

DE BEERS GROUP

Gahcho Kué Mine

**2018 Aquatic Effects Monitoring Program
Response Plan – Fish Habitat and Community -
Version 2**

May 2019

ABBREVIATIONS AND ACRONYMS

Abbreviation / Acronym	Definition
AEMP	Aquatic Effects Monitoring Program
De Beers	De Beers Group
DFMP	Downstream Flow Mitigation Plan
DFO	Fisheries and Oceans Canada
EIS	Environmental Impact Statement
Golder	Golder Associates Ltd.
KLM watershed	Streams and Lakes in the K, L, and M watersheds, downstream of Kennady Lake
Mine	Gahcho Kué Mine
MVLWB	Mackenzie Valley Land and Water Board
NWT	Northwest Territories
YOY	young-of-year

UNITS OF MEASURE

Unit / Symbol	Definition
m	metre

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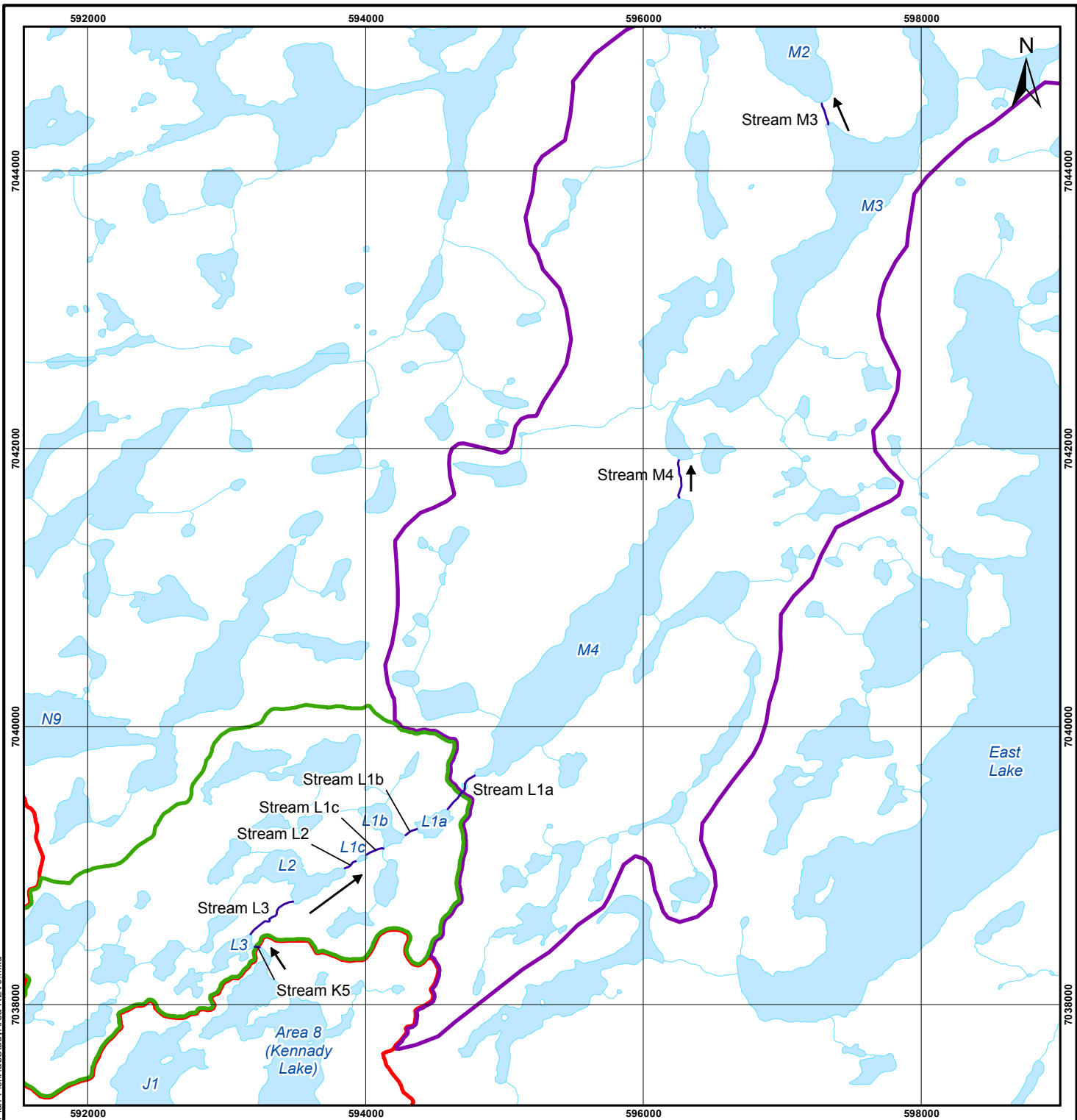
1 INTRODUCTION

De Beers Canada Inc. (De Beers) monitors the fish habitat and community in streams downstream of the Gahcho Kué Mine (Mine) and Area 8 of Kennady Lake (Area 8) as a component of the Aquatic Effects Monitoring Program (AEMP). This monitoring under the AEMP is a requirement of the Water Licence MV2005L2-0015, issued by the Mackenzie Valley Land and Water Board (MVLWB or the Board; MVLWB 2014). A monitoring program was developed to support the Downstream Flow Mitigation Plan (DFMP; Golder 2012) and to also support the *Fisheries Act* Authorization (Authorization 03-HCAA-CA6-0057.1) for the Mine, which has been integrated with the fish habitat and community and flow mitigation monitoring components of the AEMP. These two monitoring programs evaluate the potential effects of the Mine on flow, fish habitat and community, and success of any flow mitigation, downstream of Kennady Lake (i.e., the KLM watershed). They also provide information on potential effects on traditional uses of fish, based on monitoring at stations shown in Figure 1-1 (i.e., study area).

Based on the results of the 2017 fish habitat and community monitoring, which indicated that Arctic Grayling (*Thyallumus arcticus*) were either absent or at very reduced levels of occupancy from the KLM watershed, De Beers submitted an AEMP Response Plan (De Beers 2018a) in fulfillment of Part I, Condition 7 of Water Licence MV2005L2-0015. This plan was approved by the Board on May 2, 2018. As part of the Response Actions detailed in the Response Plan, a special effects study was conducted in 2018. The geographic extent of the study area was extended in 2018 to include the lake habitat of Area 8, the interconnected lakes between Area 8 and Lake 410, Streams M3, M2 and M1, and the outlet of Lake 410 into the P-System, as shown in Figure 1-2, to determine if Arctic Grayling exist in further downstream reaches of Area 8 (De Beers 2018a). Additional sampling methods were added to the study to determine if Arctic Grayling exist but were not detected during the 2017 study, and included lake shoreline observations, lake snorkelling observations, stream backpack electrofishing, underwater video recordings, and lake angling.

De Beers and Golder provided an update of the 2018 flow and fish catch results to Fisheries and Oceans Canada (DFO) on October 18, 2018 as part of De Beers' commitment to ongoing engagement with DFO on their *Fisheries Act* Authorization (Authorization 03-HCAA-CA6-0057.1) for the Mine. As part of the approved 2017 AEMP Response Plan (De Beers 2018a), De Beers submitted a technical report to the Board on October 31, 2018 (De Beers 2018b), presenting a summary of the results of the monitoring associated with the Response Actions carried out in 2018 and a summary of the flow and fish catch results. The report detailed that Arctic Grayling were not observed within the KLM watershed during the 2018 monitoring year, despite extending the geographic extent of the study area and the inclusion of additional sampling methods, as per the approved 2017 AEMP Response Plan (De Beers 2018a). This resulted in a second consecutive year where Low Action Levels were triggered under the flow mitigation component of the AEMP. In addition, as further detailed in this AEMP Response Plan for the 2018 monitoring year, the Moderate Action Level trigger related to flow mitigation: "*Arctic Grayling are absent in a subsequent monitoring year*", as defined in the approved 2017 AEMP Response Plan (De Beers 2018a), was also triggered in 2018.

The board was notified that the 2018 Low and Moderate Action Level thresholds were triggered on November 30, 2018 (De Beers 2018c). As per Part I, Condition 7.B of the Water Licence, a new AEMP Response Plan is required, detailing the exceedance and proposed Response Actions. A Draft 2018 AEMP Response Plan was submitted to the Board on January 31, 2019 which outlined De Beers' continued response to the Low Action Level triggers observed in 2017 (and continued in 2018), as well as the Moderate Action Level trigger observed in 2018.



LEGEND


- Downstream Flow Monitoring Stream
- Flow Direction
- Watercourse
- Waterbody
- Watershed Boundary**
- Kennady Lake Watershed
- L Watershed
- M Watershed

NOTES

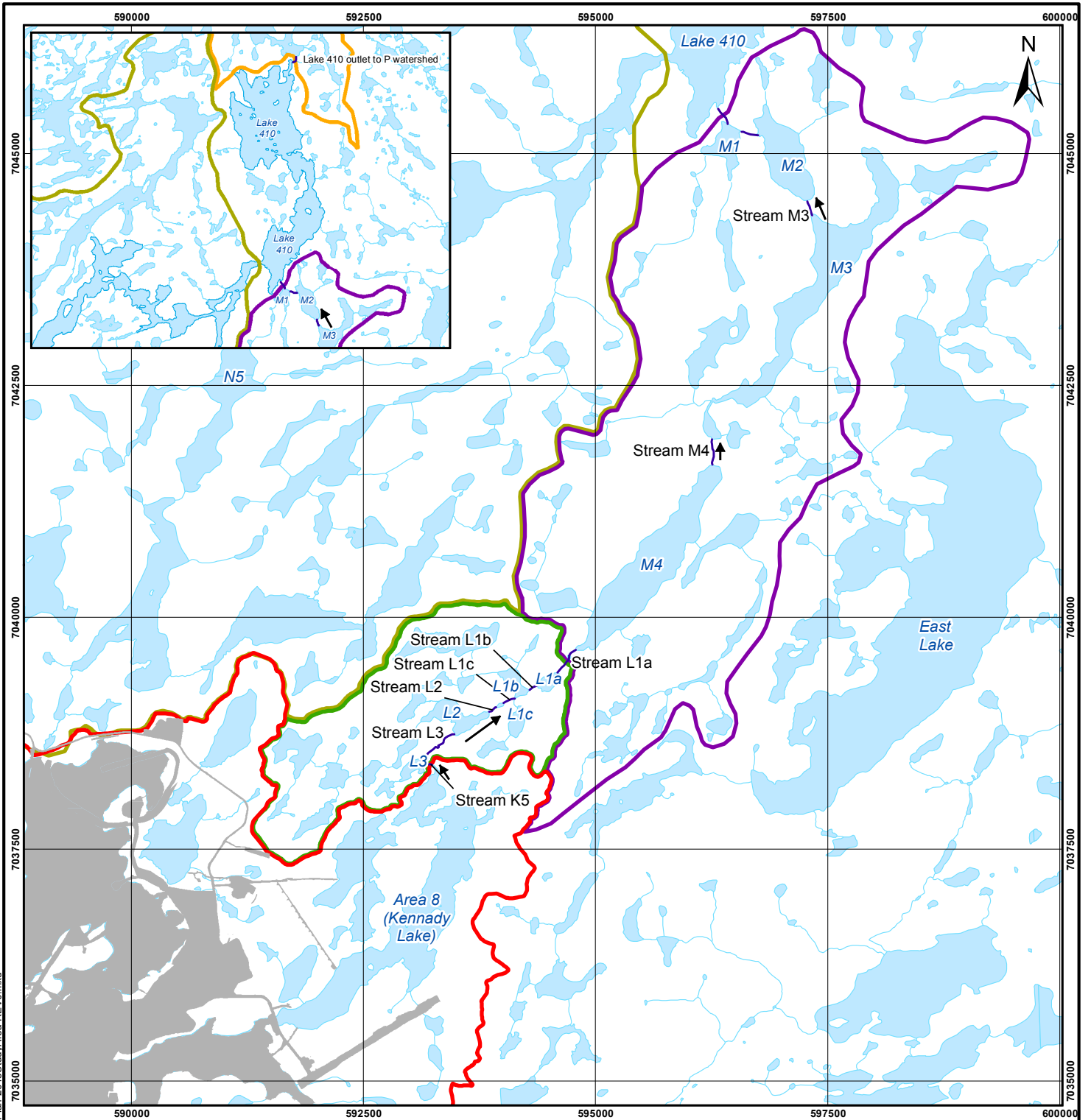
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GAHCHO KUÉ MINE

Fish Habitat and Community Study Area (2015 – 2017)

PROJECTION: UTM Zone 12		DATUM: NAD83		DE BEERS GROUP
Scale: 1:40,000 0.5 0.25 0 0.5  Kilometres				
FILE No: AEMP2018_FHC_ResponsePlan-FishHabStudyArea-REV0		DATE: January 29, 2019		
JOB NO: 18104155		REVISION NO: 0		Figure 1-1
OFFICE: GOLD-CAL		DRAWN: ANK CHECK: KC		

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LEGEND

- Downstream Flow Monitoring Stream
- Flow Direction
- Watercourse
- Waterbody
- 2018 Mine Footprint
- Watershed Boundary**
- Kennedy Lake Watershed
- L Watershed
- M Watershed
- N Watershed
- P Watershed

GAHCHO KUÉ MINE

Fish Habitat and Community Study Area (2018)

PROJECTION: UTM Zone 12		DATUM: NAD83		DE BEERS GROUP
Scale: 1:60,000 <div style="display: flex; justify-content: center; align-items: center;"> 1 0.5 0 1 </div> <div style="text-align: center; margin-bottom: 5px;"> </div> Kilometres				
FILE No: AEMP2018_FHC_ResponsePlan-2018StudyArea-REV0		DATE: January 29, 2019		
JOB NO: 18104155		REVISION NO: 0		Figure 1-2
OFFICE: GOLD-CAL		DRAWN: ANK CHECK: KC		

NOTES
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1.1 Conformity Response

The draft plan was reviewed by the Board and preliminary review comments were provided to De Beers on February 26, 2019. De Beers submitted responses to the preliminary review comments to the Board on March 8, 2019. The Board reviewed the responses and denied the Draft 2018 AEMP Response Plan on April 9, 2019 citing concerns with the High Action Level as defined in the draft plan, although the Moderate Action Level was approved. De Beers is submitting this revised AEMP Response Plan (Version 2) in accordance with review comments and revision requirements made by the Board. Changes to the AEMP Response Plan (Version 2) are presented in a conformity response summary and as revisions to the response actions in Section 5 of this Plan. A summary of the sections within the AEMP Response Plan (Version 2) that address each of the revision requirements as stated by the Board is presented in the conformity table below.

Board Directives Items to include in the Version 2 of the AEMP Response Plan		Response and Cross Reference
1.	Clarification of timing and effort proposed for the 2019 special effects study as indicated in De Beers' response to ENR comment #7.	Section 5.2.1 For 2019, three field surveys are planned consistent with 2018 effort. The spring program will be planned for early June to monitor spawning movements, the summer program will be planned for late July to detect resident fish and young-of-the-year, and an early September program will be completed to determine access to overwintering habitats. Visual surveys will be expanded with the use of underwater drone searches during the summer program.
2.	Clarify how and when the results of the 2019 flow augmentation assessments will be reported to the Board and reviewers.	Section 5.2.2 A draft of the Flow Augmentation Assessment memo, completed as an action under the 2017 AEMP Response Plan, will be submitted to the Board prior to June 1, 2019. The Flow Augmentation Assessment for the 2019 monitoring year will be submitted as part of the 2019 AEMP Annual Report.
3.	Clarification of the ecological implication of the moderate Action Level exceedance as required by the Licence as indicated in De Beers' response to Board staff comment #1	Section 2.2 Additional text added.
4.	Update the AEMP Response Plan – special effects study to include (2) assessing if low water and the diversion from Lake N11 is of sufficient volume or at the right time to support spawning of Arctic grayling; and, (3) determining if diversions from Lake N11 would be required on a more frequent basis other than the existing frequency which was to ensure Arctic grayling spawning.	Section 5.2.2 The Flow Augmentation Assessment special effects study incorporates the identified objectives.
5.	Reflect the responses to Board staff comment #6 regarding how the 2018 data will assist the assessment of Grayling's return.	Sections 5.2.2 and 5.2.6 Addressed in the Flow Augmentation Assessment and information to follow in the Re-evaluation Report.

<p>6.</p>	<p>Propose a more suitable high action level with the following direction:</p> <ul style="list-style-type: none"> i Revise the high action level in accordance with the approved AEMP Design Plan and considering reviewer comments; ii Engaging with affected parties and other regulators to determine what significant threshold is acceptable, and propose high action level(s) accordingly; iii Set high action level above predictions, but below the significant threshold as per the approved AEMP Design Plan and engagement with affected parties and reviewers; iv Propose fish species indicator(s) that is considered valued components (VC), and also applicable to the flow mitigation plan; and v Support the high action level with scientifically defensible rationale. 	<p>Section 5.2.5</p> <p>Discussions with ENR (April 12, 2019) and DFO (April 24, 2019) were held prior to modification of the High Action Level. The primary concern was identified as using another “absence” metric; use of Slimy Sculpin was considered acceptable.</p> <p>High Action Level:</p> <p><i>Slimy Sculpin density shows a statistically significant temporal trend showing decreasing densities over time across a four-year period within the KLM watershed and relative to a reference site.</i></p>
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1.2 Background

Arctic Grayling was selected as a valued fish species for the Environmental Impact Statement (EIS; De Beers 2011), and subsequently for the AEMP (De Beers 2015), because of the following characteristics:

- Importance to local Aboriginal communities and to the Northwest Territories (NWT) sport fishery.
- Unique life history makes it suitable for assessing the potential effects of the Project on streams.

In the Barrenlands, Arctic Grayling have an adfluvial life history and use stream habitat for spawning and rearing. Arctic Grayling can exist in most, if not all, lakes downstream of Kennady Lake and in the adjacent N watershed and use the connecting streams as spawning habitat (De Beers 2011). The Mine has the potential to alter the physical and hydrological characteristics of streams downstream of Kennady Lake within the KLM watershed streams. Therefore, effects to stream habitat will have the potential for a direct effect on Arctic Grayling recruitment and the sustainability of downstream populations during and after the Mine (De Beers 2011). The use of Arctic Grayling as a monitoring species can also provide an indication of potential effects on other fish species that are found in the streams in the KLM watershed.

The approved 2017 AEMP Response Plan (De Beers 2018a) detailed the two Low Action Level thresholds that were triggered, presented the likely causes and lines of evidence that resulted in these threshold triggers, and presented various Response Actions committed to by De Beers. These were investigatory for 2018 and were designed to be continually evaluated and adapted as part of the AEMP should Arctic Grayling continue to be absent from the downstream KLM watershed in subsequent years (i.e., 2018 and onwards). The Response Actions included (De Beers 2018a):

- Confirmation of the Low Action Level trigger, in terms of spatial and temporal extent in 2018. As required by the Board, this included a special effects study to determine if Arctic Grayling exist but were not detected during the 2017 study and to determine if they exist in reaches further downstream from Area 8.
- Conducting an assessment to determine whether existing flow augmentation is adequate.
- Revision of the Low Action Level criteria, if warranted and scientifically defensible.
- Setting of site-specific benchmarks, if appropriate.
- Setting the Moderate and High Action Level criteria, if warranted and scientifically defensible.
- Identification of mitigation(s) to stop or slow trend, and implement mitigation(s), where applicable, which included:
 - Assessing if flow mitigation from Lake N11 is of sufficient volume or at the right time to support spawning of Arctic Grayling during low flows, or if flow mitigation is required at a higher volume or on a more frequent basis.
 - Investigating and identifying measures which can be implemented to ensure Arctic Grayling return to Area 8 during operations, should Arctic Grayling's absence be confirmed in the 2018 monitoring program.
 - Providing a contingency plan should Arctic Grayling continue to be absent in 2018.
- Provide an assessment of whether Arctic Grayling would be expected to return to Kennady Lake post-closure, if they do not exist or spawn in Area 8 or the KLM watershed during operation.

2 ACTION LEVEL DESCRIPTION

As this AEMP Response Plan is a continuation of the approved previous version, this section summarizes the previous Low Action Level descriptions and details the Moderate Action Level description, as approved by the Board.

2.1 Low Action Levels

The two criteria that triggered the Low Action Level in 2017 and again in 2018 were:

1. **Arctic Grayling adults are not moving to spawning areas within the normal spring period.**

Arctic Grayling move to spawning habitat during or immediately after ice break-up and tend to return to summer feeding habitat a few days or weeks after spawning (Stewart et al. 2007). This pattern has been documented previously at site, with most fish fence observations showing fish moving from downstream habitat back into Kennady Lake by mid-June (Golder 2014, 2015, 2016, 2017).

The ecological implication of the Low Action Level trigger *Arctic Grayling adults not moving to spawning areas within the normal spring period* is that the persistence of an Arctic Grayling population downstream of Area 8 could be impaired if fish are unable to access spawning habitat, or if the timing of spawning is altered. Changes to spawning success may result in adult Arctic Grayling being unable to reproduce, resulting in the sustained absence of Arctic Grayling (De Beers 2015). The sustained absence of Arctic Grayling may then result in effects to other fish species through changes in the community structure and food web interactions. This outcome could move Area 8 and the downstream watersheds towards the significance threshold (i.e., that ecological function downstream of Kennady Lake is not maintained).

2. **Arctic Grayling fry are not present in the system and/or not distributed similar to baseline.**

Arctic Grayling fry, or young-of-year (YOY), emerge from spawning habitat and move to sheltered rearing habitat near their spawning habitat. YOY generally remain in their rearing habitat for the first growing season before moving to overwintering habitat (Stewart et al. 2007). This pattern of habitat use and timing has been documented previously at site, with abundant YOY fish observations (greater than 1,000 YOYs in 2014) in the summer and declining in the fall (Golder 2014, 2015, 2016, 2017).

The ecological implication of the Low Action Level trigger "*Arctic Grayling fry not being present in the system and/or not being distributed similar to baseline*" is that the persistence of an Arctic Grayling population downstream of Area 8 could be impaired if successful recruitment to the population does not occur. Changes to recruitment success may result in Arctic Grayling fry are unable to survive or grow, and thus the sustained absence of Arctic Grayling (De Beers 2015). The sustained absence of Arctic Grayling may then result in effects to other fish species through changes in the community structure and food web interactions. This outcome could move the Area 8 and downstream watersheds towards the significance threshold (i.e., that ecological function downstream of Kennady Lake is not maintained).

2.2 Moderate Action Level

As defined in the approved 2017 AEMP Response Plan (De Beers 2018a), the Moderate Action Level trigger: "*Arctic grayling are absent in a subsequent monitoring year*", was also triggered in 2018. The

Moderate Action Level is associated with the sustained absence of a fish species downstream of Kennady Lake.

The ecological implication of the Moderate Action Level trigger: "*Arctic grayling are absent in a subsequent monitoring year*", is that the sustained absence of Arctic Grayling may then result in effects to other fish species through changes in the community structure and food web interactions. This outcome could move Area 8 and the downstream watersheds towards the significance threshold (i.e., that ecological function downstream of Kennady Lake is not maintained).

As confirmed through the expanded geographic extent of sampling, Arctic Grayling remain in the larger Kirk Lake watershed and were detected at the outlet of Lake 410. The expanded sampling methods implemented in 2018 also confirmed that other stream resident species (e.g., Slimy Sculpin) remain in the KLM streams, and Lake Trout and Northern Pike are present in downstream lakes. Habitat conditions in the KLM streams remain suitable to support fish, and flows that would allow for widespread fish movements from downstream habitats are well understood. These results would indicate that although the Moderate Action Level for the absence of Arctic Grayling in subsequent monitoring years was triggered, the potential ecological implications to the fish community remain local and reversible. The potential for recolonization of Arctic Grayling into the KLM streams remains possible, and the other indicators of the aquatic ecosystem necessary to support the fish community (e.g., benthic invertebrate community, water quality) remain within baseline conditions, as reported in the annual AEMP summary reports.

3 ACTION LEVEL EXCEEDANCE DETERMINATION

The 2018 distribution of Arctic Grayling in the K, L and M streams during the 2018 open-water season was not consistent with previous monitoring programs conducted from 2013 to 2017 (Golder 2014, 2015, 2016, 2017; De Beers 2018a). Extending the geographic extent of the study area and the inclusion of additional sampling methods, as per the approved 2017 AEMP Response Plan (De Beers 2018a), did not result in documentation of any Arctic Grayling between Area 8 and Lake 410. Arctic grayling do continue to occupy Lake 410. Although Arctic Grayling were not detected from the study area, Burbot, Lake Chub, Lake Trout, Ninespine Stickleback, Northern Pike, and Slimy Sculpin were confirmed to be present between Area 8 and Lake 410, in 2018 (De Beers 2018b).

Arctic Grayling were not observed between Area 8 and Lake 410 in 2018 (De Beers 2018b). In addition, no YOY Arctic Grayling were documented in 2018, suggesting that spawning did not occur or was not successful in 2018. This resulted in a second consecutive year where Low Action Levels were triggered under the flow mitigation component of the AEMP, and with a second consecutive year where Arctic Grayling were unconfirmed or absent within the KLM watershed, the Moderate Action Level threshold was therefore also triggered.

4 LIKELY CAUSES AND LINES OF EVIDENCE

As discussed in the approved 2017 AEMP Response Plan (De Beers 2018a), it is likely that the sequence of multiple events, some Mine-related and some environmental, all contributed to the result of no observed Arctic Grayling in 2017. The timing of each stressor was such that one perturbation potentially confounded the other. In summary:

- The isolation of Area 8 and removal of a large proportion of the Arctic Grayling population from Kennady Lake occurred in 2014 and 2015 as part of the fish out.
- In 2014, naturally occurring high water temperatures were recorded, which may have caused additional mortalities to the already reduced population in Area 8 (due to the fish out) and the immediate downstream watershed.
- In 2016, high water temperatures, likely caused by a combination of high air temperatures, dry conditions, and low flow conditions, may have caused additional mortalities to the already reduced population and restricted movement to refuge or overwintering habitats.

In addition to the likely causes presented, the evidence indicated that the availability of suitable physical habitat (excluding considerations of temperature) and access to spawning habitat was not the cause of the observed decline and subsequent absence of Arctic Grayling in 2017 (De Beers 2018a). However, dry hydrologic conditions have occurred every year since 2016, and although short periods of moderate flows have allowed access to spawning habitat, sustained periods of higher flows have not occurred that would allow for the widespread movement of fish throughout the system without encountering barriers. A naturally wet cycle would be necessary for these conditions to be present.

As part of the Response Actions in 2018 (De Beers 2018a), extending the geographic extent of the study area and the inclusion of additional sampling methods in 2018, was aimed at trying to confirm if Arctic Grayling exist, but were not detected during the 2017 study, and determine if they exist in further downstream reaches of the KLM watershed. Despite these actions, Arctic Grayling were not detected between Kennady Lake and the inlet of Lake 410 (i.e., downstream of Stream M1) (De Beers 2018b). They were however detected at the outlet of Lake 410.

The evidence suggests that the remaining population of Arctic Grayling downstream of Kennady Lake are either at such low numbers that the possibility of detection is low, or have been restricted to deeper, cooler waters in the inter-connected lakes within the KLM watershed and have avoided detection or are currently absent from the KLM watershed.

5 RESPONSE ACTIONS

5.1 Proposed Actions for 2019

In 2019, a continuation of the special effects study implemented in 2018 will be conducted to address the sustained absence of Arctic Grayling from the KLM Watershed (i.e., confirmation of the Moderate Action Level trigger). The response actions listed in the 2018 AEMP Response Plan (Version 2) include revisions as required by the Board following review as detailed in Section 1.1, as well as an evaluation of the ecological implications if the Low Action Level trigger is sustained, with a discussion of how this relates to the significance threshold, as defined by the AEMP Design Plan (De Beers 2015a).

The Response Actions, as per approved 2017 AEMP Response Plan (De Beers 2018a) and summarized in Section 1.2, will continue to be evaluated and adapted as part of the 2018 AEMP Response Plan, as Arctic Grayling were again absent from the downstream KLM watershed in 2018. The Response Action to confirm the Low Action Level trigger in terms of determining the spatial extent of Arctic Grayling will be continued for 2019 with minor adjustments.

5.2 Justification of Actions

5.2.1 2019 Special Effects Study – Confirmation of the Low and Moderate Action Level Triggers

The Low Action Level triggers from 2017 were confirmed in 2018 (De Beers 2018b), with the sustained absence of Arctic Grayling in the KLM watershed in 2018, despite the extended geographic extent of the study area and the additional sampling methods used in 2018.

The 2018 sampling used traditional methods (i.e., fish fences, backpack electrofishing, angling, visual observations within streams by foot, from the shorelines of lakes by foot and boat, snorkelling in sections of lakes and streams, and underwater video recordings along sections of shorelines in the larger lakes) to determine the presence (or absence) of Arctic Grayling within the KLM watershed. These methods are effective at detecting fish and will be continued in 2019 as a continuation of the Special Effects Study.

As such, for 2019, confirmation that Arctic Grayling are present or absent from the KLM watershed requires the continuation of the special effects study conducted in 2018, to address the sustained absence of Arctic Grayling from the KLM Watershed (i.e., confirmation of the Moderate Action Level trigger). Field programs, sampling effort and areas will be consistent with those conducted in 2018, with three field surveys planned. The spring program will be planned for early June to monitor spawning movements, the summer program will be planned for late July to detect resident fish and young-of-the-year, and an early September program will be completed to determine access to overwintering habitats.

The evidence suggests that the remaining population of Arctic Grayling, downstream of Kennady Lake, are either at such low numbers that the possibility of detection is limited, or have been restricted to deeper, cooler waters in the inter-connected lakes within the KLM watershed, or are currently absent from the KLM watershed. For 2019, consideration will be made to make the deployment of the additional methods more effective to detect fish in deeper habitats, specifically:

- Expanding underwater visual observations within deeper habitats in the inter-connected lakes between Area 8 and Lake 410.

In 2018, underwater video assessments were conducted in Area 8, Lake M4, and Lake M3. These primarily focused on the littoral-pelagic zones where Arctic Grayling have previously been documented. Visual observations from shore and from a boat, as well as snorkelling surveys, were also conducted at these lakes but were limited to the shorelines due to visibility. While these assessments are effective for confirming Arctic Grayling present in the targeted locations sampled (i.e., up to about 4 to 5 m depths), they did not address the presence of Arctic Grayling that may now be utilizing deeper and cooler habitats within the pelagic zones of these lakes. To improve the potential for visual detection, visual surveys will be expanded in 2019 with the use of underwater drone searches within Area 8, Lake M4 and Lake M3. De Beers will conduct these surveys in the 2019 summer field program, which will replace the pole-mounted method used in 2018.

5.2.2 2019 Special Effects Study - Flow Augmentation Assessment

The DFMP (Golder 2012) was developed specifically for Arctic Grayling migration and spawning, but also to be protective of species such as Slimy Sculpin and Northern Pike. The Flow Augmentation Assessment was initiated, in part, in 2018, as an action under the 2017 AEMP Response Plan, and a flow mitigation pumping plan was developed for 2018. In the Board's direction dated March 29, 2018, De Beers was to include a special effects study in 2018 to:

- Assess if low water and the diversion from Lake N11 is of sufficient volume or at the right time to support spawning of Arctic grayling
- Determine if diversions from Lake N11 would be required on a more frequent basis other than the existing frequency which was to ensure Arctic grayling spawning

These questions were included as a component of the Flow Augmentation Assessment, which was intending to rely on the flow monitoring results from 2018 to incorporate into the analysis. However due to the operational challenges, as summarized in the 2018 Response Action Summary (De Beers 2018b), further information and review of flow data is still required. Additional mitigation measures in the form of infrastructure upgrades have been implemented (e.g., the installation of permanent diffuser in Area 8 that possesses heat-traced pipeline) or are planned (e.g., upgrades associated with the Lake N11 intake and pumps) to increase potential for the successful implementation of the downstream flow mitigation for the 2019 open-water season.

A draft of the Flow Augmentation Assessment memo using 2015-2018 data, completed as an action under the 2017 AEMP Response Plan, will be submitted to the Board prior to June 1, 2019. In summary, this assessment includes (De Beers 2018a):

- Evaluation of the existing flow monitoring methods to determine if improvements to data capture and analysis are required to allow for real-time assessment and operational adjustments to pumping targets
- Evaluation of the operational flow mitigation pumping activities to determine if improvements or changes to the pumping system are required to achieve the downstream flow conditions necessary to support (and potentially to re-establish) the Arctic Grayling population downstream of Area 8

At the completion of the 2019 monitoring year, the Flow Augmentation Assessment conclusions will be reviewed to determine the effectiveness of the 2019 pumping program. Updates to the assessment and recommendations will be integrated based on 2019 results, as warranted. Details of the 2019 flow augmentation assessment will be summarized in the 2019 AEMP Annual Report.

5.2.3 Revise the Low Action Level Criteria, if Warranted and Scientifically Defensible

No revisions were made in 2018. Changes to the AEMP will be recommended in the AEMP Re-evaluation report, which will incorporate the findings of this AEMP Response Plan and those in the approved 2017 AEMP Response Plan (De Beers 2018a).

5.2.4 Set Site-specific Benchmarks, if Appropriate

No site-specific benchmarks are required for the fish habitat and community Action Levels.

5.2.5 Set Moderate and High Action Level Criteria, if Warranted and Scientifically Defensible

As directed by the Board, only the Moderate Action Level trigger for flow mitigation was revised for Version 2 of the AEMP Response Plan in 2018 (De Beers 2018a). The Moderate Action Level for flow mitigation was set in 2018 and remains unchanged in 2019.

Arctic Grayling was originally selected as an indicator species for the remaining fish population downstream of Area 8 (including fish species such as Northern Pike). As directed by the Board, the High Action Level was to be evaluated and set after 2018, or when there is a better understanding of the issues associated with Arctic Grayling presence, distribution and population, downstream of Kennady Lake (De Beers 2018a).

With the Moderate Action Level being associated with the sustained absence of a fish species downstream of Kennady Lake (De Beers 2018a), the High Action Level needs to be triggered prior to exceeding the threshold of ecological significance. However, with the sustained absence of Arctic Grayling already confirmed for 2017 and 2018, additional triggers related to this species would not provide any additional insight on potential project effects to fish habitat if Arctic Grayling are already absent from the KLM watershed. The Moderate Action Level trigger needs to be confirmed in 2019 and the absence of Arctic Grayling from the KLM watershed still needs further confirmation. To this end, an additional species with relatively consistent catch record in the inter-connected streams in the KLM watershed is recommended to be used as part of the High Action Level trigger.

Low and Moderate Action Level triggers remain focussed on Arctic Grayling, and as such, De Beers considers the further use of Arctic Grayling as a High Action Level trigger to be invalid, given the current situation, and as such is proposing to substitute this species for the high-action level in order to detect the potential for ecosystem-level changes. Consideration was made to use either Northern Pike or Slimy Sculpin, the two species most consistently observed in the KLM watershed. Northern Pike are not a true stream-dependent species and in the case of the watersheds downstream of Area 8, this species is an opportunistic predator that follows food, rather than being restricted to a specific habitat area. Available spawning and feeding habitats for Northern Pike are available in lake habitats of the KLM watershed. Therefore, the use of Northern Pike for a High Action Level trigger may not provide further insight as to the suitability of the Downstream Flow Mitigation measures in that their use of stream habitat may be a feeding response, rather than a response to habitat conditions. Similarly, neither Burbot or Lake Trout were considered to be appropriate given their preference for lake habitat within the KLM watershed (and primarily in deep habitats of Kennady Lake pre-development) and their low pre-development abundance in the downstream lakes/streams.

De Beers viewed the next most-appropriate species as Slimy Sculpin, which is a stream-dependent species and is commonly found during electrofishing surveys conducted in 2018. While Slimy Sculpin was not

identified as a Valued Component (VC) in the Environmental Assessment, its preference for stream habitat over lake habitat makes it the most suitable choice for assessing the effectiveness of flow augmentation on stream habitat conditions. Since this species is more stream dependent, it would be more susceptible to changes in stream habitat conditions than the remaining VCs that are currently present in the lake habitats in the KLM watershed. Slimy Sculpin continue to be found in all stream habitats in the KLM watershed, would rely on suitable flow conditions for food production and spawning, and are expected to be a good indicator of ecosystem function in response to the Downstream Flow Mitigation and in the absence of Arctic Grayling.

A limiting factor in establishing Slimy Sculpin as an indicator is the lack of site-specific baseline data on Slimy Sculpin densities and distribution as this species was not typically the focus of prior sampling efforts. Although comparison to a reference site is possible, the pre-development conditions or differences would be unknown. However, with the continued application of the Low and Moderate Action Levels, this should not be a constraint in defining a High Action Level based on Slimy Sculpin moving forward.

As such, the High Action Level trigger is proposed as:

Slimy Sculpin density shows a statistically significant temporal trend showing decreasing densities over time across a four-year period within the KLM watershed and relative to a reference site.

The hypothesis around this High Action Level is that fish density may fluctuate around a normal range of variability but should be relatively stable over time if conditions are suitable. Previous sampling efforts have identified the presence of Slimy Sculpin throughout the KLM stream; however, sampling was not conducted such that an estimate of density, either pre-development or from recent surveys, can be made that would serve as a suitable comparison to future monitoring.

To define the High Action Level, a focussed study design will need to be implemented in the 2019 field season during the summer field program and carried forward into future AEMP monitoring years. Multiple sampling sites, approximately 10 m in length, will be established throughout the KLM streams (n=9), located within similar habitat conditions that support Slimy Sculpins, namely riffle habitats with relatively shallow water (less than 30 cm depth) and gravel and cobble substrates (Evans et al. 2002). Additional sites will be established at a reference stream (n=3) located downstream of Lake 410. Each sampling site will be isolated with block nets, and three-pass removal electrofishing will be conducted to obtain a density estimate for each site. Habitat conditions (depth, velocity and substrate composition) will be documented at each site to confirm similarity in habitat conditions.

To examine whether there is any significant change in the density of Slimy Sculpin per sites in the KLM streams compared to the reference streams, the density of Slimy Sculpin among sites will be examined using one-way ANOVA (analysis of variance). Prior to statistical analyses, the assumptions of parametric tests such as normality will be evaluated, and data transformation and equivalent non-parametric tests will be considered. However, since the baseline conditions were not defined or compared between the KLM sites and the reference sites, a temporal analysis is proposed for the High Action Level. Two-way ANOVAs will then be used to investigate if density of Slimy Sculpin differ over time and if a declining trend can be detected within the KLM streams and relative to the reference sites. A minimum of four years of monitoring is proposed to allow for a reliable identification of a trend and to account for expected natural year-to-year variability.

5.2.6 Assessment of Arctic Grayling Return to Kennady Lake during Post-Closure

This assessment is being addressed, in part, as a component of the flow augmentation assessment to understand the potential for Arctic Grayling to recolonize Area 8 (and thus Kennady Lake post-closure). The findings will be incorporated in the AEMP Re-evaluation Report. Any changes to the conclusions, based on the results of the 2019 monitoring program, will be incorporated into the 2019 AEMP Report.

The results of the 2019 Flow Augmentation Assessment will be needed prior to help support the analysis for conditions that may be required to allow for Arctic Grayling to become re-established during operations or closure. Options to consider may include the need for physical reintroduction of Arctic Grayling. Additional information that is still being evaluated as part of the assessment are results from the University of Waterloo large-scale migratory study that De Beers funded and is still in the process of being analyzed. Any newly proposed mitigation measures will be presented in the AEMP Re-evaluation Report.

5.2.7 Identify Mitigation(s) to Stop or Slow Trend, and Implement Mitigation(s), where Applicable

This Response Action is being addressed with the flow augmentation assessment to determine whether the current flow augmentation is adequate, and will be concluded in 2019. Due to the absence of Arctic Grayling in 2018, mitigation options are being investigated and identified which would possibly allow Arctic Grayling to return to Area 8 during operations.

These will be incorporated in the AEMP Re-evaluation Report. Any changes to these, based on the results of the 2019 monitoring program, will be incorporated into the 2019 AEMP Report.

5.3 Timeline

Any changes to the AEMP Action Levels will be incorporated into the AEMP Re-evaluation Report. Any changes to these, based on the results of the 2019 monitoring program, will be subsequently incorporated into the 2019 AEMP Report.

5.4 Projection of Environmental Responses

De Beers will review existing data on the downstream fish habitat and community in the AEMP Re-evaluation Report. Prior to any mitigation or contingency, it is unknown at this time whether Arctic Grayling will be observed within the KLM watershed during operations and thus a projection of environmental response is not provided.

5.5 Monitoring Plan

Monitoring will continue as described in the AEMP Version 5 for 2019, with the same extension of the geographic extent of the study area as described in 2018 (i.e., monitoring in Area 8 itself and the downstream KLM lakes and streams, up to and including a portion Lake 410, near the Stream M1 inlet and Lake 410 outlet channel) and inclusion of the underwater drone surveys. Electrofishing effort will continue with a minor revision to include replicate sites and reference sites where closed, three-pass removal electrofishing will be completed to estimate Slimy Sculpin density. No further field monitoring is proposed.

5.6 Reporting Schedule

A technical report presenting the results of the 2019 monitoring program described herein will be submitted to the Board on December 1, 2019. The results will be incorporated, as necessary, in the 2019 AEMP Report. The outstanding items which form part of the approved 2017 AEMP Response Plan (De Beers 2018a) will be presented the AEMP Re-evaluation Report. A conformity table, as detailed below, will be included in the AEMP Re-evaluation Report.

Items to be Submitted in the Re-evaluation Report	
1.	Flow augmentation results and study including Downstream Flow Mitigation Plan methodology and monitoring to ensure flows are adequate for all species of fishes
2.	An assessment of potential losses to Arctic Grayling productivity that has occurred in the downstream reaches of Kennady Lake including losses to be expected should Grayling not return in 2019 and beyond
3.	Mitigation/contingency response actions should Arctic Grayling not return during operations. Given their relevance to significance thresholds and EIR predictions and commitments, these works should be clearly identified and highlighted within this report along with timelines and milestones for reporting and implementation (e.g. pilot tests/studies)
4.	Assess the return of Grayling post-closure and address ENR's recommendation including: <ol style="list-style-type: none"> a. details on the ability of any remnant downstream populations to repopulate Kennady Lake; b. flow restrictions that may be present post-closure; and c. in addition, how the successful recolonization of this species may be impacted due to the length of their absence from the system between Area 8 and Lake 410 (e.g. the likelihood of populations to re-inhabit spawning areas after prolonged absences)
5.	Provide mitigation measures for physical reintroduction of Arctic Grayling and address ENR's recommendation to provide long-term studies to better understand options of re-introducing Arctic Grayling into Kennady Lake post-closure
6.	An updated graph of Summary of Flows (2015-2018) at the Area 8 Outlet and associated flow augmentation assessment
7.	An assessment of how observed flows at the Area 8 compare to any other hydrological information in the area

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