

DE BEERS GROUP

Gahcho Kué Mine

2023 Aquatic Effects Monitoring Program
Response Plan for Benthic Invertebrates

May 2024

REVISION HISTORY

Version	Date	Notes/Revisions
Version 1	May 2024	Submitted to the Mackenzie Valley Land and Water Board (MVLWB) under Part I of Water Licence MV2005L2-0015.

ABBREVIATIONS AND ACRONYMS

Abbreviation / Acronym	Definition
AEMP	Aquatic Effects Monitoring Program
CES	critical effect size
De Beers	De Beers Canada Inc.
DFMP	Downstream Flow Mitigation Plan
Mine	Gahcho Kué Mine
SD	standard deviation

UNITS OF MEASURE AND SYMBOLS

Unit / Symbol	Definition
%	percent
≥	greater than or equal to
±	plus or minus
org/m ²	organisms per square metre

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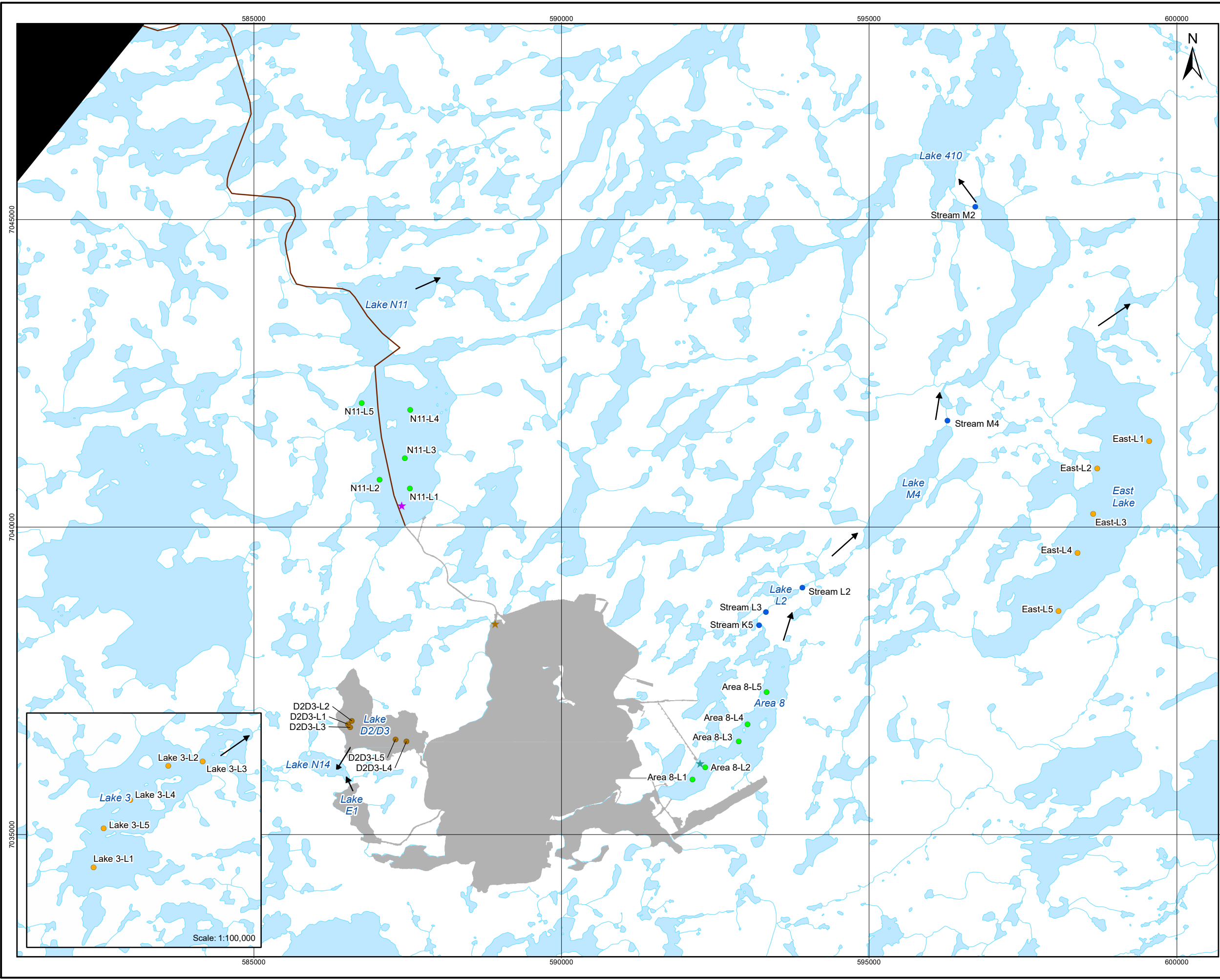
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1 INTRODUCTION

De Beers Canada Inc. (De Beers) monitors hydrology, water and sediment quality, plankton, benthic invertebrates, and fish and fish habitat in lakes and streams near the Gahcho Kué Mine (Mine) as components of the Aquatic Effects Monitoring Program (AEMP). The purpose of the AEMP is to identify potential effects of the Mine on the surrounding aquatic environment and evaluate whether aquatic ecosystems and their uses are adequately protected in areas affected by the Mine. Monitoring under the AEMP is a requirement of Water Licence MV2005L2-0015, issued by the Mackenzie Valley Land and Water Board (MVLWB or the Board; MVLWB 2021).

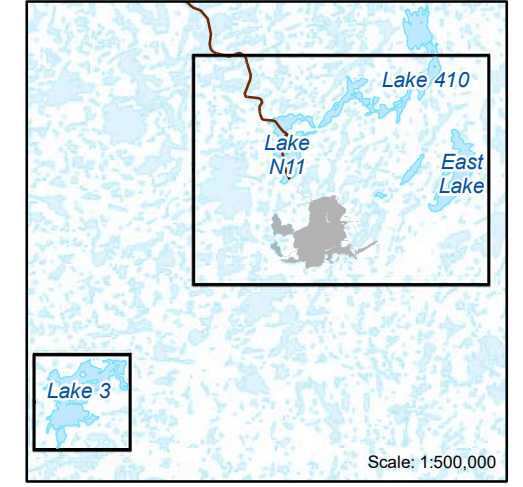
The 2023 AEMP was conducted according to the approved AEMP Design Plan Version 7.1 (De Beers 2023), which includes monitoring benthic invertebrate communities in streams downstream of Area 8. These include Streams K5, L3, L2, M4, and M2 (Map 1-1). Following analysis of the 2023 AEMP data, it was determined that the Moderate Action Level criteria related to benthic invertebrate communities for the streams downstream of Area 8 were met, thus triggering the Moderate Action Level. Per the AEMP Design Plan and requirements of the Water Licence, the Board was notified on 11 March 2024 (De Beers 2024a) that the exceedance was detected and this AEMP Response Plan is being submitted within sixty (60) days of the notification.

This response plan provides information to better understand the likely causes of the Moderate Action Level exceedance, provides evidence to support the interpretation that the change does not represent an adverse effect on aquatic life in the KLM streams, and proposes that the response action for this Moderate Action Level exceedance be a refinement of the Low Action Level criteria for benthic invertebrates in streams downstream of Area 8.



LEGEND

- ★ Downstream Flow Mitigation Diffuser
 - ★ Permanent Operational Discharge Diffuser
 - ★ In-line Monitoring Station, WMP to Lake N11
 - Gahcho Kué Winter Access Road
 - Watercourse
 - Waterbody
 - Flow Direction
 - 2023 Mine Footprint
- Benthic Invertebrate Sampling Stations**
- Core Lake
 - Reference Lake
 - Raised Lake
 - Stream



NOTES
 Source: Base Data Obtained From Geogratis, © Department of Natural Resources Canada. All Rights Reserved.

GAHCHO KUÉ MINE

AEMP Benthic Invertebrate Sampling Stations

PROJECTION: UTM Zone 12	DATUM: NAD83
Scale: 1:60,000	
FILE No: Map8-2-1-AEMP-2023-GIS-Benthic-Sample-Rev0	DATE: April 20, 2024
JOB NO: CA0023460.8480	REVISION NO: 0
OFFICE: WSP-CAL	DRAWN: AL
CHECK: KS	

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Map 1-1

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2 SIGNIFICANCE THRESHOLD

The Significance Threshold for all waters downstream of Kennady Lake (except for Lake D2/D3) are defined in Section 8.3 of the AEMP Design Plan (De Beers 2023). The Significance Threshold pertinent to streams downstream of Area 8 is defined in terms of a corresponding effect on fish communities, as:

- *Ecological function is not maintained (i.e., inadequate food for fish; fish unable to survive, grow and reproduce; and/or sustained absence of a fish species).*

An effect equivalent to the Significance Threshold in streams downstream of Area 8 would occur if changes to the benthic invertebrate community resulted in inadequate food for fish.

3 PARAMETER DESCRIPTION AND ACTION LEVEL DETERMINATION

Sections 8.5.2 and 15.6.1 of the 2023 AEMP Annual Report (De Beers 2024b) outline how the Low Action Level for benthic invertebrates in streams downstream of Area 8 was exceeded for the density of *Micropsectra/Tanytarsus*. Per the AEMP Design Plan (De Beers 2023), the Moderate Action Level criterion for benthic invertebrates in streams downstream of Area 8 is “Low Action Level triggered in three consecutive surveys”. The density of *Micropsectra/Tanytarsus* exceeded the Low Action Level in 2021, 2022, and 2023 because for each year, the stream-wide average was above the normal range and there was a statistically significant increase in the density of this taxon greater than two standard deviations from the reference mean. This is the third consecutive year that this variable has exceeded the Low Action Level, which corresponds to an exceedance of the Moderate Action Level for 2023.

4 LIKELY CAUSES AND LINES OF EVIDENCE

Overall, average *Micropsectra/Tanytarsus* density has been greater at most stations downstream of Area 8 from 2016 to 2023 compared to baseline (i.e., 2013), with a large degree of variability among years at each station (Figure 4-1). Average density for all stations between 2015 and 2023 ranged from 39 to 30,888 organisms per square metre (org/m²), compared to 41 to 234 org/m² in the 2013 baseline year. The low variability in the density of this taxon in the 2013 baseline year results in a low critical effect size (i.e., 2013 mean plus two standard deviations) of 253 org/m², which is lower than the upper bound of the reference normal range of 530 org/m². In addition to the large degree of variability in the dataset, three lines of evidence support that the increase in *Micropsectra/Tanytarsus* density does not represent an adverse effect on aquatic life in the KLM streams:

- lack of temporal and spatial trends;
- a direction of change inconsistent with predicted changes; and
- the general lack of change in other metrics such as taxonomic richness, evenness, and diversity, combined with no clear overall shift in community composition.

The increase in the density of this taxon does not appear to follow any consistent temporal or spatial trends that would be related to the Mine (Figures 4-1 and 4-2). Densities were generally greatest in 2016, 2019, 2022, and 2023, depending on the station, and were greatest at station L3 in some years, including the baseline year. Greater densities were generally associated with years that had drier than normal climatic conditions; daily mean runoff volumes in 2016 were lower than 100-year dry baseline values in July to September (De Beers 2017), and 2022 and 2023 were described as dry climatic years in Section 4.0 in the 2023 AEMP (De Beers 2024b). The 2023 water quality data indicate that nutrient enrichment occurred in the streams, where the concentration of total nitrogen was elevated at Stream K5 and generally decreased towards Stream M4. The concentration of the likely limiting nutrient in these streams (total phosphorus), was highest at Stream K5, but otherwise did not show any spatial trend from Stream L2 to Stream M4. However, the spatial trend in benthic invertebrate density did not follow the spatial trend in total nitrogen concentration.

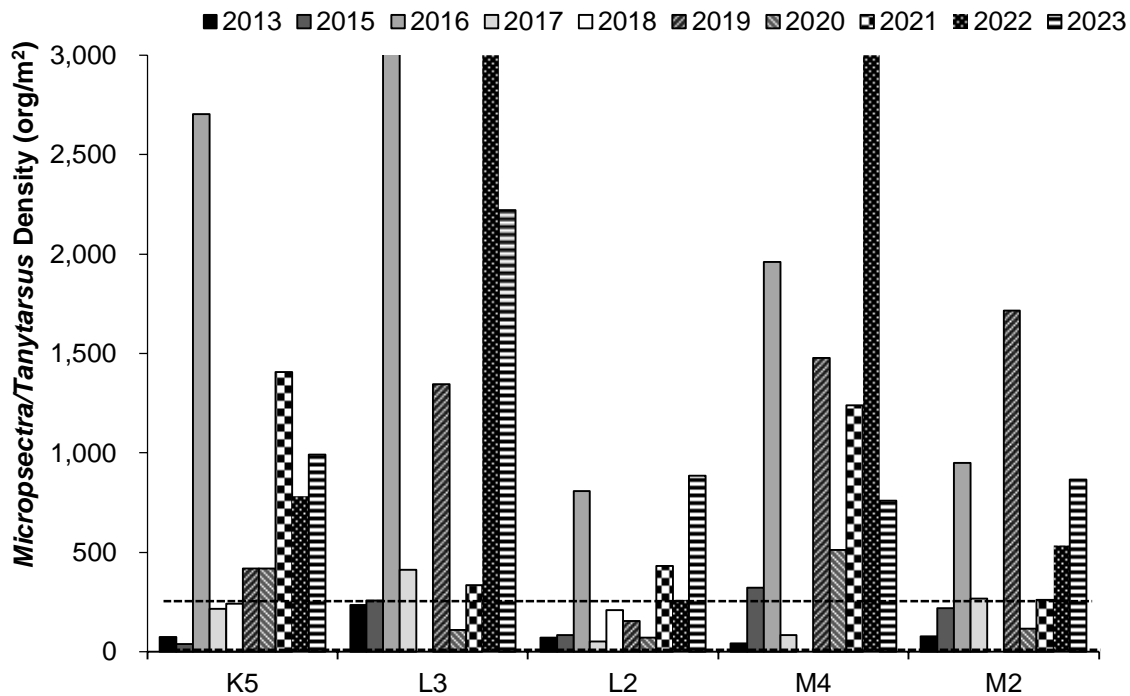
The direction of change in *Micropsectra/Tanytarsus* density (i.e., an increase in density compared to baseline) is inconsistent with the predicted Mine-related changes to benthic invertebrate communities in these streams. The Mine-related changes during operations predicted a reduction in available habitat, minor reductions in current velocity, and an overall decrease in benthic invertebrate biomass, with the largest changes predicted to occur in Streams K5 and L3, with diminishing effects downstream (De Beers 2023).

There was no clear change in other benthic invertebrate community metrics at the stream stations sampled. Average richness, diversity, and evenness in the KLM streams has generally been within or above the upper bound of their respective baseline normal range since 2013, with no clear change compared to the baseline year (Figure 4-3). In addition, there was no clear overall shift in community composition based on a review of relative density data, although some small and brief differences in major taxa have occurred among stations and years (Figure 4-4).

The increase, rather than decrease, in *Micropsectra/Tanytarsus* density, without a spatial trend of diminishing effects in a downstream direction, and no clear overall shift in community composition are

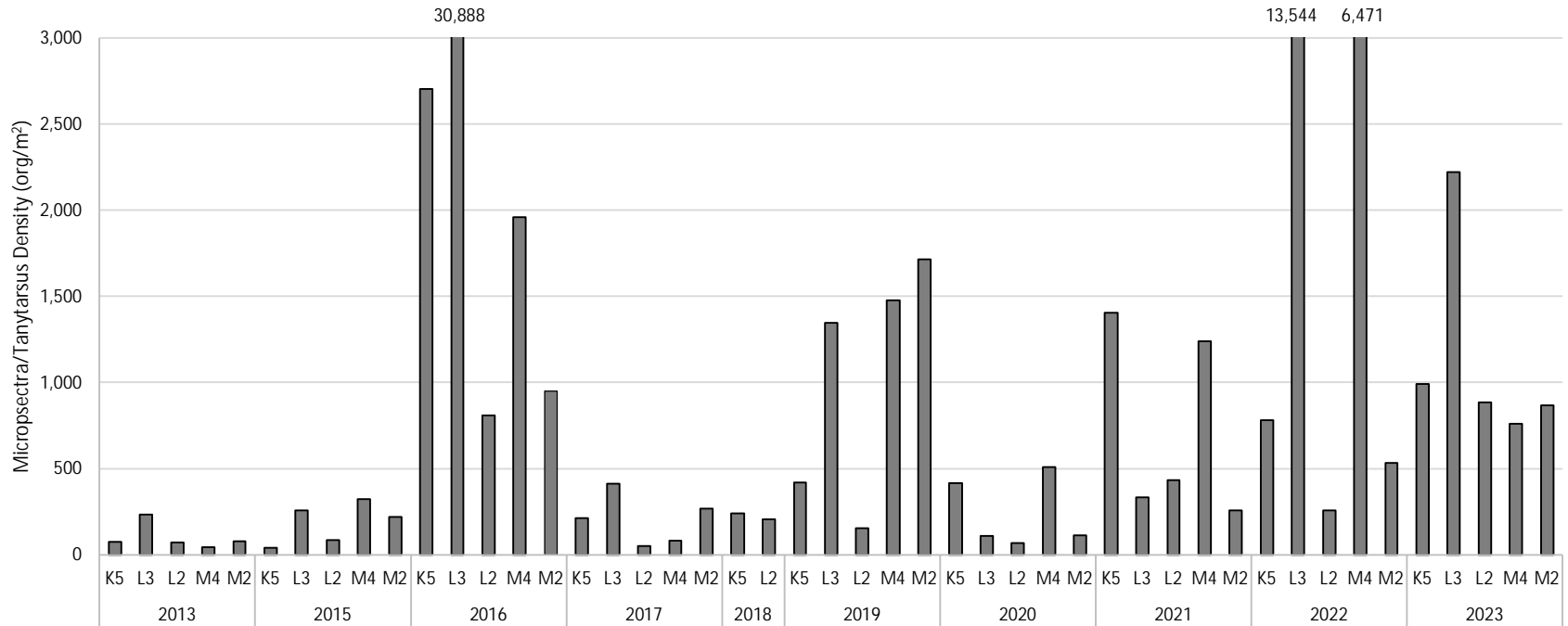
inconsistent with predictions and inconsistent with an adverse effect regarding food availability for fish. The increase in density may instead provide additional food for fish. Overall, the increase in *Micropsectra/Tanytarsus* density in the KLM streams relative to baseline suggests that this response was most likely attributable to a combination of natural variability and climatic conditions. Results were variable and the critical effect size criterion of the Low Action Level may be unrepresentative of actual background conditions, due to the low variability in the baseline dataset. The low baseline variability originated from a single year of data and, therefore, are limited to that year's hydrological conditions.

Figure 4-1 *Micropsectra/Tanytarsus* Density in Streams Downstream of Area 8 from 2013 to 2023 Compared to the Baseline Normal Range



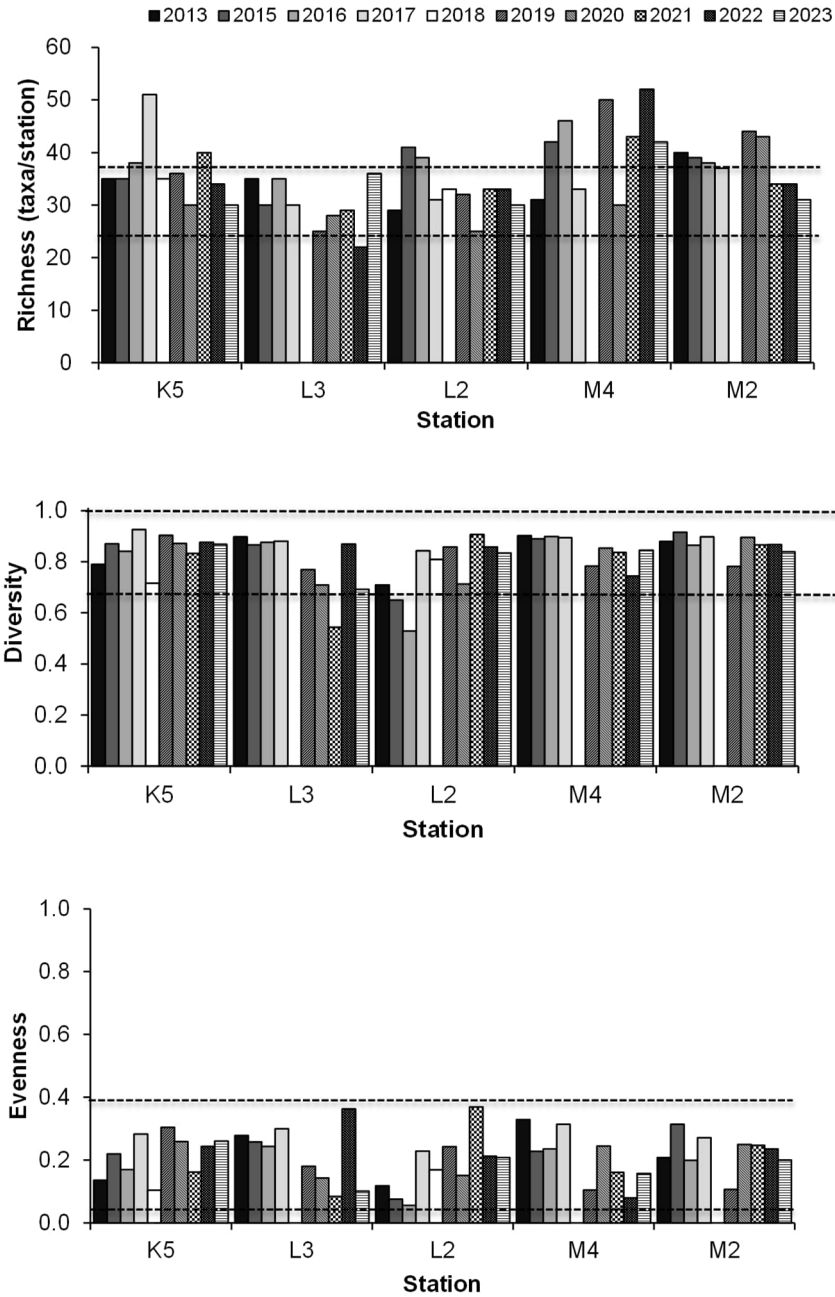
Note: The horizontal dashed grey lines represent the baseline mean plus and minus two standard deviations. Values greater than 3,000 org/m² were excluded from the plot to improve data visualization: Stream L3 in 2016 (30,888 org/m²), Stream M4 in 2022 (13,544 org/m²), and Stream L3 in 2022 (6,471 org/m²). Stations are presented from upstream to downstream.
 org/m² = organisms per square metre.

Figure 4-2 *Micropsectra/Tanytarsus* Density from 2013 to 2023 in Streams Downstream of Area 8



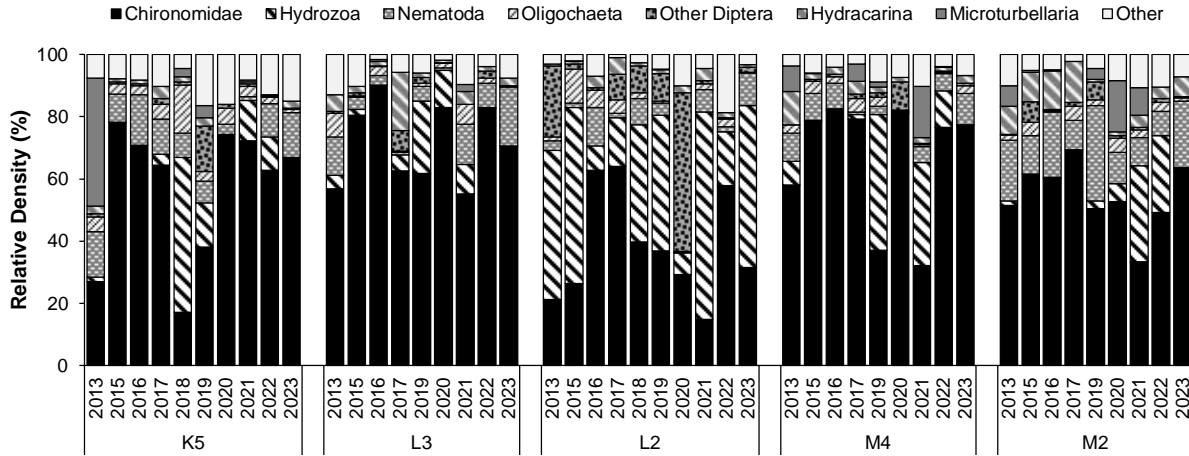
Note: Values greater than 3,000 org/m² were excluded from the plot and added to the top of the bar to improve data visualization: Stream L3 in 2016 (30,888 org/m²), Stream M4 in 2022 (13,544 org/m²), and Stream L3 in 2022 (6,471 org/m²). Stations are presented from upstream to downstream.
 org/m² = organisms per square metre.

Figure 4-3 Benthic Invertebrate Community Summary Variables in Streams Downstream of Area 8, 2013 to 2023



Note: The lower and upper bounds of the normal range reported by De Beers (2024b) for streams downstream of Area 8 are plotted as horizontal dashed lines.

Figure 4-4 Benthic Invertebrate Community Composition in Streams Downstream of Area 8, Based on Density, 2013 to 2023



5 ECOLOGICAL IMPLICATIONS

The increase in *Micropsectra/Tanytarsus* density from 2016 to 2023 compared to baseline (i.e., 2013) does not represent an adverse effect on aquatic life. The benthic invertebrate communities in streams downstream of Area 8 remain a suitable food source for fish, and the increase in density may instead provide additional food for fish compared to baseline conditions.

6 RESPONSE ACTIONS

Two changes are recommended to the Low Action Level: removal of densities of dominant taxa from the criteria, and refining the criteria to identify decreasing trends only.

The removal of dominant taxa densities from the criteria is proposed to reduce Action Level exceedances due to the spatial and temporal variability in densities of individual genera. The densities of individual genera that tend to be dominant in these streams, typically Chironomidae, vary spatially and temporally and are therefore not diagnostic of adverse community changes. Action Levels based on total density and richness are better suited to identify changes at the community level in terms of food availability (total density), and community diversity and stability (richness).

The second change involves refining the Low Action Level to identify decreasing trends in total density and richness. Specifically, the Low Action Level would be exceeded when the stream-wide average was below the normal range with a statistically significant decreasing trend. The change is proposed to eliminate Action Level exceedances that are indicative of improvements to the benthic invertebrate community (e.g., such as when density and richness increase compared to baseline). This change aligns with the intention of the Action Level assessment for streams downstream of Area 8 in assessing whether the Downstream Flow Mitigation Plan (DFMP) is effective at maintaining a habitat suitable for fish (i.e., adequate food for fish). An additional condition is proposed to be added to the Low Action Level: in addition to the criteria mentioned, the average value at Stream K5 must also be below the lower bound of the normal range. Because the largest changes were predicted to occur in Streams K5 and L3, located closest to the Mine, with diminishing effects downstream, this criterion requires that effects be present, at least, at the most affected station, Stream K5. Effects at downstream stations that are absent at Stream K5 suggest effects that are unrelated to the Mine and should not result in an action level exceedance.

The proposed changes to the Low Action Level are intended to decrease exceedances based on factors beyond the Mine's control, such as natural variability and climatic conditions. The proposed changes to Action Levels for benthic invertebrates in streams downstream of Area 8 are presented in Table 6-1.

Table 6-1 Proposed Changes to the Action Levels for Benthic Invertebrates in Streams Downstream of Area 8

Action Level	Action Level per AEMP Design Plan (De Beers 2023)	Proposed Action Level for use in the 2024 Annual Report and Thereafter
<p>Low^(a) <i>Effects are measurable but well below the Significance Threshold – trigger meant as a warning and requirement for further evaluation</i></p>	<p>1. Stream-wide average value^(b) for total density, richness or the densities of dominant taxa greater than or less than the baseline normal range AND 2. Significant increase or decrease in total density, richness, or the densities of dominant taxa relative to the baseline mean, with magnitude \geqCES (± 2SD) between the baseline mean and stream-wide average value^(b)</p>	<p>1. Stream-wide average value^(b) for total density or richness below the lower bound of the baseline normal range AND 2. Significant decrease in total density or richness relative to the baseline mean, with average value^(b) at Stream K5 below the lower bound of the normal range</p>
<p>Moderate <i>Effects are measurable and are trending towards the Significance Threshold, but still well below it</i></p>	<p>Low Action Level triggered in three consecutive surveys^(c)</p>	<p>Low Action Level exceeded in three consecutive surveys^(d)</p>
<p>High <i>Measured effects continue to trend towards the Significance Threshold</i></p>	<p>1a. Stream-wide average value^(b) for total density 50% less the background normal range or 1b. Stream-wide average value^(b) for total density trending toward 50% less than the background normal range over a period of at least three surveys.</p>	<p>1a. Stream-wide average value^(b) for total density 50% less the background normal range or 1b. Stream-wide average value^(b) for total density trending toward 50% less than the background normal range over a period of at least three surveys.</p>

Notes: A higher tier Action Level cannot be exceeded without first exceeding the Action Level below it (e.g., a Moderate Action Level exceedance implies that all Low Action Level criteria have been met in the same AEMP). Action Levels to be applied to streams downstream of Area 8.

a) Changes below the Low Action Level are within the estimated magnitude of background variation and are considered to represent negligible levels of environmental change.

b) The stream-wide average value is defined as either the mean or median value, depending on the underlying statistical distribution.

c) Low Action Level exceedance must occur in the effect indicator over a period of at least three years.

AEMP = Aquatic Effects Monitoring Program; CES = critical effect size; SD = standard deviation; \geq = greater than or equal to; \pm = plus or minus.

7 SUMMARY AND CONCLUSIONS

The Moderate Action Level was exceeded in 2023 in streams downstream of Area 8, because this was the third consecutive year that the stream-wide average density of *Micropsectra/Tanytarsus* was above the normal range, with a statistically significant increase beyond two standard deviations from the reference mean. Evidence was provided to support that this increase was likely the result of natural variability and dry climatic conditions, and that the change does not represent an adverse effect on the benthic invertebrate community in the KLM streams. The proposed response action for this Moderate Action Level exceedance is a refinement of the Low Action Level criteria for benthic invertebrates in streams downstream of Area 8, to decrease exceedances based on factors beyond the Mine's control, such as natural variability and climatic conditions.

8 REFERENCES

- De Beers (De Beers Canada Inc.). 2017. Gahcho Kué Mine – 2016 Aquatic Effects Monitoring Program Report. Submitted to the Mackenzie Valley Land and Water Board, Yellowknife, NT, Canada. May 2017. 634 pp + Appendices.
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