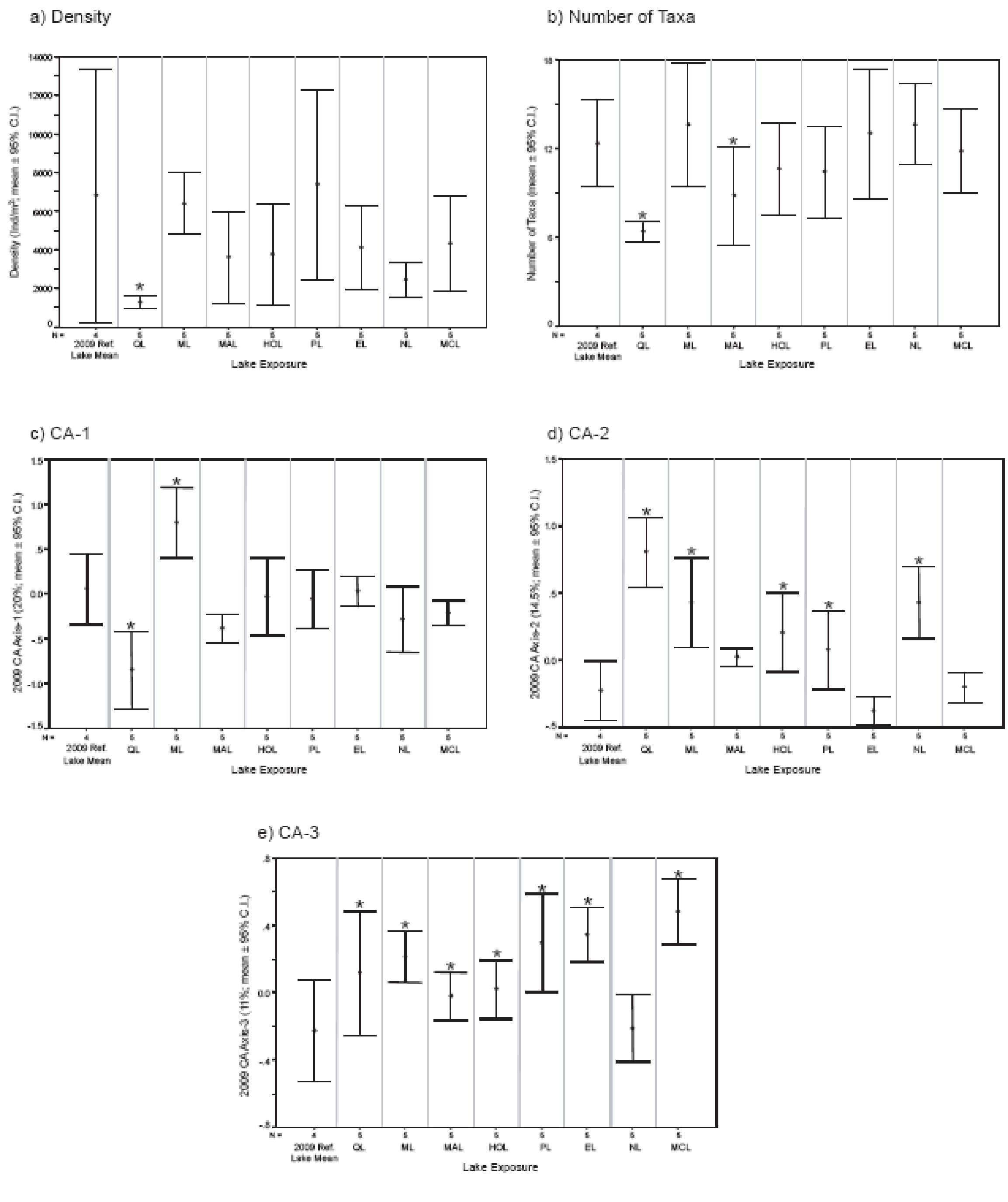


Figure 5.7: Benthic community characteristics in mine-exposed lakes of the Serpent River watershed relative to the pooled reference lakes. Asterisks (*) indicate exposure lakes that were statistically different from reference for each metric (p<0.1).

The pattern of deviations from reference mean values for the exposure lakes generally decreased through the three cycles of study, from 4 out of 5 metrics in 1999, to 3 out of 5 in 2004, and to only 2 out of 5 metrics in 2009. This supports a hypothesis of gradual recovery in the exposure lakes since 1999, though deviations from the reference means persist in both the density and community structure in the 2009 samples (Fig.5.8).

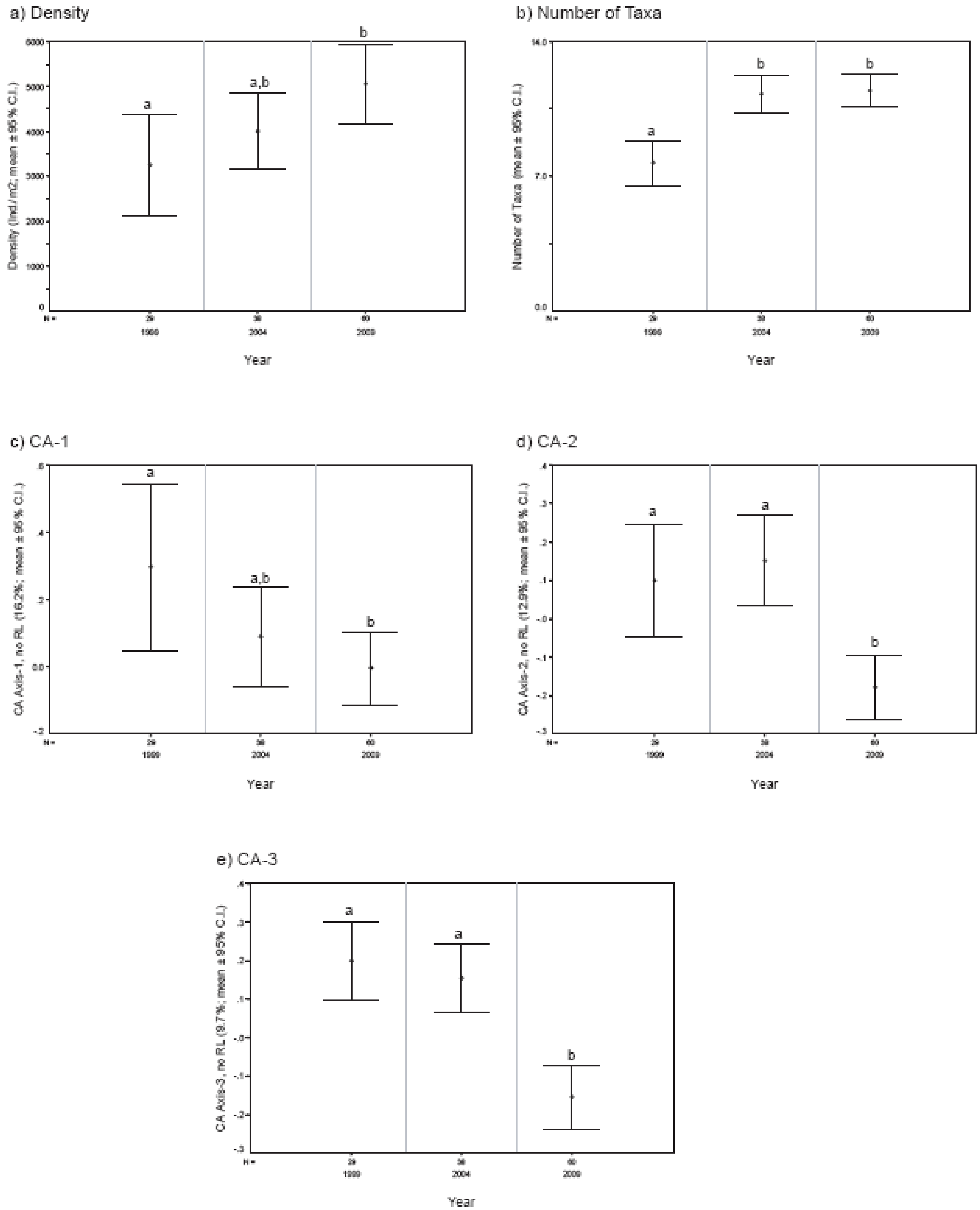


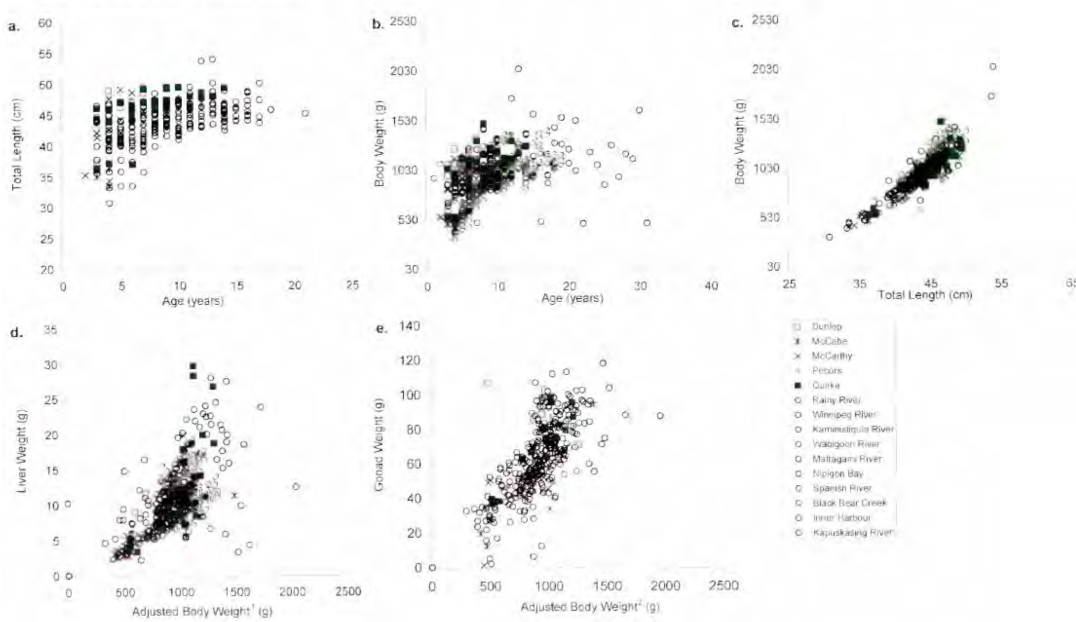
Figure 5.8: Benthic invertebrate community metrics for combined reference and exposure stations among years (1999, 2004, 2009). Years with similar letters were not significantly different ($p > 0.1$).

Impact to fish

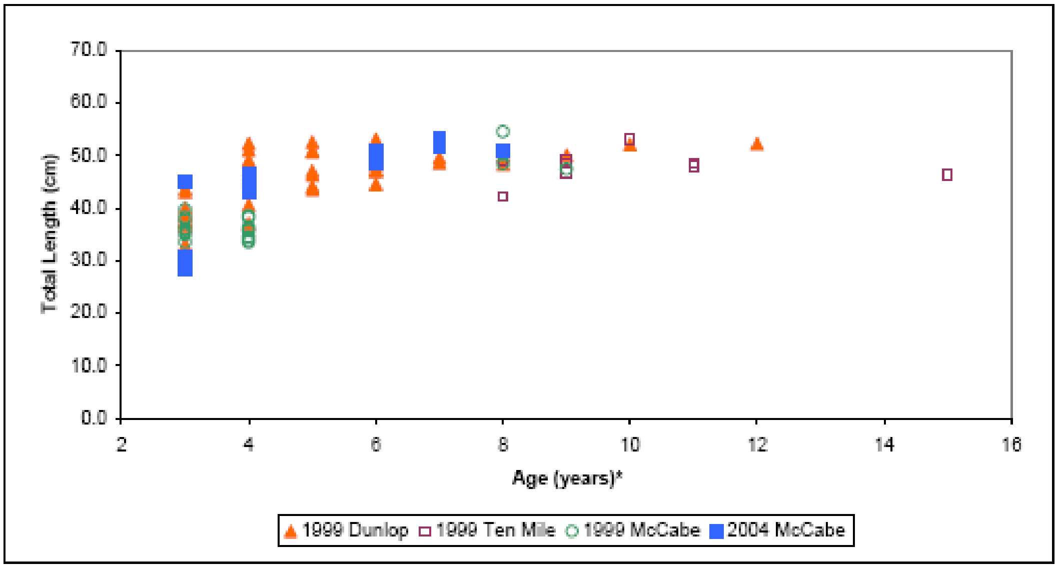
Fish Health

A detailed survey of white sucker populations was undertaken in two reference lakes (Ten Mile and Dunlop Lakes), three near-field lakes (Quirke, McCabe, and Nordic Lakes), and two far-field lakes (Pecors and McCarthy Lakes) in 1999 (Minnow and Beak 2001). Fish abundance was not adversely impacted in the five mine-exposed lakes compared to reference lakes. The exception to this was McCabe Lake, where there was some evidence of reduced abundance and diversity. Fish health was also assessed by measurement of characteristics associated with the growth, condition, and reproduction of white sucker. The fish residing in the lakes downstream of the mines showed similar health characteristics to those residing in the reference lakes. Further comparison was undertaken by obtaining data for more than 200 white sucker collected from un-impacted (reference) areas in nine other Northern Ontario watersheds using similar methods (Fig.7.6). The data for SRW white sucker were within the range of natural variation indicated by the white sucker from the other nine watersheds. The exception was potential reductions in some characteristics among McCabe Lake sucker relative to reference.

Figure 7.6: Male White Sucker, Dunlop Lake, McCabe Lake, McCarthy Lake, Pecors Lake, Quirke Lake and Regional Reference Data, SRW, 1999.



Based on the findings of Cycle 1 (Minnow and Beak 2001), the Cycle 2 SRWMP (Minnow 2006) focused on evaluation of the fish community and white sucker abundance and population health in McCabe Lake. The fish heath survey conducted in McCabe Lake in 2004 (Cycle 2) focused on abundance, growth, and condition of white sucker. Estimates of catch-per-unit-effort (CPUE) indicated a substantial increase in white sucker abundance between 1999 and 2004 from 1.1 to 2.85 white sucker per 1,000 ft hours respectively (Minnow 2006). The abundance measured in McCabe Lake in 2004 was similar to that measured in 1999 in Dunlop Lake (2.9/1,000 ft hrs) and greater than that measured in Ten Mile Lake (0.52/1,000 ft hrs) indicating that white sucker abundance is in the range of reference lakes. In 2004 white sucker were collected over a broader size range enabling comparison to the 1999 reference data (Figure 5.1). These data show that both growth and condition are within the range of reference fish.



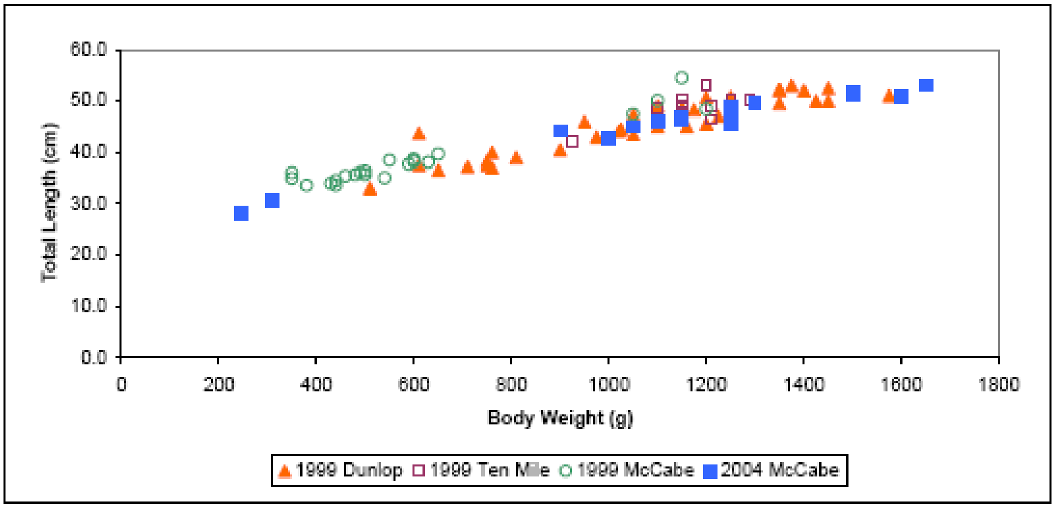


Figure 5.1: Growth and condition of white sucker caught in McCabe Lake and reference lakes in 1999 vs. 2004. Asterisk (*) indicates age inferred from length for some juveniles. All adults were aged. In order to reduce mortalities in juveniles, only some individuals from different length classes were aged. (0-7 cm assumed as YOY, 9-18 cm assumed as 1 year).

Given the improvement in abundance and the confirmation that growth and condition are within the range of background, no further sampling of the fish within McCabe Lake was proposed and accepted by CNSC.

Fish Tissue

Fish tissue samples collected in 1999 and 2004 indicated that fish have not accumulated mine related chemicals to concentrations of concern with respect to the health of human consumers (benchmarks). In fact, tissue concentrations were generally 10 to 1,000 times less than the benchmark (Tables 5.2). There is no reason to expect tissue concentrations to exceed benchmarks in the future if water and sediment concentrations remain less than 1999 levels. Thus, the fish tissue monitoring was eliminated from the SRWMP (CNSC 2009).

Table 5.2: Comparison of 1999 and 2004 mean concentrations of metals and radionuclides in fish muscle relative to human health benchmarks.

Lake	Year	Fish[a]	Component	Aluminum	Barium	Cobalt	Iron	Lead	Manganese	Radium-226	Selenium	Silver	Thorium	Uranium
			Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	Bq/kg	mg/kg	mg/kg	mg/kg	mg/kg
			Benchmark	6422.02	51.38	32.11	-	11.56	450	21.11	16.06	16.06	16.68	1.93
Dunlop (Reference)	1999	SMB	Mean	< 2	na	< 0.050	< 5	0.11	0.15	< 0.20	1.1	0.060	na	< 0.05
	2004	W, SMB, LT, WS	Mean	2.8	0.11	0.004	4	0.21	0.13	0.10	0.76	0.015	0.03	0.01
Elliot	1999	SMB	Mean	2.1	na	< 0.050	13	< 0.10	0.21	0.19	0.62	< 0.050	na	< 0.05
	2004	SMB, NP	Mean	1.5	0.06	0.007	5	0.16	0.15	0.20	0.46	0.008	0.03	0.01
McCarthy	1999	SMB	Mean	< 2.0	na	< 0.050	< 5	< 0.10	0.10	0.23	0.52	< 0.050	na	< 0.05
	2004	SMB, NP	Mean	3.9	0.04	0.008	3	0.12	0.49	0.32	0.42	0.014	0.03	0.01
Quirke	1999	SMB	Mean	2.3	na	< 0.050	9	< 0.10	0.22	0.22	1.9	< 0.050	na	0.05
	2004	SMB, LT	Mean	1.9	0.06	0.008	3	0.13	0.21	0.25	0.79	0.013	0.03	0.01

na - not analyzed

Value exceeds benchmark.

[a] LT - lake trout, NP - northern pike, SMB - smallmouth bass, W - walleye, WS - white sucker

Dose to Biota

The largest calculated doses to aquatic biota occurred at Quirke Lake, where the doses to fish, aquatic plants and benthos were 0.92, 2.61 and 0.256 mGy/d, respectively. For all aquatic biota, the largest component of dose was internal and the largest contributor to dose was generally Po-210 for both fish and benthic invertebrates. CNSC staff independently verified the Ecometrix dose calculations, obtaining a dose to pelagic fish of 43 µGy/h (i.e. 1.03mGy/d), a value similar to those obtained by Ecometrix.

Benthic community indices in Quirke Lake are different than reference indicating benthic invertebrate impairment persists (Fig.5.7), however, white sucker health indicators appear similar to reference lakes. Whether or not the benthic invertebrate community impairment can be ascribed to radiotoxicity or chemical toxicity remains to be proven. Hence, the licensee, in the spirit of transparency, in addition to indicating that dose rates are well below the UNSCEAR (1996) benchmark dose of 10 mGy/d (or 400 µGy/h) should acknowledge that the dose rates calculations are higher than the 0.24mGy/d used in the ERICA tool (Brown et al. 2008) for some aquatic biota and the more conservative CNSC dose rate criterion of 0.6 mGy/d. The more recently derived CNSC dose rate criteria (0.6 mGy/d for fish, 3 mGy/d for aquatic plants, and 6 mGy/d for benthic invertebrates) and the ERICA tool screening benchmark for the assessment of effects to aquatic biota should have been included in the ecological risk assessment and the SOE report and shall be included in future reports.

Dose to Humans

The calculated doses ranged from 0.036 to 0.301 mSv/a, all less than the public dose limit of 1 mSv/a, before background correction. Background dose from the same pathways was estimated at 0.013 mSv/a. Therefore, incremental doses ranged from 0.023 to 0.288 mSv/a. The smallest doses were at McCarthy, Elliot and Nordic lakes, whereas the largest dose was at Quirke Lake. The dose at Quirke Lake was dominated by consumption of mallard ducks, and was driven by the high concentration of Po-210 in aquatic macrophytes at Quirke Lake. However, macrophytes were collected in Quirke Lake from a former tailings deposition area near Panel Mine and thus likely over estimate typical macrophyte uptake within the lake. The estimated dose at Quirke Lake without the waterfowl component is 0.072 mSv/a (total) or 0.064 mSv/a (incremental).

The contributions of water, fish, moose and waterfowl to the SRFN dose are approximately 28%, 37%, 25% and 10%, respectively, with slight variations between actual use and future use scenarios.

Spatial extent of impacts

There are obvious trends which indicate that the environmental impacts are decreasing both in overall magnitude and spatial extent in the Serpent River watershed. Areas of concern can now be restricted to Quirke Lake, McCabe Lake and May Lake. In addition, loadings from the Pronto TMA continue to require further attention and monitoring.

Reversibility of impacts

With water quality improving, it is only a matter of time before sediment also show a clear indication of recovery. Statistically measurable sediment recovery will be delayed as a result of the low depositional rates one would expect in these environments and the influence of bioturbation. Benthic invertebrate impacts are mainly observed in Quirke Lake and McCabe and May lake which receive contaminants from Quirke and Denison TMAs and Stanleigh TMA, respectively. As long as released are actively controlled at the TMAs, environmental conditions should continue to improve in the Serpent River Watershed.

Conclusion

In general, water quality is improving and environmental impacts, such as decreased benthic community taxonomic richness and abundance have reduced in magnitude and spatial extent such that only waterbodies immediately downstream of Quirke, Denison, Panel and Stanleigh are measurably impacted. Lakes further afield are generally in good environmental health conditions. While sediment contaminant levels continue to appear somewhat elevated, sediment cores in zones of limited benthic activity may better define historical contaminant deposition from recent contaminant deposition.

2- Evaluate mine sources (TMA releases) in terms of concentrations and loads to the Serpent River Watershed (SRW) and utilize trend analysis to anticipate future conditions in source contributions to the watershed;

Quirke Lake:
In the spirit of continuous improvement the licensee should within the present management system:

- investigate options for limiting loadings from the Quirke and Denison TMAs;
- investigate opportunities to minimize seepage from the Quirke II mine, in particular with respect to cobalt; and
- investigate whether improved control of Ra-226 at the Denison TMAs can be achieved considering the recent increase in loadings documented in this report.

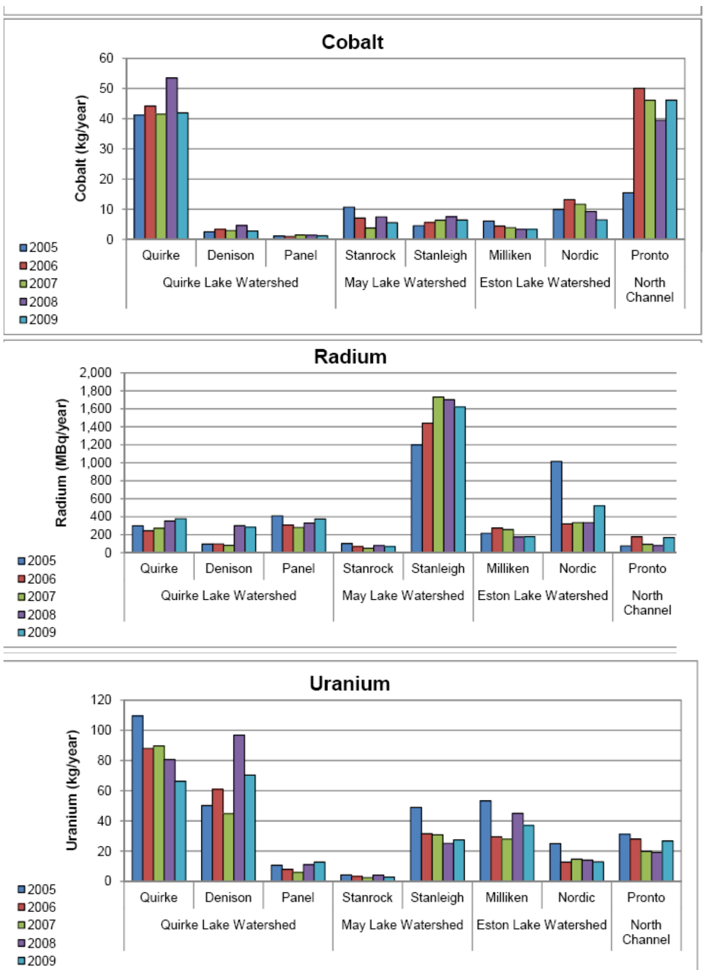


Figure 4.3: Annual TMA loadings by watershed (2005-2009).

Stanley TMAs:
In the spirit of continuous improvement the licensee should, within the present management system:

- review present practices for opportunities to optimise performance and demonstrate that releases are being kept as low as reasonably achievable, social and economics considered.

Pronto TMAs:

In the spirit of continuous improvement the licensee should within the present management system:

- review present practices for opportunities to optimise performance with specific attention paid to cobalt.

3- **Assess TMA performance relative to discharge criteria as well as performance objectives and predictions made in the Environmental Impact Statements (EIS);**

No comments

4- Changes in SRWMP

Background
At the onset of the SRWMP it was recognized that the program would need to be modified over time and the requirement for monitoring should be reduced as the zone of influence of the decommissioned mines recedes and conditions in the watershed improve. Consistent with this understanding the SRWMP was designed to evolve over time responding to previous study findings. Environmental acceptability criteria were developed and approved as the basis for assessing study findings and reducing/eliminating aspects of the program (Beak 1999). Given the long-term history of mine-related activities in the watershed, and existing knowledge of environmental conditions, a "weight-of-evidence approach" was approved by CNSC for defining environmental acceptability. Criteria denoting acceptable environmental quality include:

- Contaminant concentrations in environmental media are below objectives or guidelines (*e.g.,* Provincial Water Quality Objectives (PWQO) (MOEE 1994) or Canadian Water Quality Guidelines (CWQG), Provincial Sediment Quality Guidelines (PSQG) (MOE 1993)), or the Interim Sediment Quality Assessment Values (ISQAV) (Environment Canada 1995); The guidelines of Thompson et al. 2005 should also be considered.
- Contaminant concentrations above guidelines, but within the natural range of background variability (*i.e.,* as measured at reference stations);
- Acceptable doses and risks for human and ecological receptors based on site specific information and compared to risk guidelines and/or background levels; and
- Contaminant concentrations demonstrating stable and/or decreasing trends or, if increasing, doing so in accordance with EIS predictions.

At the time the program was developed (1999) it was expected that few areas of the watershed would reach guideline levels in the foreseeable future. Some near-field areas were expected to recover over a very long time frame while recovery of far-field areas was expected on a shorter time frame. Therefore, acceptability criteria were expected to be different for different areas of the watershed. The SRWMP design document (Beak 1999) stated that:

"Should monitoring demonstrate that an area is achieving relevant guidelines, then this should be defined as acceptable conditions, eliminating the need for further monitoring. In other areas, acceptability may be achieved when a stable or slowly decreasing trend is documented".

A rationale/decision path for modifying the program was established and approved as part of the Implementation Document for the SRWMP (Figure 1.2). This decision path presents the criteria for acceptability of evaluation endpoints and the ensuing change to the program based on the findings of the previous study. Based on the decision path and the acceptability criteria, stations (*i.e.*, whole lakes or creek/river areas) with concentrations of mine indicator parameters in water and sediment below guidelines (or at background if background exceeds the guideline) and with no ecologically significant effects on benthic and fish community parameters can be eliminated from the program. Similarly, if a particular parameter meets criteria for water, sediment, and tissue quality, and there are no detectable effects on benthic and fish communities at all areas, that parameter can be eliminated from the program. Ultimately, it is expected that the program should retract spatially with improvement and only expand in response to ecosystem impacts.

While the acceptability criteria and decision pathway for modifying the program were described in SRWMP Framework and Implementation documents (Beak 1999), the application of the acceptability criteria to specific program components (*i.e.*, water quality, sediment quality, benthos, fish, and dose and risk) has been described in more detail in this document in the context of the findings from the Cycle 2 study. Consistent with the guiding principals of the program design, a weight of evidence approach has been employed to rationalize changes to the program.

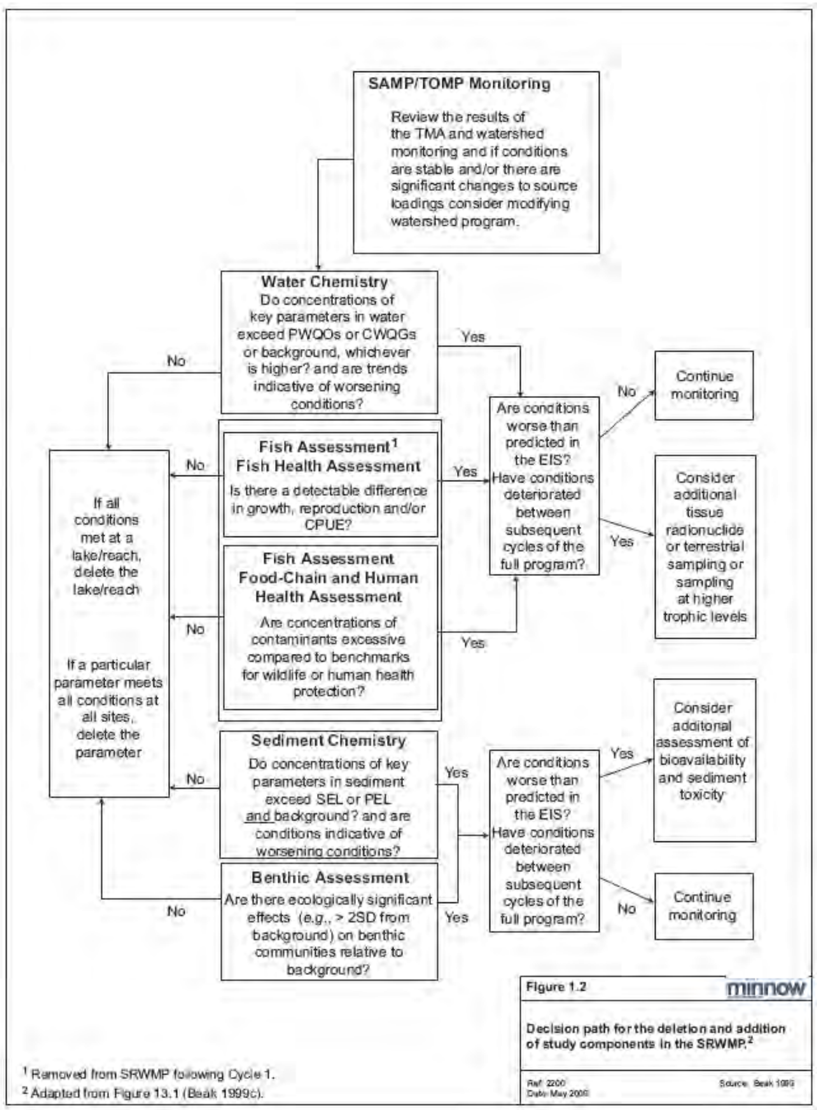


Figure 1.2

Decision path for the deletion and addition of study components in the SRWMP.²

Recommended change to the SRWMP

Based on this rationale, the licensee now recommends:

- Conditions are expected to continue to improve, but the rate of change in sediment and benthic invertebrates is slow, so consideration should be given to reducing the frequency of monitoring to once every 10 years.
- When the next SRWMP is implemented the list of exposure lakes to be included should be reduced to remove those lakes showing limited or no effects on benthic invertebrates (Elliot, Hough and McCarthy).

CNSC response

The following documents the CNSC staff position regarding the proposed changes to the monitoring program

Benthic Community:

- It is the position of CNSC staff that the sampling frequency should remain the same given that impacts are still noted at Quirke, McCabe and May lakes and that correspondence analysis still indicate differences with control areas at most sites.

Sediments:

- CNSC staff concur with the Licensee's statement that collecting surface sediment samples every 5 years may not demonstrate sediment recovery in the short term due to bioturbation and low depositional rates (e.g., possibly 2mm/yr)
- This difficulty was known when the protocols were developed; however, the primary objective at that time was to link sediment contamination with impacts to the benthic community. When the benthic community indices at historically exposed lakes become similar to the reference lakes, it is the position of CNSC staff that the sediment sampling program should be modified to include the collection of deep water cores to be sectioned at 0.5 cm to 1 cm horizons (to be discussed by the CNSC and the licensee). Should the cores indicate clear evidence of improved sediment quality since the decommissioning activities, CNSC staff will consider eliminating the sediment monitoring program.

Removal of Elliott, Hough and McCarthy lakes from the program:

- It is CNSC staff position that Elliot Lake should remain in the monitoring program as it is the only monitored receiving environment receiving drainage from Nordic and Milliken TMAs.
- It is CNSC staff position that Hough and McCarthy lakes may be removed from the program. This is based on the evidence which demonstrates that water quality is meeting the PWQO and that the benthic communities are similar compared to references.

CNSC recommended changes to the SRWMP

- It is CNSC staff position that the licensee should verify the high Po-210 numbers in forage fish. If these numbers are confirmed by the laboratory, resampling should be performed as they are well beyond the norms measured at other exposure sites and Po-210 is the dominant radionuclide responsible to the calculated dose above the ERICA screening benchmark in Quirke Lake.

- Should these elevated numbers be confirmed consideration will be given to modifications to the present monitoring program to follow-up on the role and importance of Po-210 in the environment at this site.

CNSC staff noted that Po-210 level in whole forage fish were well beyond the norms measured at other exposure sites. In light of these elevated results and the fact that Po-210 is the dominant radionuclide responsible to calculated doses, means that these results merited further confirmation and discussion. The forage fish results were not placed in context to any Po-210 levels in fish from the 1999, 2004 or 2009 (may not be available) nor unfortunately were any literature comparisons made.

In light of this finding CNSC staff completed a quick review of the available Po-210 data for Elliot Lake with some of the findings provided below to assist the licensee.

Table 3.4: Average Activity Concentrations of U-238 and Th-232 Decay Chain Radionuclides in Whole Forage Fish (fresh weight)

Lake	U Bq/kg	Th-230 Bq/kg	Ra-226 Bq/kg	Pb-210 Bq/kg	Po-210 Bq/kg	Th-232 Bq/kg	Ra-228 Bq/kg	Th-228 Bq/kg
Quirke	63.55	22.000	59.667	30.000	1006.67	< 5	*106.667*	*4.667*
Elliot	14.92	*4.333*	11.000	< 20	29.000	< 5	*116.667*	< 5
Nordic	4.51	< 5	10.333	< 20	396.667	< 5	< 100	< 5
McCabe	11.40	< 5	21.667	*36.667*	503.333	< 5	*223.333*	< 5
May	5.41	*5.000*	13.000	*23.333*	453.333	< 5	*143.333*	*5.667*
McCarthy	10.70	< 5	9.000	< 20	56.000	< 5	< 100	< 5

Note: values in italics contain some detects and some non-detects taken at face value

Despite the elevated levels in forage fish, Po-210 was not detected in water (Table 3.3). The licensee indicated that forage fish might have been exposed to Po-210 by interaction with historically contaminated sediments downstream of the Panel TMA.

Table 3.3: Measured Activity Concentrations of U-238 and Th-232 Decay Chain Radionuclides in Lake Water

Lake	U Bq/L	Th-230 Bq/L	Ra-226 Bq/L	Pb-210 Bq/L	Po-210 Bq/L	Th-232 Bq/L	Ra-228 Bq/L	Th-228 Bq/L
Quirke	0.0640	< 0.01	0.05	0.06	< 0.01	< 0.01	< 0.1	< 0.01
Elliot	0.0418	< 0.01	< 0.01	0.03	< 0.01	< 0.01	< 0.1	< 0.01
Nordic	0.0394	< 0.01	0.03	0.03	< 0.01	< 0.01	< 0.1	< 0.01
McCabe	0.0295	< 0.01	0.06	0.03	< 0.01	< 0.01	< 0.1	< 0.01
May	0.0369	< 0.01	0.05	< 0.02	< 0.01	< 0.01	< 0.1	< 0.01
McCarthy	0.0123	< 0.01	< 0.01	0.03	< 0.01	< 0.01	< 0.1	< 0.01

In addition, the Pb210 to Po-210 ratio in gut contents (Clulow et al. 1998) are different from sediments possibly indicating that food prey items are the main Po-210 source.

Pb210/Po210 ratios in Fish from different lakes in the Elliott Lake area (Clulow et al. 1998)

Fish	Bone	Muscle	Gut contents
Lake Trout			
Quirke	1.1	NA	0.76
McCabe	NA	NA	0.74
Whiskey	0.87	NA	1.35

Elliot	NA	NA	NA
JimChrist	NA	NA	NA
Whitefish			
McCabe	1.0	NA	NA
Whiskey	1.3	NA	0.27
Elliott	NA	NA	1.44
Semiwite	NA	NA	NA

NA Pb-210 were below detection limit of 50 Bq/Kg

Other than the study of Clulow et al. (1998), the licensee should provide the Po-210 levels in bone, gut and tissue of sport fish as well as indicate if there is cause for concern from Po-210 in fish tissue consumed by humans. Data from Clulow et al. (1998) indicated that the polonium although present in the gut, seems to preferably accumulate in bone like uranium and not much in fish tissue. Based on the results of dose estimates for forage fish, benthos effects, and contaminant loading estimates in Quirke Lake, fish health and fish tissue survey should be considered for Quirke Lake. The licensee has committed to provide a sampling protocol to CNSC in order to discuss a monitoring campaign that will measure levels of Po-210 in sport fish in 2011

<u>Reference</u>:

Brown J.E., Alfonso B., Avila R., Beresford N.A., Copplestone D., Prohl G., Ulanovsky A. 2008. The Erica Tool. Journal of Environmental Radioactivity. 99(9): 1371-1383.

Clulow F.V., N.K. Dave, T.P. Lim and R. Avadhanula. 1998. Radionuclides (Pb-210, Po-210, Th-230 and Th-232) and thorium and uranium in water, sediments and fish from lakes near the city of Elliot Lake Ontario, Canada. Env. Pollut. 99: 199-213.

CNSC 2009 ERAD review of Denison and Rio Algom Ltd. Serpent River Watershed Cylce 3 Monitoring Design. E-docs#3342858.

Environment Canada. 2002. Metal Mining Guidance Document for Aquatic Environmental Effects Monitoring. June 2002.

Environment Canada. 2003. National Assessment of Pulp and Paper Environmental Effects Monitoring Data: A Report Synopsis. National Water Research Institute, Burlington, Ontario. NWRI Scientific Assessment Report Series. No. 2. 28p.

Minnow Environmental Inc. & Beak International Inc. 2001. Serpent River Watershed Monitoring Program – 1999 Study E-docs#952532 incomplete hard copy in Richard's office

Minnow Environmental Inc. 2006. Serpent River Watershed Monitoring Program, Cycle 2 interpretative report. E-docs#1260180

Rio Algom Limited & Denison Mines Inc. 2009. Serpent River Watershed Monitoring Program Cycle 3 design study. E-Docs#346935

Rio Algom Limited & Denison Mines Inc. 2011. Serpent River Watershed State of the Environment. E-docs#3689265

APPENDIX K

Response to CNSC Comments Provided by Rio Algom Limited and Denison Mines Inc

Response to Comments Provided by the CNSC on the State of the Environment Report

1 Introduction

Rio Algom Limited (RAL) and Denison Mines Inc. (DMI) retained Minnow Environmental to prepare the Serpent River Watershed State of the Environment (SOE) Report. The objective of the SOE is to integrate information regarding tailings management areas (TMAs) performance with the conditions in the downstream Serpent River Watershed. This allows trends in mine sources to be used to anticipate future conditions within the watershed.

To achieve this objective a number of goals were identified:

- Evaluate mine sources (TMA releases) relative to current watershed conditions;
- Assess TMA performance relative to discharge criteria as well as performance objectives and predictions made in the Environmental Impact Statements (EIS);
- Compare dose and risk values anticipated under closure conditions to those based on measured values within the watershed and assess progress against closure objectives; and
- Identify anticipated near and long-term future conditions within the TMAs and watershed through trend analysis, review of anticipated changes within TMAs (EIS predictions) and assess the environmental risks of anticipated performance on the downstream receiving environment.

To meet the project objective and goals, a weight of evidence approach was used that incorporated existing performance, trend analysis, loadings assessment and downstream conditions relative to established criteria and expected conditions (EIS predictions).

RAL and DMI submitted the Regulatory Review Draft of the SOE to the Canadian Nuclear Safety Commission (CNSC) and members of the Elliot Lake Joint Review Group (JRG) on March 4, 2011. CNSC issued review comments on the draft report April 21, 2011. The licensees, RAL and DMI, presented their initial response to comments to members of the JRG at a review meeting held in Elliot Lake on May 12, 2011. It is planned that the CNSC Detailed Review of the Draft Serpent River Watershed SOE Report will be included in the final SOE report as Appendix J with this response to comments included as Appendix K.

The response to comments is organized in a parallel manner to the comments received from CNSC.

2 Assess Watershed Conditions

2.1 Water quality

The licensees are in agreement with the summary of water quality conditions presented in the CNSC comments but wish to acknowledge the following:

- While concentrations of uranium were found to exceed the PWQO at M-01 and Q-09, the Canadian Water Quality Guideline (CWQG) was recently updated (CCME 2011) based on the most recent toxiciology data. The new value is 15 ug/L (0.015 mg/L) which is higher than the PWQO. The CWQG is the value set by the Canadian Council of Ministers of the Environment (CCME) and used by Environment Canada for the protection of aquatic life. When the SRWMP data are compared to this guideline almost all samples collected between 2005 and 2009 were below the CWQG for uranium at all stations (Table 2.1). The only exception is one uranium sample at Q-09 in August 2007 and even this sample (0.0163 mg/L) was just marginally above the CCME guideline of 0.015 mg/L. Therefore, it should be concluded that uranium concentrations within the downstream receiving environment (SRW) are at levels which are protective of fish and aquatic life.

- Similar to uranium, cobalt was elevated above the PWQO in some samples at some locations. However, a new cobalt guideline has been developed federally under CEPA and Environment Canada is expected to adopt this guideline. The new cobalt guideline value is based on a “predicted no-effect-concentration” (PNEC) of 2.5 µg/L. When the receiving water data in the SRW are compared to this value, the concentrations at all locations except SC-01 are less than the new guideline (Table 2.1). It should be noted that the values at SC-01 which were above 2.5 µg/L were measured in 2005 and 2006 and are associated with the dam breech on Westner Lake. Since 2006, all values at all stations are less than the PNEC of 2.5 µg/L. Therefore, current cobalt concentrations are at acceptable levels in the watershed and protective of fish and aquatic life.
- The apparent trend in pH (decreasing over time) at the outlet of McCabe Lake needs to be considered in the context of natural variability and influent flows. The trend (Figure E.13 in the SOE report) is largely attributed to lower pH values which occurred during a period of low pH inflow from Canyon Lake (Figure 2.1). At no time did pH in McCabe Lake drop below background levels.

Figure 2.1. McCabe Lake, Canyon Creek and Stanleigh Discharge pH

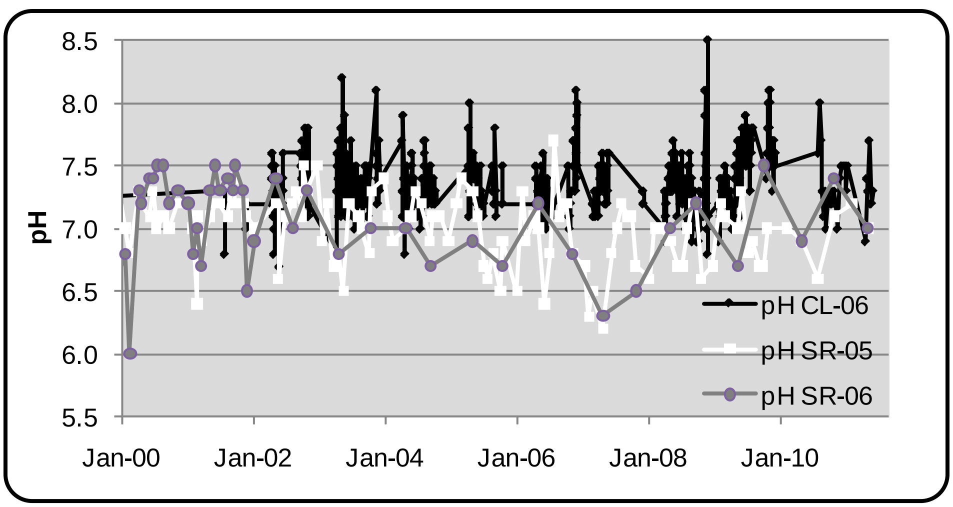


Table 2.1. Percent of samples exceeding selected benchmarks (shaded values) at SRWMP stations, 2005-2009.

Station	# of Samples	Barium	Cobalt[c]	Iron	Manganese	pH	Radium	Sulphate[b]	Uranium[d]
		mg/L	mg/L	mg/L	mg/L	pH units	Bq/L	mg/L	mg/L
Upper limit of Background		**0.047**	**0.0007**	**0.47**	**0.098**	**6.3**	**0.006**	**6.3**	**0.0006**
PWQO[a]		**-**	**0.0025**	**0.30**	**-**	**6.5**	**1.0**	**100**	**0.015**
D-5	60	48%	0%	0%	0%	0%	0%	0%	0%
D-6	57	0%	0%	14%	65%	2%	0%	12%	0%
DS-18	60	0%	0%	15%	0%	0%	0%	20%	0%
M-01	50	0%	0%	56%	na	4%	0%	0%	0%
Q-09	60	52%	0%	na	na	0%	0%	17%	2%
Q-20	5	0%	0%	na	na	0%	0%	0%	0%
SC-01	16	0%	44%	0%	na	18%	0%	0%	0%
SR-01	5	0%	0%	na	na	0%	0%	0%	0%
SR-06	10	100%	0%	na	na	0%	0%	60%	0%
SR-08	60	0%	0%	na	na	2%	0%	97%	0%

[a] Provincial Water Quality Objectives (OMOEE 1994)

[b] Sulphate criterion based on BCMOE

[c] CEPA value to be adopted by CCME

[d] CCME value from Canadian Environmental Quality Guidelines, Canadian Council of Ministers of the Environment (CCME), 2011

na - Parameter not sampled at respective station.

2.2 Sediment quality

The licensees agree with the CNSC's comments that sediment chemistry is changing slowly. There are a number of factors which could be influencing the slow rate of demonstrated change in sediment concentrations including:

- Sediment deposition rates may be slower than anticipated (2 mm/yr). Work by McKee *et. al.* (1987) found that pre-mining sedimentation rates in Quirke Lake ranged from 0.31 to 0.45 mm/yr. This could mean that surface sediments in the top 1 cm (sampling interval) are changing very slowly (10 to 30 years).
- Changes in the partitioning of metals may also contribute to observed improvements in the benthic invertebrate community while seeing no changes in bulk sediment chemistry. Over time, increased pH and improved general water quality will influence the flux of metals (to and from the sediments, respectively).
- Bioturbation at the sampling locations (15 m depth to sediment water interface) could further complicate the detection of improvement.

As discussed at the JRG meeting of May 12th, the continued value of sediment monitoring at the current frequency may be questionable given our ability to detect change. The licensees will investigate tools to evaluate deposition rates, including deep water cores, and incorporate the findings in the Cycle 4 SRWMP Study Design.

2.3 Impact to aquatic environment

The licensees agree with the assessment of conditions summarized by the CNSC.

2.4 Impact to fish

The licensees agree with the assessment of conditions summarized by the CNSC.

2.5 Dose to Biota

The licensees acknowledge that dose rates to biota in Quirke, McCabe, May and to a lesser extent Nordic Lakes exceed the ERICA tool benchmark of 0.24 mGy/d, but disagree that this is an appropriate benchmark for a quantitative risk assessment. With respect to proposed CNSC benchmarks (0.6 mGy/d fish, 3.0 mGy/d aquatic plants, 6.0 Gy/d aquatic biota), only forage fish in Quirke Lake exceeded the proposed CNSC benchmark at 0.92 mGy/d.

The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) reviewed the 0.24 mGy/d benchmark used by the ERICA tool and concluded that the benchmark is inappropriate for quantitative assessment of ecological risk as the proposed benchmark is below any observed effect level (UNSCEAR, 2008). Similarly, the draft CSA N288.6 standard does not recommend that benchmark for use in quantitative ecological risk assessment (D. Hart, pers comm.).

The ERICA benchmark was derived as a conservative screening value for derivation of radionuclide screening concentrations (Tier 1 of the ERICA framework). While ERICA decided to also use the benchmark for Tier 2 quantitative assessment, we consider this to be inappropriate because it results in incorrect conclusions about risk.

The conservatism in derivation of the 0.24 mGy/day value arises firstly from using extrapolated EDR10 values from each study as species "effect": levels, and secondly from the application of a safety factor to the 5th percentile of those values. The lowest actually observed effect levels from those studies were never lower than 200 uGy/h (4.8 mGy/day). This agrees with the UNSCEAR (2008) finding of only minor effects in some studies at chronic dose rates less than 100 uGy/h (2.4 mGy/day). UNSCEAR concludes that maximum dose rates of 100 uGy/h (2.4

mGy/day) and 400 uGy/h (9.6 mGy/d) would be unlikely to have significant effects on terrestrial and aquatic populations, respectively. None of the doses determined for biota in the Serpent River Watershed exceeded these international benchmarks.

The dose benchmark of 0.6 mGy/day suggested for fish by Environment Canada/Health Canada (2003) is based on studies of silver carp in a Chernobyl cooling pond where likely confounding factors include higher parental exposures and chemical pollution. UNSCEAR (2008) reviewed the Chernobyl cooling pond studies and did not find convincing evidence of effects on fish populations due to chronic irradiation at this level.

2.6 Dose to Humans

The licensees agree with the assessment of human dose as summarized by the CNSC.

2.7 Spatial extent of impacts

The licensees agree with the assessment of conditions summarized by the CNSC that areas of concern can now be restricted to Quirke Lake, McCabe Lake and May Lake. With respect to the Pronto TMA, the licensees would like to note the following:

- Loadings from the Pronto TMA will continue to be monitored at PR-01 through the SAMP program. Concentrations at PR-01 are within an order of magnitude of SRW receiving environment criteria. Furthermore, Pronto TMA effluent is consistently non-toxic and the loadings are unlikely to result in measurable changes in Lake Huron concentrations outside of the immediate mixing area. Water quality monitoring downstream of PR-01 (in Pronto discharge channel and Lake Huron) is not included in the receiving environment monitoring program (SRWMP) due to confounding influences immediately downstream of the TMA discharge, including a rail line, Highway 17, and drainage from a lime calcining plant which enters Lake Huron adjacent to the Pronto discharge channel (Minnow, 2009).

2.8 Reversibility of impacts

The licensees agree with the assessment of conditions summarized by the CNSC that benthic invertebrate impacts are mainly observed in Quirke Lake, McCabe Lake and May Lake and that "*As long as releases are actively controlled at the TMAs, environmental conditions should continue to improve in the Serpent River Watershed*". However, it should be noted that the rate of improvement particularly with sediment may be slower than anticipated and future monitoring scope and frequency will need to reflect this.

3 Evaluate Mine Sources

3.1 Commitment to Continuous Improvement

CNSC has suggested that "*in the spirit of continuous improvement" the licensees should within the present management system"* investigate options for reducing releases from a number of the Elliot Lake facilities. An overview of the present management system and effectiveness of continuous improvement projects is presented below with response to specific locations provided in Sections 3.2 thru 3.4.

The Rio Algom Limited and Denison Mines Inc. Elliot Lake facilities have been decommissioned in full conformance with decommissioning plans that were subject to environmental assessments and regulatory approvals (RAL, 1995; DMI, 1995; SENES, 1997; CNSC, 2001). Individual and cumulative effects on health and safety of persons and the environment were predicted and determined to be permissible in Canada at the time of the regulatory decision (P-

290 CNSC, 2004) and performance indicators and targets based on sound science were developed for follow-up evaluation (P-223, CNSC, 2001).

Operating care and maintenance of the Rio Algom sites is conducted in conformance with Waste Facility Operating License WFOL-W5-3101.03.indf which incorporates Operating, Care and Maintenance Program and Plans that specify the elements of the management system that apply to the sites. Operating, care and maintenance of the Denison Mines Inc. sites is conducted in conformance with UMDL-MINEMILL-DENISON.01/indf and UMDL-MINEMILL-STANROCK.02/indf. With respect to control of source contributions to the watershed, both companies conform to the Water Quality Assessment and Response Plan (Minnow, 2011 App. A) which has been highly effective in focusing continuous improvement efforts in the watershed. Both companies have also implemented inspection and operational review programs that also contribute to focusing source reduction, but also focus efforts on risk reduction. Table 3.1 provides a brief summary of projects initiated through each of these programs and demonstrates the source and risk reduction effectiveness of these continuous improvement projects.

Table 3.1. Continuous Improvement Source and Risk Reductions

Project	Description	Source Reduction	Risk Reduction
Water Quality Program Response			
2004 Westner Lake Outlet Structure Replacement: RAL	2003 beaver dam failure dropped lake level by 3 m exposing historic sediments resulting in depressed pH and increased cobalt and iron. Outlet structure replaced and lake neutralized.	Water quality restored to pre dam failure quality within 18 months of response program trigger (RAL & DMI, 2007 Table 4.3) ; pH and cobalt remain within SRWMP water quality guidelines (Minnow, 2011 Table E.8).	Beaver dam replaced with engineered structure designed to safely convey Timmins Storm via spillway and overtop with no loss of containment during PMP (Golder, 2004)
2005 Buckles Creek Channel Maintenance: RAL	2005 restoration of Buckles Creek Diversion Channel and historic precipitate pond berm to improve isolation of Historic Precipitate Pond and Buckles Wetland from Buckles Creek.	Decreasing trends in barium, radium and uranium at station N-12 (Minnow, 2011 Table 4.4) with mean annual loadings of radium decreasing from 1180 MBq/y in 2003 - 2006 (Minnow, 2009 Table J.71) to 450 MBq/y in 2005-2009 (Minnow, 2011 Table D.7.3)	Buckles creek channel and associated retention and conveyance structures upgraded to safely convey Timmins Storm (Golder, 2005)
Inspection Program Response			
2007 Pronto Dam F: RAL	2007 maintenance of Pronto Dam F to reduce seepage and improve flood protection.	Decreasing trends in barium, manganese, radium, sulphate and uranium (Minnow, 2011 Table 4.5) with mean annual loadings of radium decreasing from 28 MBq/y in 2003 - 2006 (Minnow, 2009 Table K.11) to 15 MBq/y in 2005-2009 (Minnow, 2011 Table D.8.4).	Dam F upgraded by installation of upstream inclined core and 0.3 m raise to reduce seepage and protect structure during probable maximum failure or upstream dam failure (Golder, 2007)
2008 Panel Pond C: RAL	2008 maintenance Panel Pond C Berm to reduce seepage and improve flood protection.	Emerging radium decreasing trend (RAL, 2011) not confirmed in Table 4.2 of SOE (Minnow, 2011) due to SOE data set ending in 2009	French drain replaced with bedrock spillway; structure raised to convey Timmins Storm via spillway and overtop with no loss of containment during PMP (Golder, 2008)
Operational Reviews			
2003 pH set point adjustment: RAL	2003 increase pH set-point to improve removal of cobalt at Pronto and Quirke.	Pronto decreasing trend not detected as change implemented concurrent with commencement of TOMP in 2003; PR-01 mean annual loading decrease from 42 kg/y in 2003 - 2006 (Minnow, 2009 Table K.11) to 39 kg/y in 2005 - 2009 (Minnow, 2011 Table D.8.4) despite 60% increase in mean annual discharge in 2003 - 2006 compared to 2005 - 2009. Decreasing trend detected at Quirke with loadings decreasing from 42 kg/y to 38 kg/y at similar mean annual discharge rates (Minnow, 2009, Table E.73 and Minnow, 2011 Table D.2.7).	
2005 Panel lime addition RAL	2005 restoration of lime neutralization to improve radium removal following completion of testing of sodium hydroxide as alternative low-energy consumption neutralization alternative	Decreasing trend in radium (Minnow, 2011 Table 4.2) with mean annual radium loading decreasing from 255 MBq/y in 2003 - 2006 (Minnow, 2009 Table F22) to 126 MBq/y in 2005 - 2009 (Minnow, 2011 Table D.3.7).	Sodium hydroxide system maintained on stand-by to provide neutalization during power outage when lime pumping and agitation not powered.
2009 Beaver Lake siphon installation: DMI	2010 C of A acquired for operations of Beaver Lake siphon for improved water control at Stanrock treatment plant	Water quality improvements in Orient Creek.	Improvements in treatment efficiency and control on final discharge by directing Beaver Lake water to Stanrock Effluent Treatment Plant.
2010 Stanrock Dam M Coillection Pond and Pump Station: DMI	2010 completion of Dam M Collection Pond and Pump Station for directing contaminant seepages to Stanrock treatment plant.	Significant reduction of seepage (DS-16) into Quirke Lake.	Seepage collected and pumped to Stanrock Effluent Treatment Plant for treatment.
2010/11 Halfmoon Wetland Berm Construction: DMI	2010/11 construction of Halfmoon Wetland berms replaced beaver dams to provide long term dam stability and preservation of wetland downstream of Stanrock effluent disharge point.		Beaver Dams replaced with engineered berms.

3.2 Quirke Lake

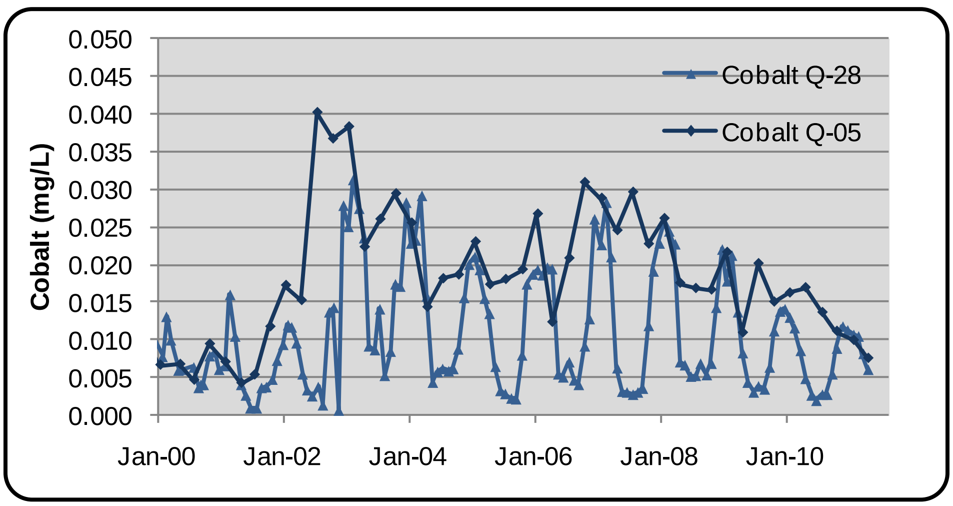
3.2.1 Quirke TMA

Discharge from the Quirke TMA continues to be consistently better than discharge criteria with decreasing trends of cobalt, manganese, sulphate and uranium (Minnow, 2011 Figure 3.12 and Table 4.2). Basin surface water generally achieves Environmental Impact Statement predictions with decreasing trends of influent sulphate and uranium (Minnow, 2011 Figure 3.11 and Table 3.8).

In 2001 RAL replaced the tanker-based *in-situ* lime addition system with a plant-based dilute lime batching and cell distribution system. Implementing the system reduced cell lime consumption by 75% with moderate increases in TMA and discharge cobalt concentrations that have since declined (Figure 3.1). RAL intends to continue to operate the *in-situ* lime addition system as long as it remains effective in neutralizing historic acidic porewaters and reducing cobalt concentrations in basin waters and discharges.

Iron, manganese, cobalt and to a lesser extent radium concentrations in discharge reflect a seasonal pattern with highest concentrations occurring during periods of ice cover. Opportunities to reduce concentrations during ice cover will be considered as part of the Dam D drop box maintenance incorporated in the current five year maintenance plan. In the interim, operational efforts to optimize storage in Cell 18 to reduce peak winter flows in response to mid-winter melt events will continue.

Figure 3.1. Quirke Cobalt Concentrations in Influent and Discharge



3.2.2 Denison TMA

The Denison TMA was decommissioned as flooded tailings following mine closure in 1992, with decommissioning completed in 1997. TMA-1 Final Effluent Discharge is monitored at Stollery Lake Outlet, (D-2) which drains into the Serpent River. DMI acknowledges CNSC comments regarding the consideration for continuous improvement measures to reduce radium releases. Although effluent discharge quality has remained compliant, DMI is currently investigating effluent quality improvement options as noted most recently in the 2010 Annual Report.

3.2.3 Quirke II Mine Site

The Quirke II mine site was decommissioned and rehabilitated in the 1992 – 1995 time period. A combination of excavation and covering was used to shape and grade the waste rock pile and ensure conformance with gamma remediation criteria (RAL, 1999). Sustainable vegetation in the form of grasses and trees has been established on the site (photo 3.1).

Drainage from the Quirke II mine site as monitored at ECA-398 has decreasing concentrations of cobalt, manganese, radium, sulphate and uranium and increasing pH (Minnow, 2011 Table 4.2). Annual mean loads of uranium have declined from 25 kg/y in 2003 – 2006 to (Minnow, 2009 Table E.73) to 16.3 kg/y in 2005 – 2009 (Minnow, 2011 Table D.2.7). During the same timeframes, cobalt annual mean loads have declined from 5.8 kg/y to 4.4 kg/y.

The ECA-398 channel flows through a series of wetlands (Photos 3.2 and 3.3) prior to discharging to a cranberry bog on the south shore of the Serpent River (photo 3.4). Water quality downstream at Q-09 occasionally exceeds provincial water quality objectives for uranium and cobalt, but is consistently better than CCME uranium guideline of 0.015 mg/L and proposed cobalt Canadian water quality guideline of 0.0025 mg/L. Water quality at Q-09 shows decreasing trends for cobalt, radium, uranium and sulphate (Minnow, 2011 Table 5.2).

Given the mature status of the site and minimal, if any, impact on receiving environment, RAL does not plan any incremental remedial measures at this site, but will continue to monitor improving conditions.

Photo 3.1. Quirke II Mine Site

Photo 3.3. Quirke II Dranage Wetland 3

Photo 3.2. Quirke II Drainage Wetland 1

Photo 3.4. Quirke II Drainage looking north to Serpent River from south shore Cranberry Bog

3.3 Stanleigh TMA

Discharge from the Stanleigh TMA continues to be consistently better than discharge criteria with decreasing trends of manganese, and sulphate (Minnow, 2011 Figure 3.28 and Table 4.3). Basin surface water generally achieves Environmental Impact Statement predictions with decreasing trends of influent iron, manganese, sulphate and uranium (Minnow, 2011 Figure 3.26 and Table 3.20). Concentrations of radium, uranium, iron, manganese, and cobalt in influent, discharge and receiving environment are all consistently better than water quality benchmarks (Figure 3.2).

RAL replaced the aging high energy sand filtration treatment plant with a small conventional treatment plant powered by a cross-flow turbine in the influent in 2007. The new plant utilizes retention and gravity in the downstream Settling Pond to remove treatment solids. Barium chloride consumption has increased to levels consistent with other conventional treatment plants operated in the region with moderate increases in radium concentration releases. Operational controls in the form of reduced flow rates during spring turnover and melt have reduced seasonal peak radium releases (Figure 3.3). Optimization of the treatment system will continue through on-going operational monitoring and reviews.

Figure 3.2. Stanleigh Basin Surface Water (CL-04), Discharge (CL-06) and Receiving Environment (SR-06) Water Quality Trends

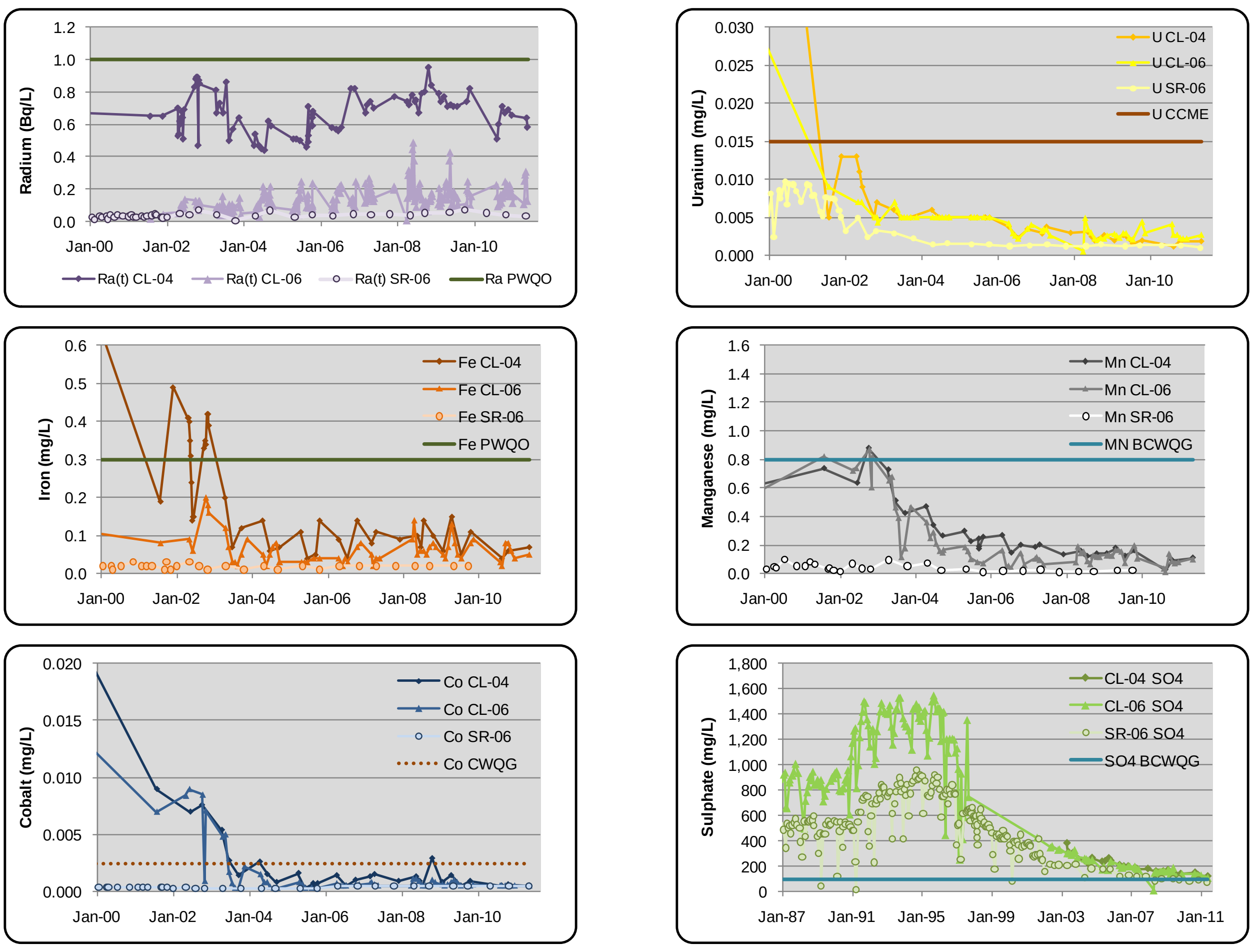
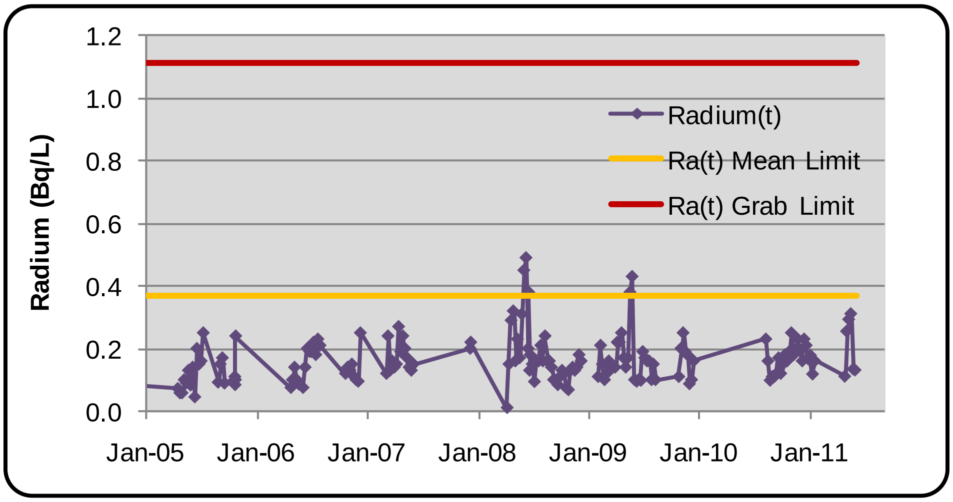


Figure 3.3. Stanleigh Discharge Radium Control 2005 - 2011



3.4 Pronto TMA

Discharge from the Pronto TMA continues to be consistently better than discharge criteria with decreasing trends of barium (Minnow, 2011 Figure 3.38 and Table 4.2).

Projects to improve the quality of discharge from the Pronto facility have included:

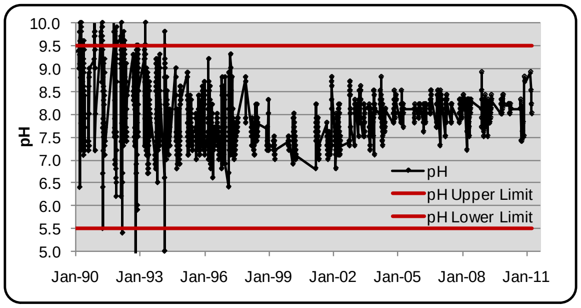
- 1997 replacement of the treatment facility including improvements in pH control and retention to provide better control of discharge pH and TSS (Figure 3.4a and 3.4b)
- 1998 rehabilitation of the lime reject pile immediately upstream of treatment plant to provide better control of discharge pH and TSS
- 199 dredging of the Settling Pond to improve retention time and settling of treatment solids
- 2003 pH set-point increase to improve removal of cobalt (see Table 3.1).

Temporary increases in influent cobalt concentrations during rehabilitation activities may be associated with the decrease of lime reject alkalinity in the Holding Pond (Figure 3.4c) and are returning to historic levels. In addition to pH set-point increase, the following operational adjustments have been implemented to reduce discharge cobalt concentration (Figure 3.4d)

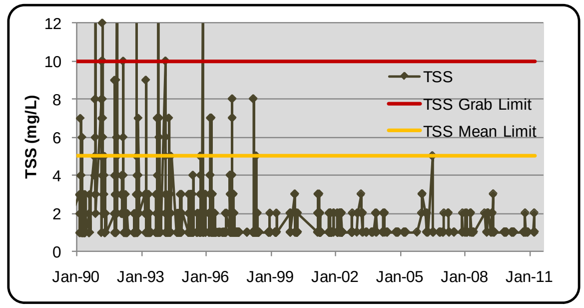
- Optimizing storage in the Holding Pond to reduce peak winter flows and increase retention under ice cover conditions.
- Reduced flow and increased lime addition during period of plant start-up to provide improved treatment of high acidity water that pools upstream of plant intake during periods of plant shut-down.

Optimization of the treatment system will continue through on-going operational monitoring and reviews.

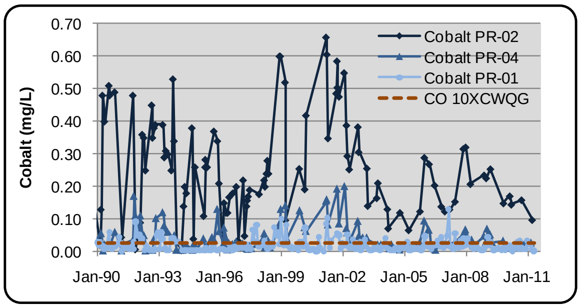
Figure 3.4. Pronto Influent (PR-02), Discharge (PR-04) and Downstream (PR-01) Water Quality Trends 1990 - 2011



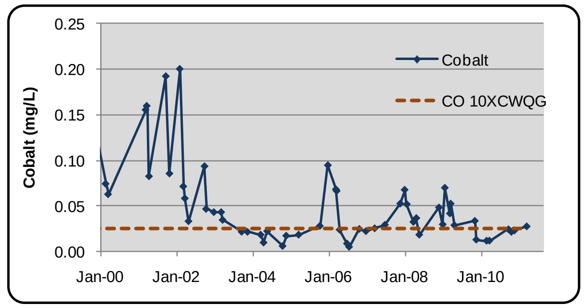
3.4a. PR-04 Discharge pH



3.4b. PR-04 Discharge Total Suspended Solids



3..4c. Pronto influent, discharge and downstream cobalt



3.4d. PR-04 Discharge cobalt

4 Assess TMA Performance

In response to comments section 3, the licensees have identified sections of the TMA Performance Review that are relevant to evaluation of continuous improvement and source reduction undertakings.

5 Changes in SRWMP

The licensees confirm that the following actions will be taken with respect to CNSC recommendations for changes to the SRWMP:

- The licensees agree that benthic invertebrate sampling at McCabe, Quirke and May Lakes will be included in the Cycle 4 Study Design.
- The licensees acknowledge the CNSC's comments with respect to the difficulty in demonstrating change (improvement) in sediment quality. The licensees will investigate tools to evaluate deposition rates, including deep water cores, and incorporate the findings in the Cycle 4 SRWMP Study Design
- The licensees agree with the CNSC's assessment to remove McCarthy and Hough Lake from the SRWMP.
- To address concerns with respect to polonium-210 in fish tissue, the licensees intend to conduct a supplementary study in the summer of 2011 in Quirke Lake. The program will include sampling the muscle tissue of 10 sport fish (likely lake trout and small mouth bass) and five composite samples of forage (small-bodied) fish from different areas

within the lake. Samples will be analyzed for the radionuclides found to contribute to dose (U, Ra226, Po210, Pb210, Th230 and Ra228). The results of the study will be provided in a technical memorandum to the CNSC. It should be noted that polonium concentrations measured in 2009 as part of the special investigation were not compared to previous years because prior monitoring programs have not included polonium but rather focused on radium-226 and metals.

References

Canadian Council for Ministers of the Environment (CCME). 2011. Canadian Water Quality Guidelines for the Protection of Aquatic Life. In: Canadian Environmental Quality Guidelines Summary Table, Winnipeg.

Canadian Environmental Protection Agency (CEPA) 2011. Screening Assessment for the Challenge; Cobalt: (Elemental cobalt)Chemical Abstracts Service Registry Number7440-48-4 www.ec.gc.ca

Canadian Nuclear Safety Commission (CNSC), 2001. Regulatory Policy P-223 Protection of the Environment.

Canadian Nuclear Safety Commission (CNSC), 2001. Environmental Assessment Screening Repoort Possession and Management of Waste Nuclear Substances Situated at Spanish American, Milliken, Lacnor, Nordic/Buckles, and Pronto Historical Properties in the Elliot Lake Area, Ontario. A report of the Canadian Nuclear Safety Commission, May 2001.

Canadian Nuclear Safety Commission (CNSC), 2004. Regulatory Policy P-290 Managing Radioactive Waste.

Denison Mines Limited (Denison), 1995. Environmental Impact Statement Decommissioning of the Denison and Stanrock Tailings Management Areas

Environment Canada/Health Canada. 2003. Releases of Radionuclides from Nuclear Facilities (Impact on Non-human Biota). Priority Substances List Assessment Report.

Golder, 2004. Westner Lake Outlet Design Brief, Elliot Lake Ontario. Prepared for Rio Algom Limited October 2004.

Golder, 2007. 2007 Pronto Dam F Improvement Plan Design Consideration, Elliot Lake Ontario. Prepared for Rio Algom Limited June 2007.

Golder, 2008. Pond C Berm Maintenance Panel Tailings Management Area (TMA). Prepared for Rio Algom Limited July 2008.

McKee, P.M., Snodgrass, W.J. and Hart, D.R., Duthie, H.C., McAndrews, J.H. and Keller, W. 1987. Sedimentation rates and sediment core profiles of 238U and 232Th decay chain radionuclides in a lake affected by uranium mining and milling. Canadian Journal of Fisheries and Aquatic Sciences 44: 390-398.

Minnow, 2011. Serpent River Watershed State of the Environment Report, Regulatory Review Draft. Prepared for Rio Algom Limited and Denison Mines Inc, February 2011.

Minnow, 2009. Serpent River Watershed State of the Environment Report. Prepared for Rio Algom Limited and Denison Mines Inc. January 2009.

Rio Algom Limited (RAL), 1995. Environmental Impact Statement Decommissioning of the Quirke and Panel Waste Management Areas.

Rio Algom Limited (RAL), 1999. Decommissioning of the Quirke and Panel Mines Site Remediation Final Status Report. Submitted to Atomic Energy Control Board February 1999.

Rio Algom Limited (RAL) and Denison Mines Inc (DMI), 2007. Serpent River Watershed Monitoring Program Water Quality Report 2007.

Rio Algom Limited (RAL), 2011. 2010 Operating Care and Maintenance Annual Report.

Senes, 1997. Comprehensive Study Report Decommissioning of the Stanleigh Waste Management Area Mine and Mill. Prepared for Rio Algom Limited May 1997.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), 2008. Sources and Effects of Ionizing Radiation; Annex E.