

DE BEERS GROUP

October 16, 2020

Angela Love, EP
Regulatory Specialist
Mackenzie Valley Land and Water Board
P.O. Box 2130
Yellowknife, NT X1A 2P6

Via Email: angela.love@mvlwb.com

Dear Ms. Love:

RE: Responses to 2020 Gahcho Kue Water Licence and Land Use Permit Public Hearing Undertakings

De Beers Canada Inc. (De Beers) is pleased to submit responses to the 2020 Gahcho Kue Water Licence and Land Use Permit Public Hearing Undertakings. If you have any questions regarding this application, please contact me by phone (867) 445-1485, or email william.liu@debeersgroup.com.

Sincerely,



William Liu
Regulatory Specialist
De Beers Canada Inc.

De Beers Canada inc.

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DE BEERS GROUP

Gahcho Kué Mine

2020 Water Licence and Land Use Permit Amendment
Responses to Undertakings

October 16, 2020

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1.0 INTRODUCTION

De Beers Canada (De Beers) operates the Gahcho Kué Mine (Gahcho Kué), in accordance with Water Licence MV2005L2-0015 and Land Use Permit MV2005C0032. In order to incorporate the additional ore from the north end of 5034 Pit into the mine plan and to extend the mine life for two additional years, De Beers submitted an application to amend the Water Licence and Land Use Permit in March 2020.

During the Public Hearing on September, 30 and October, 1 2020, De Beers received two undertakings:

Undertaking #1: De Beers to describe the volume of water that would need to be withheld from discharge from the Water Management Pond, relative to the planned discharge volume, in order for the Site-specific Water Quality Objectives, calculated with baseline hardness, to be met in Lake N11.

Undertaking #2: De Beers to revisit Total Cadmium and Total Manganese and to calculate the revised Effluent Quality Criteria for those parameters.

De Beers appreciates reviewers and interveners' continued participation during the Gahcho Kue Water Licence and Land Use Permit Amendment review process. The sections below include De Beers' responses to the undertakings.

2.0 UNDERTAKING #1

De Beers to describe the volume of water that would need to be withheld from discharge from the Water Management Pond, relative to the planned discharge volume, in order for the Site-specific Water Quality Objectives, calculated with baseline hardness, to be met in Lake N11.

Response

The Lake N11 water quality model was used to calculate the volume of water that would need to be withheld from the water management pond (WMP) discharge to Lake N11, relative to the planned discharge volume, to meet site-specific water quality objectives (SSWQO) calculated using baseline hardness concentrations. The site water balance model was used to determine the effects of withholding water from the WMP discharge to Lake N11 on water levels in the WMP.

2.1 Volume of Water Withheld from the Water Management Pond Discharge to Lake N11

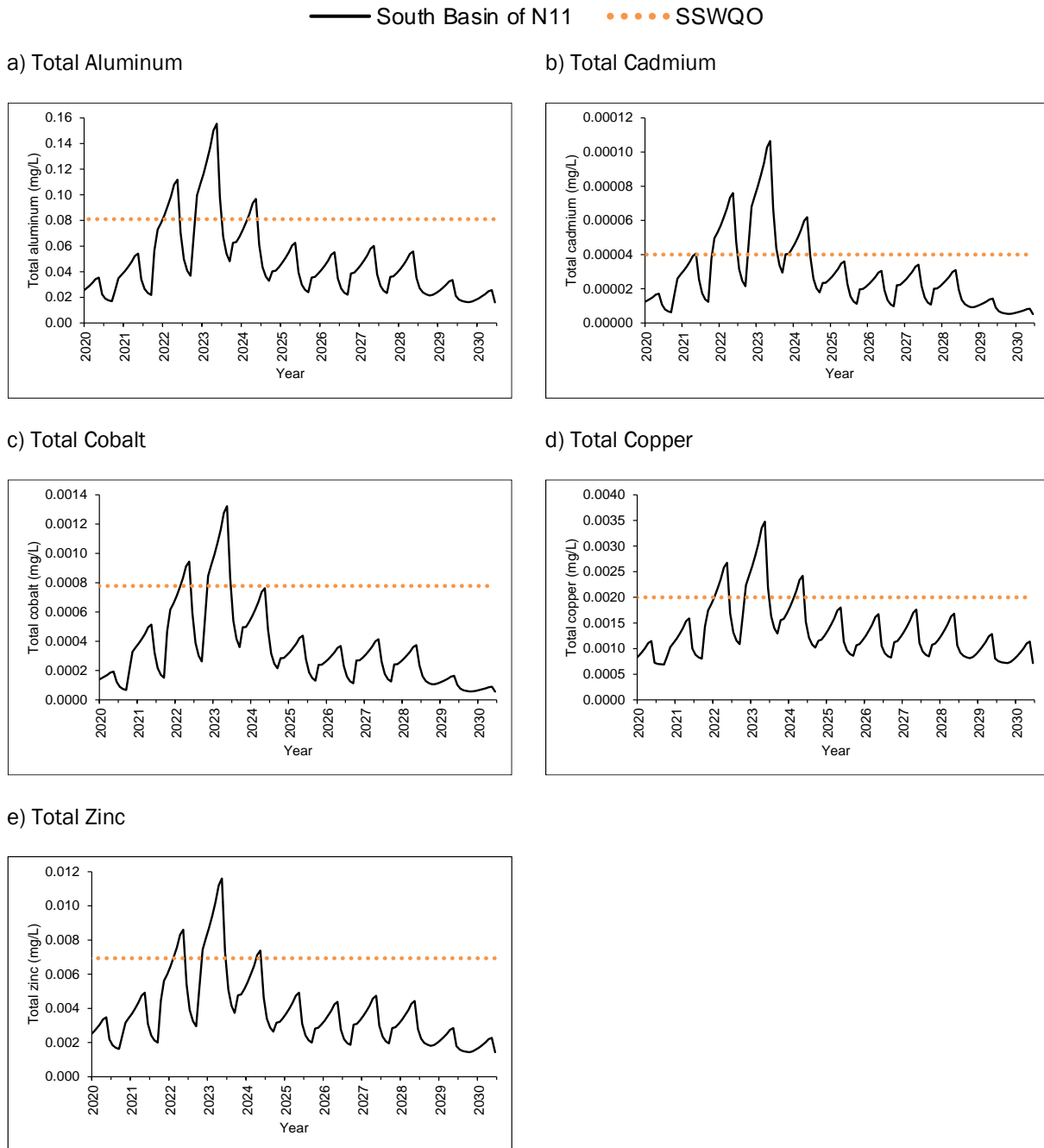
Concentrations of total aluminum, cadmium, cobalt, copper, and zinc are predicted to exceed SSWQO in Lake N11 calculated using baseline hardness concentrations in 2022, 2023, and 2024 (Figure UT1-1 panels a to e and Table UT1-1) assuming:

- An average precipitation year WMP discharge scenario presented in Version 6 of the Operational Water Management Plan (Attachment 6 of the 2020 Water Licence Amendment Application) and
- Constant WMP discharge concentrations of total aluminum, cadmium, cobalt, copper, and zinc equal to the proposed MAC EQC (Table UT1-2).

To meet SSWQO calculated using baseline hardness concentrations, several simulations were performed in the Lake N11 water quality model to calculate the volume of water that would need to be withheld from the WMP discharge to Lake N11. The simulations were based on:

- The same average precipitation year WMP discharge scenario presented in Version 6 of the Operational Water Management Plan
- Assigning constant WMP discharge concentrations of total aluminum, cadmium, cobalt, copper, and zinc equal to the proposed MAC EQC from January 2021 to the end of Operations (Table UT1-2)
- Gradually withholding water from the WMP discharge to Lake N11 in 2021 until concentrations of total aluminum, cadmium, cobalt, copper, and zinc are predicted to be below SSWQO in 2022 and
- Gradually withholding water from the WMP discharge to Lake N11 in 2022 until concentrations of total aluminum, cadmium, cobalt, copper, and zinc are predicted to be below SSWQO in 2023 and 2024

Figure UT1-1: Comparison of Predicted Concentrations of Parameters in Lake N11 (based on the Water Management Pond Discharge Scenario Presented in the Water Licence Amendment Application and Constant Water Management Pond Discharge Concentrations Equal to Maximum Average Concentration Effluent Quality Criteria) to Site-specific Water Quality Objectives Calculated Using Baseline Hardness Concentrations



mg/L = milligrams per litre; SSWQO = site-specific water quality objective.

Table UT1-1: Site-specific Water Quality Objectives for Total Aluminum, Cadmium, Cobalt, Copper, and Zinc Based on Baseline Hardness

Parameter	Baseline Hardness (mg/L as CaCO ₃)	DOC (mg/L)	pH	SSWQO (mg/L)	Source
Total aluminum	9	2 ^(a)	6.5 ^(a)	0.081	USEPA (2018)
Total cadmium		-	-	0.00004	CCME (2014)
Total cobalt		-	-	0.0008	ECCC (2017)
Total copper		-	-	0.002	CCREM (1987)
Dissolved zinc		2 ^(b)	7.3 ^(b)	0.007	CCME (2018)

a) The SSWQO for total aluminum is hardness, DOC, and pH-dependent. The water quality criterion was calculated at a pH of 6.5 because pH in surface water should be maintained between 6.5 and 9 (CCREM 1987) and as the pH decreases, the water quality criterion also decreases. The criterion was calculated at a DOC concentration of 2 mg/L because baseline DOC concentrations in Lake N11 were always greater than 2 mg/L and as the DOC concentration decreases, the water quality criterion decreases.

b) The SSWQO for dissolved zinc is hardness, pH and DOC-dependent. The water quality guideline was calculated at a pH of 7.3, which is the upper end of the measured range in Lake N11, represented by the mean plus two standard deviations because as the pH increases, the water quality guideline decreases. The water quality guideline was calculated at a DOC concentration of 2 mg/L because baseline DOC concentrations in Lake N11 were always greater than 2 mg/L and as the DOC concentration decreases, the water quality guideline decreases.

mg/L = milligrams per litre; CaCO₃ = calcium carbonate; CCME = Canadian Council of Ministers of the Environment; CCREM = Canadian Council of Resource and Environment Ministers; DOC = dissolved organic carbon; ECCC = Environment and Climate Change Canada; SSWQO = site-specific water quality objective; USEPA = United States Environmental Protection Agency; - = the SSWQO is not dependent on DOC concentrations or pH values.

Table UT1-2: Proposed Maximum Average Concentration Effluent Quality Criteria at Surveillance Network Program Station SNP 02

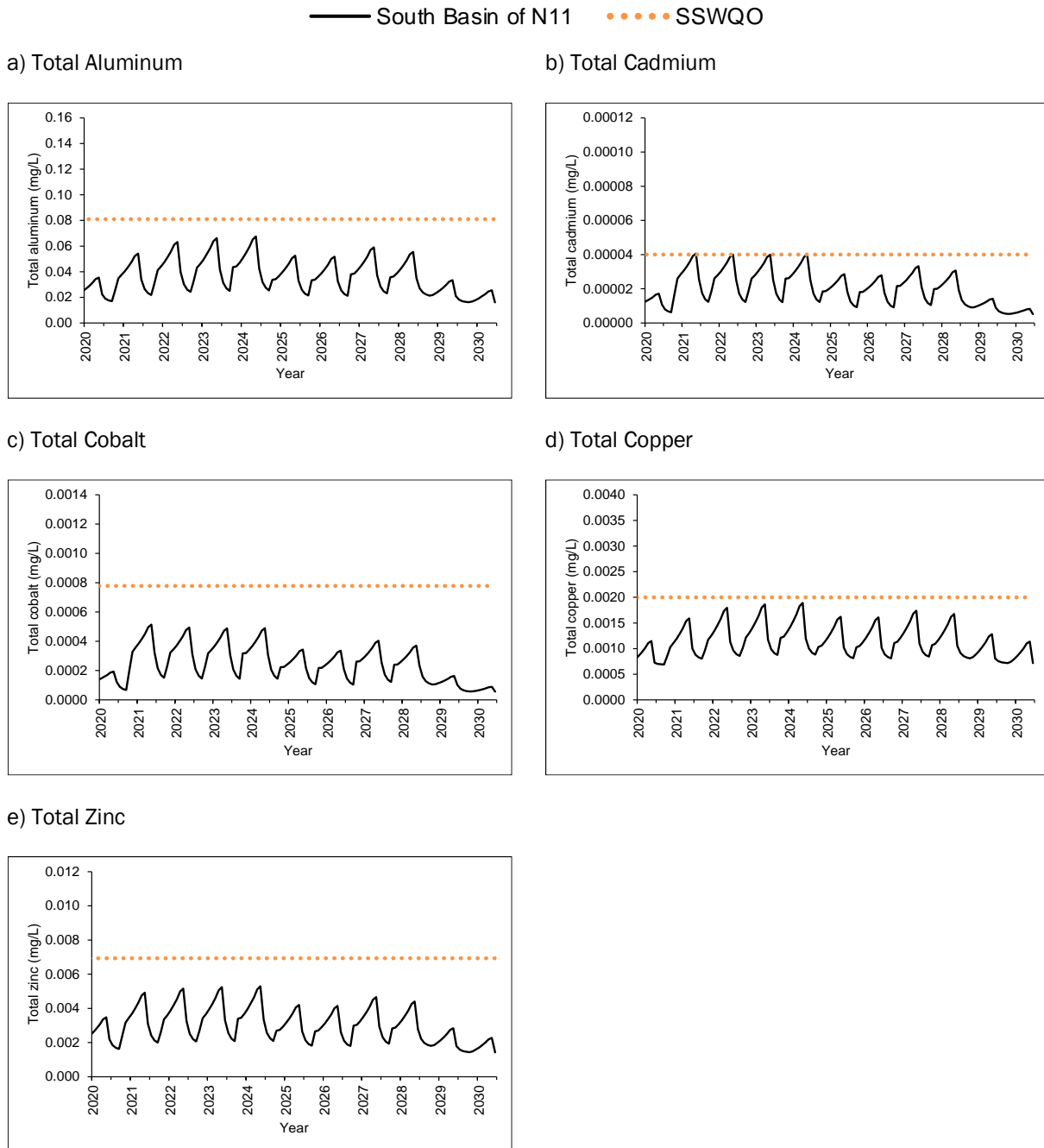
Total Metals	Maximum Average Concentration Effluent Quality Criteria (mg/L)
Aluminum	0.23
Cadmium	0.0002
Cobalt	0.0025
Copper	0.0045
Zinc	0.02

mg/L = milligrams per litre.

The results of the scenario where all five concentrations of parameters are predicted to be below SSWQO are presented in this response. The Lake N11 water quality model showed:

- To meet SSWQO calculated using baseline hardness concentrations, the discharge of water from the WMP to Lake N11 would have to be reduced by 63% and 74% in 2021 and 2022, respectively.
- With reductions of 63% and 74% in the discharge of water from the WMP to Lake N11 in 2021 and 2022, concentrations of total aluminum, cadmium, cobalt, copper, and zinc are predicted to remain below SSWQO calculated using baseline hardness concentrations (Figure UT1-2).

Figure UT1-2: Comparison of Predicted Concentrations of Parameters in Lake N11 (Based on Withholding 63% and 74% of the Discharge Volume in 2021 and 2022 and Constant Water Management Pond Discharge Concentrations Equal to Maximum Average Concentration Effluent Quality Criteria) to Site-specific Water Quality Objectives Calculated Using Baseline Hardness Concentrations



mg/L = milligrams per litre; SSWQO = site-specific water quality objective.

2.2 Water Levels in the Water Management Pond

Reductions of 63% and 74% in the volume of water discharged from the WMP to Lake N11 in 2021 and 2022 were accounted for in the site water balance model. The site water balance model showed:

- Under average precipitation years (i.e., mean in Figure UT1-3), water levels in the WMP are predicted to be above the Maximum Operating Water Level (MOWL) in 2022 and 2023. As showed in the stochastic water balance model, there is 5-15% probability that water in the WMP will exceed the MOWL in 2021.

Note: In accordance with the Water Licence, Part G, 20 a), a minimum 1 m freeboard is required to be maintained at all times to avoid dyke overtopping due to an extreme rainfall event or wave runoff. Therefore, the MOWL is set at minimum 1 m below the dyke containment crest elevation.

- As shown in the stochastic water balance model, water levels in the WMP during wet years with the inflow design flood (IDF) are predicted to exceed the dyke containment crest elevation. There are 5-15% and 15-25% probabilities that the water in the WMP will exceed the containment crest elevation in 2022 and 2023, respectively (Figure UT1-3). The overtopping probability exceeds the design criteria of 0.11% established based on the Canadian Dam Safety Guidelines.

As a result, reducing the controlled discharge from the WMP in 2021 and 2022, as described in Section 2.1, poses a significant risk to the infrastructure and personnel safety and the environment. Therefore, De Beers recommends the ambient hardness based calculations are accepted for the SSWQO and EQC calculations.

References

CCME (Canadian Council of Ministers of the Environment). 2014. Canadian Water Quality Guidelines for the Protection of Aquatic Life: Cadmium. In: Canadian Environmental Quality Guidelines, 1999. Canadian Council of Ministers of the Environment, Winnipeg, MB, Canada.

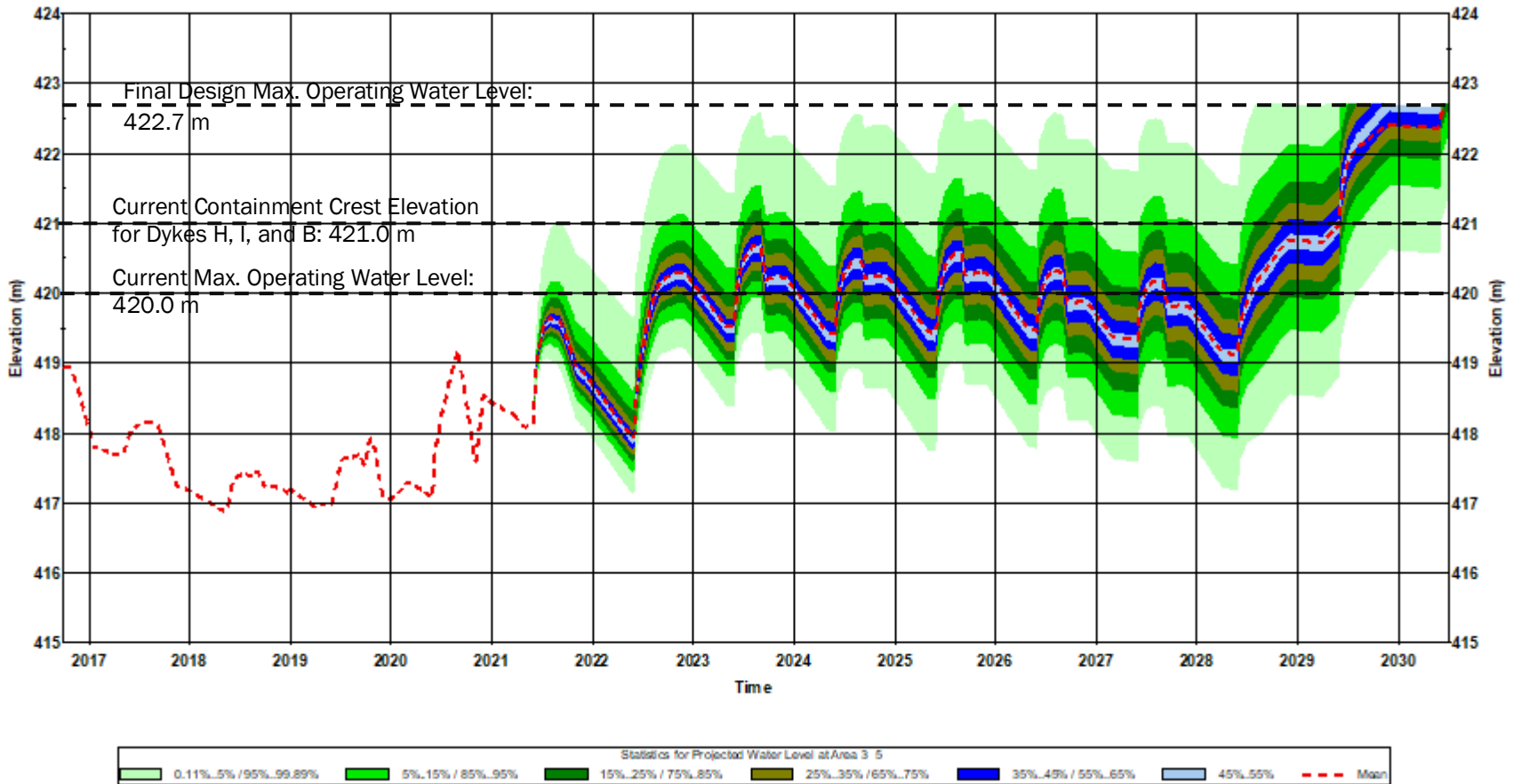
CCME. 2018. Canadian Water Quality Guidelines for the Protection of Aquatic Life: Zinc. In: Canadian Environmental Quality Guidelines, 1999. Canadian Council of Ministers of the Environment, Winnipeg, MB, Canada.

CCREM (Canadian Council of Resource and Environment Ministers). 1987. Canadian water quality guidelines. Prepared by the Task Force on Water Quality Guidelines.

ECCC (Environment and Climate Change Canada). 2017. Canadian Environmental Protection Act, 1999. Federal Environmental Quality Guidelines. Cobalt; [accessed October 2020] <http://www.ec.gc.ca/ese-ees/default.asp?lang=En&n=92F47C5D-1.Cobalt>

USEPA (United States Environmental Protection Agency). 2018. 2018 Final Aquatic Life Criteria for Aluminum in Freshwater; [accessed October 2020] <https://www.epa.gov/wqc/2018-final-aquatic-life-criteria-aluminum-freshwater>

Figure UT1-3: Projected Water Levels in the Water Management Pond with Reductions of 63% and 74% in the Volume of Water Discharged from the Water Management Pond to Lake N11 in 2021 and 2022



m = metre; % = percent.

3.0 UNDERTAKING #2

De Beers to revisit Total Cadmium and Total Manganese and to calculate the revised Effluent Quality Criteria for those parameters.

3.1 Total Cadmium

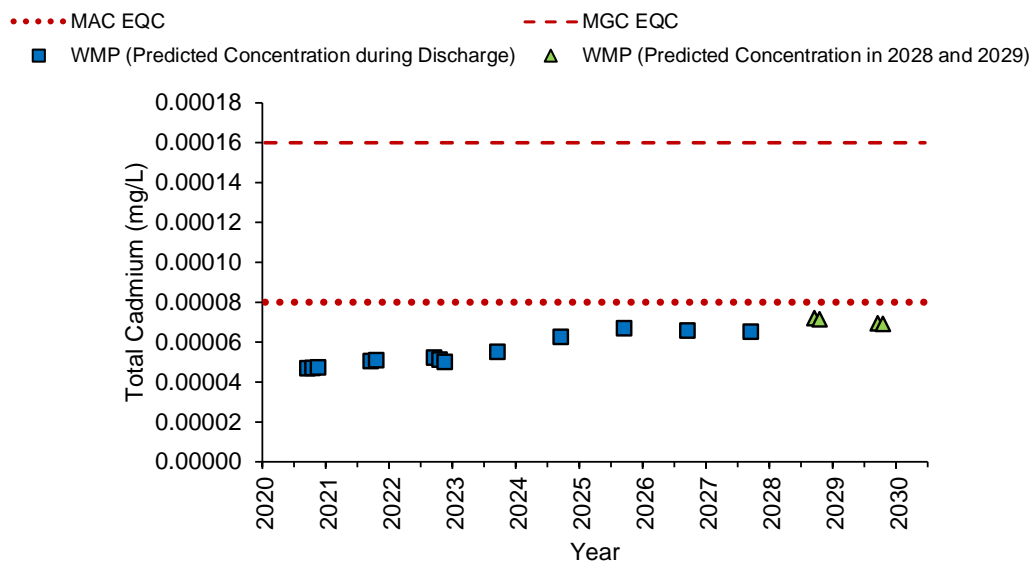
De Beers continues to recommend the MVLWB not including total cadmium as an EQC in the amended Water Licence. This is because total cadmium was not identified as a POPC through the previously accepted three-step screening process. The three-step screening process is consistent with the approach used to identify POPC in the 2018 Water Licence amendment application, and the three-step screening process was approved by the MVLWB.

Further, not including total cadmium as an EQC will not affect the monitoring of total cadmium – it will continue to be monitored and analyzed through relevant SNP and AMEP programs.

In responding to Undertaking #2, should the MVLWB decide to include total cadmium as an EQC parameter in the amended Water Licence, De Beers recommends the MVLWB considers the following EQC for total cadmium.

Total cadmium concentrations in the WMP are predicted to be close to the existing MAC EQC of 0.00008 mg/L between 2025 and 2027 (Figure UT2-1). In order to account for operational flexibility and modelling uncertainty, additional “buffer” between the regulated parameter concentration and the expected parameter concentration is required for the MAC EQC to be considered “reasonably and consistently achievable”.

Figure UT2-1: Comparison of Existing Effluent Quality Criteria for Total Cadmium to Predicted Water Management Pond Discharge Concentrations

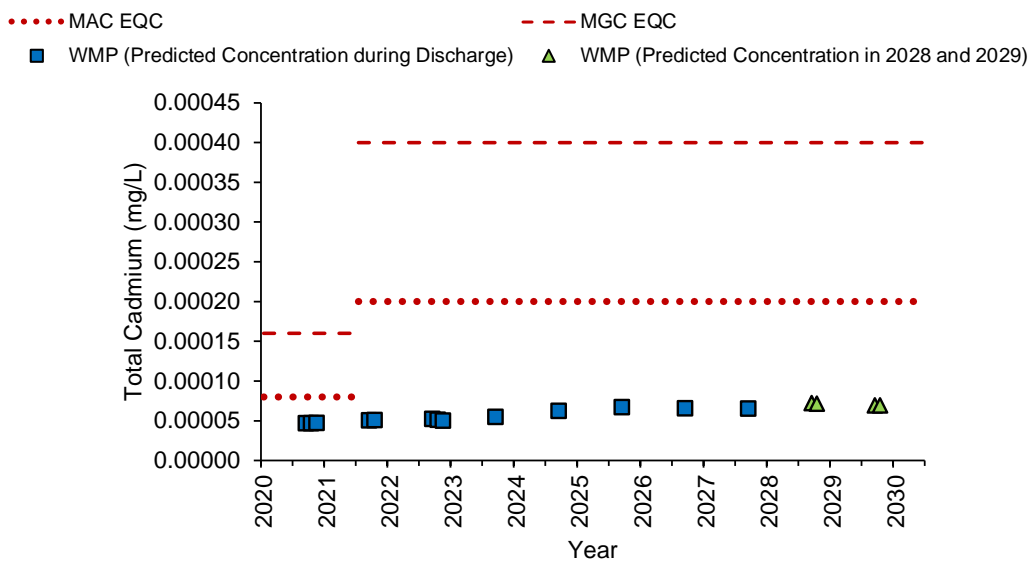


EQC = effluent quality criteria, MGC = maximum grab concentration; MAC = maximum average concentration; WMP = water management pond.

Following the same approach described in the EQC Report (Attachment 5 of the 2020 Water Licence Amendment Application), De Beers recommends that the MAC and MGC EQC for total cadmium be set at 0.0002 mg/L and 0.0004 mg/L, respectively, because:

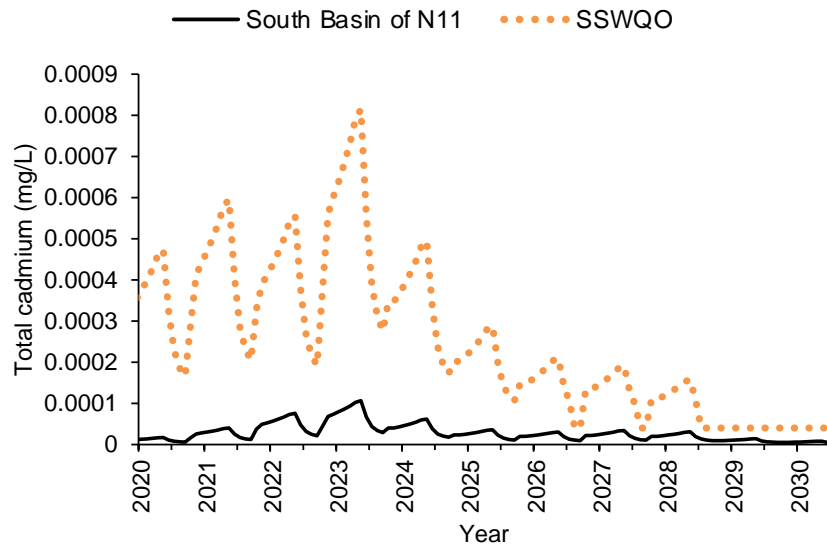
- A MAC EQC of 0.0002 mg/L provides “buffer” between the regulated parameter concentration that appears in the Water Licence and the predicted concentration in the WMP (Figure UT2-2).
- At a constant total cadmium concentration of 0.0002 mg/L in the WMP discharge to Lake N11, average total cadmium concentrations in the south basin of Lake N11 are predicted to remain below the SSWQO (Figure UT2-3). The SSWQO was calculated using ambient hardness concentrations in the south basin of Lake N11 and the equation presented in Table UT2-1.
- Total cadmium will continue to be monitored and analyzed through relevant SNP and AMEP programs.

Figure UT2-2: Comparison of Proposed Effluent Quality Criteria for Total Cadmium to Predicted Water Management Pond Discharge Concentrations



EQC = effluent quality criteria, MGC = maximum grab concentration; MAC = maximum average concentration; WMP = water management pond.

Figure UT2-3: Comparison of Predicted Average Total Cadmium Concentrations in the South Basin of Lake N11 at a Constant Water Management Pond Discharge Concentration of 0.0002 mg/L to the Site-specific Water Quality Objective



Note: The SSWQO is the generic, hardness-dependent WQG for the protection of aquatic life from CCME (2014). The SSWQO was calculated using ambient hardness concentrations in the south basin of Lake N11.

CaCO₃ = calcium carbonate; CCME = Canadian Council of Ministers of the Environment; SSWQO = site-specific water quality objective; WQG = water quality guideline.

Table UT2-1: Chronic Total Cadmium Site-specific Water Quality Objective Calculated at a Range of Hardness Concentrations

Hardness (mg/L as CaCO ₃)	SSWQO (mg/L)
< 17	0.00004
≥ 17 and ≤ 280	$(10^{(0.83 \times \text{LOG}[\text{hardness}] - 2.46)}) / 1000$
> 280	0.00037

Source: CCME (2014).

mg/L = milligrams per litre; < = less than; > = greater than; ≤ = less than or equal to; ≥ = greater than or equal to; CaCO₃ = calcium carbonate; CCME = Canadian Council of Ministers of the Environment; SSWQO = site-specific water quality objective.

References

CCME (Canadian Council of Ministers of the Environment). 2014. Canadian Water Quality Guidelines for the Protection of Aquatic Life: Cadmium. In: Canadian Environmental Quality Guidelines, 1999. Canadian Council of Ministers of the Environment, Winnipeg, MB, Canada.

3.2 Total Manganese

De Beers continues to recommend the MVLWB not including total manganese as an EQC in the amended Water Licence. This is because total manganese was not identified as a POPC through the previously accepted three-step screening process. The three-step screening process is consistent with the approach used to identify POPC in the 2018 Water Licence amendment application, and the three-step screening process was approved by the MVLWB.

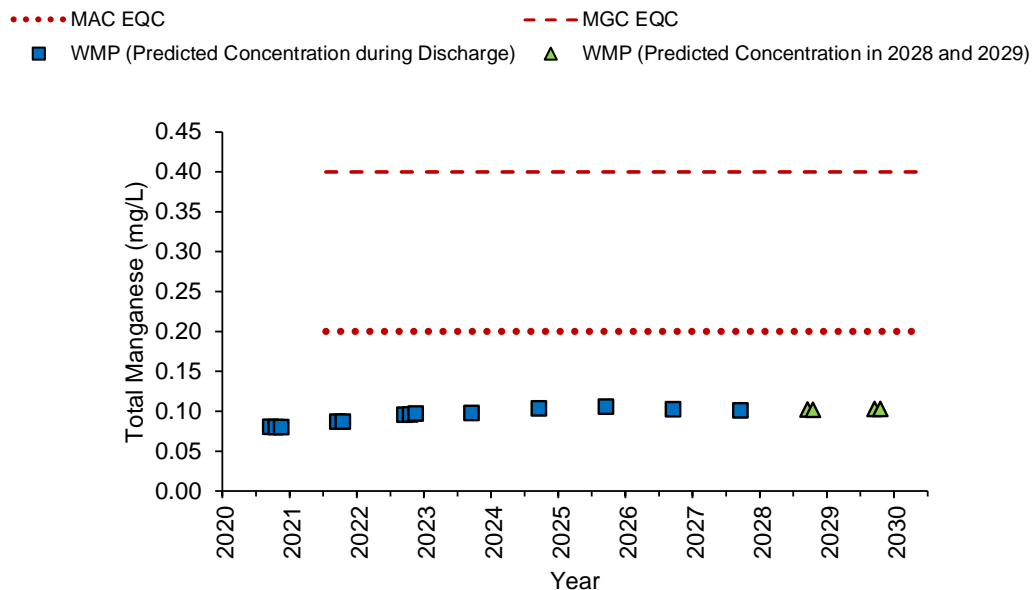
Further, not including total manganese as an EQC will not affect the monitoring of total manganese – it will continue to be monitored and analyzed through relevant SNP and AMEP programs.

In responding to Undertaking #2, should the MVLWB decide to include total manganese as an EQC parameter in the amended Water Licence, De Beers recommends the MVLWB considers the following EQC for manganese.

Following the same approach described in the EQC Report (Attachment 5 of the 2020 Water Licence Amendment Application), De Beers is proposing MAC and MGC EQC for total manganese of 0.2 mg/L and 0.4 mg/L, respectively, because:

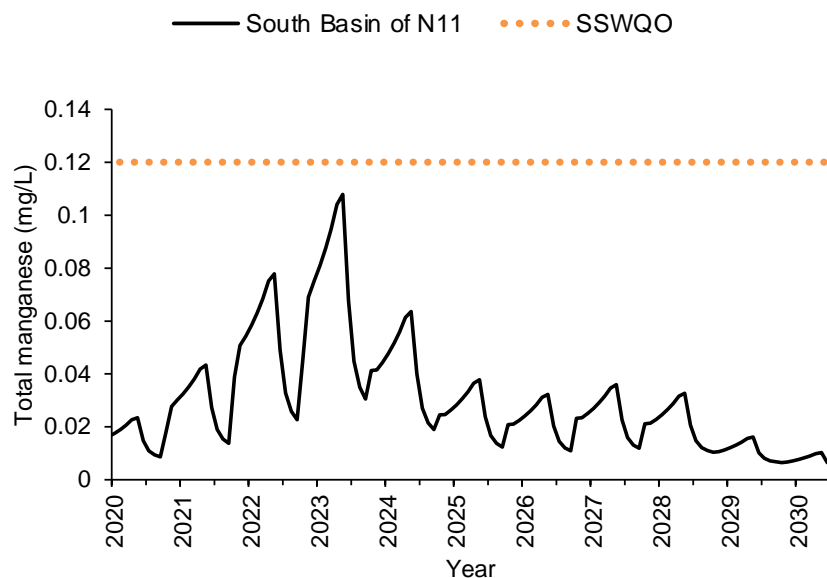
- A MAC EQC of 0.2 mg/L provides “buffer” between the regulated parameter concentration that appears in the Water Licence and the predicted concentration in the WMP (Figure UT2-4).
- At a constant total manganese concentration of 0.2 mg/L in the WMP discharge to Lake N11, average total manganese concentrations in the south basin of Lake N11 are predicted to remain below the SSWQO (0.12 mg/L; Figure UT2-4).

Figure UT2-4: Comparison of Effluent Quality Criteria for Total Manganese to Predicted Water Management Pond Discharge Concentrations



EQC = effluent quality criteria, MGC = maximum grab concentration; MAC = maximum average concentration; WMP = water management pond.

Figure UT2-5: Comparison of Predicted Average Total Manganese Concentrations in the South Basin of Lake N11 at a *Constant* Water Management Pond Discharge Concentration of 0.2 mg/L to the Site-specific Water Quality Objective



Note: The SSWQO is the maximum acceptable concentration in drinking water from Health Canada (2019).
SSWQO = site-specific water quality objective.

References

Health Canada. 2019. Guidelines for Canadian Drinking Water Quality – Summary Table. Water and Air Quality Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario, Canada.