A Review of the 2016 Diavik Diamond Mine Wildlife Monitoring Report and 2017 Wildlife Comprehensive Analysis Report

Prepared for

Environmental Monitoring Advisory Board

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Executive Summary

Summary and Recommendations

In this review on behalf of The Environmental Monitoring Advisory Board (EMAB or the Board), Management and Solutions in Environmental Science (MSES) assesses the procedures and results of the 2016 Wildlife Monitoring Report (WMR; Golder 2017a) and the 2017 Wildlife Comprehensive Analysis Report (WCAR; Golder 2017b). A WMR is completed annually while a WCAR is completed every three years. The annual data collection is mandated to follow a Wildlife Monitoring Program (WMP), developed in 2002, which determined the testable questions and the objectives that need to be addressed through the life of the project. The WMP is a requirement of the Diavik Environmental Agreement which is an agreement between DDMI, local Aboriginal groups and the federal and territorial governments that formalizes Diavik's environmental protection commitments. Review of the WMRs assists the Board in partially fulfilling its mandate as outlined in the Diavik Environmental Agreement. In the course of the past 14 years, MSES reviewed the WMRs to evaluate how the WMP was and is adhered to. In the course of 2010, MSES participated in several communications with Diavik Diamond Mine Inc. (DDMI) and other parties where a number of recommendations were discussed in workshops and other venues to adapt the data collection in light of the information available at the time (Handley 2010). These recommendations, in part, altered the objectives of the 2002 WMP which are now reflected in the WMRs since 2011. Specific to grizzly bear, the monitoring objective was revised once again at a March 2013 Wildlife Monitoring Workshop hosted by the GNWT (GNWT 2013). Below we have summarized our key review findings for the 2016 WMR and 2017 WCAR.

The overall disturbance of vegetation types remained at or below predicted levels in 2016, with four ELC types, riparian shrub, esker complex, bedrock complex, and boulder complex, at or slightly exceeding the predicted loss.

The 2016 WMR included a "2016 Comprehensive Vegetation and Lichen Monitoring Program" report in Appendix I. The vegetation and lichen monitoring programs concluded that the Mine may be having local-scale effects on plant species composition and that metal concentrations in lichen were statistically higher near the Mine than farther away, though lower overall in 2016 compared to 2010 and 2013. A constructive discussion regarding adaptive management, taking the most recent data and analyses into account, would be useful for future project-specific and regional management of impacts to vegetation and lichen. DDMI concluded that concentrations of metals in lichen will be within a safe level for caribou; however, we have requested additional information that would support this conclusion.

Direct loss of caribou habitat is still in line with the original predictions. However, the Project may be contributing to indirect loss of caribou habitat through changes in vegetation next to the Mine site. Indirect habitat loss for caribou was not specifically addressed in the 2016 WMR or 2017 WCAR.

Aerial surveys for caribou have not been completed since 2012. Based on previous detailed analyses, there appears to be a zone of influence (ZOI) for caribou occurrence, where caribou are more likely to occur at about 14 km from the Mine than closer to the Mine. In the 2017 WCAR, DDMI evaluated the caribou aggregation at 14 km using caribou density information. The new analysis of caribou density implies that

there is no caribou ZOI or a small ZOI. However, we have asked for additional details regarding the dataset and the statistical methods used in the density analysis. We are left uncertain as to whether or not the 14 km ZOI is accurate and whether the WMP objective has been adequately tested. A Government of the Northwest Territories (GNWT) Caribou Zone of Influence (ZOI) Technical Task Group was led by ENR in 2014 to discuss conditions under which aerial surveys should be resumed. A ZOI Draft Guidance Document was developed in March 2015 that outlines the conditions under which monitoring ZOI is technically appropriate. Once finalized, this ZOI Guidance Document may provide direction on when or if aerial surveys should be resumed or if other studies would better address the caribou ZOI issue. DDMI is currently waiting for recommendations and direction from this technical task group regarding aerial surveys. No timeline was provided for the finalization of this guidance document. There is a widening gap in aerial caribou data collection (2012-2016) and still no clear indication as to whether aerial surveys will be resumed or how the ZOI prediction for the Diavik Mine will continue to be tested, monitored, and managed. As such, it is not clear if or how the purpose and guiding principles in the Diavik Environmental Agreement are being met with regards to caribou movement.

Caribou behaviour data were collected but not analyzed in the 2016 WMR or 2017 WCAR. DDMI will undertake additional analyses of ground-based behavioural data when sufficient data are available. A comprehensive analysis of caribou behaviour data was last completed in 2011. Diavik and Ekati are cooperating on behavioural data collection, but combined data and analyses have not been presented. There was some discussion in the past about the Cumulative Impacts Monitoring Program (CIMP) leading a behaviour monitoring task group, but there is no new information on the status of this group. There is now a four-year gap in caribou behavioural data analysis (2012-2016) due to insufficient near-Mine data.

Analysis of caribou collar data with respect to seasonal movement was included in the 2017 WCAR. In 2016, male and female caribou distribution followed the predicted pattern for the northern (spring) migration; caribou deflected west of East Island. However, for the southern migration, most male and female collared caribou travelled west around Lac de Gras, which does not support the prediction in the Environmental Effects Report (EER). The last three years of collar data (as per the WMRs) indicate a departure from predictions for the southern migration. However, DDMI found that overall, across all years, significantly more caribou (63%) travelled east during the southern migration, providing general support for the south migration prediction. However, we have asked for additional details and made recommendations regarding the statistical methods used in the analysis. DDMI offered some discussion on potential causes for these new distributions, but in general, a constructive discussion regarding adaptive management, taking the most recent data and analyses into account, would be useful for future project-specific and regional management of impacts to caribou.

For grizzly bears, little new information was provided. Both mortality and habitat loss remain at or below the levels predicted. The 2016 incidental data seem to suggest that the occurrence of grizzly bears near the Mine is increasing over time. The grizzly bear hair-snagging program providing DNA data could address a regional scale question about the bear population. The hair-snagging program was not undertaken in 2014 through 2016 and the next sampling program is scheduled to occur in 2017.

For wolverine, there appears to be support for the prediction that mining related mortalities are not expected to alter wolverine population parameters in the Lac de Gras area. A comprehensive analysis of wolverine track data was included in the 2017 WCAR. Considering all of the results currently available

relating to wolverine, it is difficult to determine any cause or effect regarding apparent increases in the probability of wolverine occurrence over time. It could be that recent increases in occurrence are related to an increase in the abundance of wolverines in the study area. Unfortunately, we do not have 2016 information on wolverine abundance in the study area (hair snagging program) and we are waiting for analysis of the 2014 data from ENR. The next sampling program is anticipated to occur in 2017.

There do not appear to be any new findings or changes of note regarding the presence and productivity of falcons. One falcon mortality was recorded on the Mine site in 2016. We concur with DDMI's recommendation to continue Pit Wall/Mine Infrastructure monitoring for nesting raptors.

Attractants at the Waste Transfer Area (WTA) and Landfill area in 2016 are more or less consistent with 2015 levels. In 2016, misdirected waste was reported for the new A21 Area. There appeared to be a high number of misdirected food items for the A21 Area (relative to the other inspected areas) and observations of wildlife (fox and wolverine) were highest for this area. While the overall effect of waste management appears to be positive (fox numbers at the WTA are lower than previous years), the new A21 Area appears to be attracting higher numbers of wolverine and fox. This may be contributing to wildlife (particularly wolverine) presence and possible habituation near the Mine site.

As expected, there was no new information regarding the abundance and species composition of waterfowl and shorebirds in the 2016 WMR. It was agreed that the waterfowl monitoring program be discontinued in December 2013, but CWS did recommend that DDMI re-start the waterbird/shorebird monitoring program at the Mine reclamation stage.

As expected, no wind farm associated bird mortality information was presented in the 2016 WMR. Given the low likelihood of avian-turbine strikes, due to location and size of the wind farm, and the absence of bird mortalities in 2013, we agreed with DDMI's recommendation to discontinue monitoring the wind farm using 2013 methods and to instead monitor for bird mortalities as part of the overall site compliance monitoring program.

In the past, the measurements have adequately addressed the predictions at hand and the analysis of the data yielded a great deal of credible information about the effectiveness of mitigation measures. However, there are some widening gaps in data collection, analysis, and reporting, particularly relating to caribou and wolverine. Below, we present some highlights for the Boards' consideration; several are re-stated here from previous yearly reviews as they await future detailed data analyses. We recommend that the following issues be addressed:

1. Please discuss how the information gained from various caribou datasets could be used in terms of mitigation and adaptive management for the Diavik Mine in particular and for other future projects in the region in general. The CIMP indicated that they had proposed a project for 2015 that would "look at the mechanisms of ZOI and what mitigation methods could be used"; however, no further details on an adaptive management process were found.
2. Please give careful consideration to the interpretation of the 14 km ZOI presented in Boulanger et al. (2012). The 14 km distance may actually demonstrate an aggregation of caribou that would not exist without the mines. The 2017 analysis of caribou density implies that there is no caribou ZOI or a small ZOI. We recommend DDMI collect new data (either more aerial survey data or

a re-analysis including all collar data available to date) and complete more rigorous analyses to evaluate the caribou ZOI (e.g. present information on the distribution of the data and power of the analysis; evaluate potential confounding factors such as habitat associations, changes in mine activity over time, the gregarious nature of caribou, and evaluate the potential for non-linear relationships between variables).

3. There is now a four-year gap in aerial caribou data collection (2012-2016) and still no clear indication as to whether aerial surveys will be resumed or how the ZOI prediction for the Diavik Mine will continue to be tested, monitored, and managed. In the absence of guidance from ENR regarding when aerial surveys should be resumed or if other studies would better address the caribou ZOI issue, we ask DDMI how they plan to address the caribou movement objective while they await ENR guidance. Diavik should continue to monitor and verify the accuracy of the predictions in the environmental assessment and the effectiveness of mitigation measures. Will DDMI use all available caribou collar data to re-evaluate the ZOI associated with the Diavik Mine specifically?
4. There is now a four-year gap in caribou behavioural data analysis (2012-2016) due to insufficient near-Mine data. We emphasize the importance of these data in understanding the influence of the Mine on caribou and the mechanism that lead to the avoidance of the Mine vicinity. To potentially address the small sample size within 5 km of the Mine, we ask DDMI to provide:
    a. details on if and when behavioural data collection methods were reconciled between Ekati and Diavik,
    b. a summary of the current behavioural data available through both the Ekati and Diavik caribou behavioural programs (including caribou group size),
    c. a power analysis indicating the target sample size for near-mine observations,
    d. details on if and when behavioural data collection has occurred outside of autumn. If data were (or are planned to be) collected outside of autumn, DDMI should provide a summary of how much additional data have been collected using this protocol both near and far from the Mine, and
    e. a description of if and how non-parametric statistics have been or could be used in the analysis of behavioural data.
5. Please address the following in future detailed analysis of caribou occurrence and behavioural data:
    a. Please discuss any limitations that might result from the pooling of caribou behavioural data across years and any assumptions made in future analyses.
    b. Testing changes in caribou behaviour over time. This will require an increased sample size of behavioural observations to allow for an analysis of behavioural changes over time.
6. DDMI should complete an analysis of the indirect (in addition to the currently presented direct) footprint effect on caribou habitat for understanding the true effects on caribou and for determining future mitigation measures. This is particularly relevant given the effects of dust deposition on local plant species composition and elevated metal concentrations in lichen near the Mine.

7. Please provide information on the statistical independence of the data used in the caribou distribution analysis and a discussion of the potential response actions to the departure from the prediction regarding the southern migration of caribou and changes to the timing of the migration. Given the delayed southern migration in recent years, please redo the statistical analysis including data up to the end of November or later, if warranted. If another tool is used to evaluate the importance of deviations from predictions (i.e., overall changes in seasons range use), please describe how this evaluation is conducted. Please also explain how the presence of caribou from the Beverly/Ahiak herd is managed during the collection and analysis of caribou data.
8. Please maintain a schedule for surveying the Mine site, roads, rock piles, and Processed Kimberlite for caribou presence.
9. Please address the possibility that grizzly bears may be becoming habituated and their presence on the site may be on the rise. We eagerly await the results of proposed 2017 grizzly bear hair snagging data collection that would address the GNWT (2013) grizzly bear monitoring objective.
10. We still await the completion of the 2014 wolverine hair snagging data analysis. If more data collection and analysis is not anticipated for 2017, DDMI should describe alternative plans for evaluating wolverine abundance in the study area, as per the Handley (2010) objective.
11. Please evaluate whether the decrease in fox observations in the WTA in 2015 persists in future years.
12. DDMI should explore the reasons for the higher levels of misdirected food waste in the A21 Area as this may be contributing to wildlife (particularly wolverine) presence and possible habituation near the Mine site.
13. Please discuss the results showing an effect of the Mine on vegetation structure in reclamation and revegetation studies and discuss the implications for wildlife recolonization in terms of the likelihood for re-establishment of natural or pre-disturbance vegetation and wildlife communities.
14. Please discuss if and how potential project effects on vegetation abundance and composition could be mitigated.
15. We recommend that the established three-year monitoring schedule be continued in order to capture changes in vegetation and lichen parameters. With a return to above-ground mining activities scheduled for 2018, dust deposition and metal concentrations in lichen are likely to increase again.
16. Please provide responses to the detailed questions and comments (presented in bold font) in the body of this review report.
17. Except for our recommendations listed above, we are in agreement with the recommendations listed in the 2016 WMR and 2017 WCAR and do not recommend any actions additional to providing the information requested above.
18. We recommend that the Board accept the 2016 WMR with the understanding that the above listed questions and recommendations will be addressed in a timely fashion via communications and workshops by DDMI in the coming year. The responses to our questions and recommendations are necessary to maintain and improve the understanding of the effects of the

Mine on wildlife. Furthermore, we understand that detailed data analyses are required, as identified in our review, and that these analyses will be conducted in the near future.

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1.0 Introduction

The Environmental Monitoring Advisory Board (EMAB or the Board) for the Diavik Diamond Mine Inc. (DDMI) Project requested that Management and Solutions in Environmental Science Inc. (MSES) review and assess the procedures and results of the 2016 Wildlife Monitoring Report (WMR; Golder 2017a) and the 2017 Wildlife Comprehensive Analysis Report (WCAR; Golder 2017b). A WMR is completed annually while a WCAR is completed every three years. The WMR communicates the findings of surveys conducted during 2016 as well as DDMI's recommendations for future activities. The WCAR communicates the findings of surveys conducted during 2014-2016 through detailed analyses of the data and interpretation of the results. This comprehensive analysis of the data collected thus far is in addition to yearly wildlife reports produced by DDMI as part of the Wildlife Monitoring Program (WMP).

The annual data collection is mandated to follow a WMP, developed in 2002, which determined the testable questions and the objectives that need to be addressed through the life of the project. The WMP is a requirement of the Diavik Environmental Agreement which is an agreement between DDMI, local Aboriginal groups and the federal and territorial governments that formalizes Diavik's environmental protection commitments. Review of the WMRs assists the Board in partially fulfilling its mandate as outlined in the Diavik Environmental Agreement. In the course of the past 14 years, MSES reviewed the WMRs and WCARs to evaluate how the WMP was and is adhered to. In the course of 2010, MSES participated in several communications with DDMI and other parties where a number of recommendations were discussed in workshops and other venues to adapt the data collection in light of the information available at the time (Handley 2010). These recommendations, in part, altered the objectives of the 2002 WMP which are now reflected in the WMRs since 2011.

Based on its annual reviews of past WMRs and detailed data analyses (WCARs), MSES submitted numerous recommendations for EMAB and DDMI to consider. The present report takes past recommendations and discussions as well as the altered WMP objectives into account. Here, we review how DDMI addressed the above discussions and previous recommendations in the 2016 WMR and 2017 WCAR.

In our review below, for the ease of identifying our recommendations and requests, we highlight the **text in bold** where we specifically request actions from DDMI.

2.0 General Observations

2.1 Objectives of the Wildlife Monitoring Program

The objectives of the WMP v.2 were developed in 2002 and DDMI has anchored its monitoring reports on these objectives. For more clarity, below we re-state the objectives set forth in the WMP v. 2 of 2002 to emphasize that these objectives are the foundation and focus of our review, and that the methods and results in the 2016 WMR and 2017 WCAR, are reviewed in light of these objectives, as amended in 2010.

"The objectives of the wildlife monitoring program are to:

a. Verify the accuracy of the predicted effects determined in the Environmental Effects Report (Wildlife 1998) and the Comprehensive Study Report (June 1999); and

b. Ensure that management and mitigation measures for wildlife and wildlife habitat are effective in preventing significant adverse impacts to wildlife."

A number of specific questions that have been tested in the course of the years of monitoring have been found to be either largely answered or ineffective for the testing of mitigation effectiveness, prompting discussions about adapting the objectives of data collection in light of current information (Handley 2010). Specific to grizzly bear, the monitoring objective was revised once again at a March 2013 Wildlife Monitoring Workshop hosted by the GNWT (GNWT 2013). The new grizzly bear and wolverine objectives are to provide estimates of grizzly bear and wolverine abundance and distribution in the Diavik Wildlife Study Area over time. The new barren ground caribou monitoring program objectives are to determine whether the zone of influence changes in relation to changes in Mine activity and whether caribou behaviour changes with distance from the mines. The new objectives of the falcon monitoring program are to contribute data to the Canadian Peregrine Falcon Survey (CPFS), identify any pit wall or infrastructure nesting sites, determine nest success and deterrent effectiveness, and determine cause of any Mine-related raptor mortalities.

2.2 The State of Current Information

The 2016 WMR includes a discussion of effects on wildlife from the previous year and a new detailed vegetation and lichen data analyses in Appendix I. The 2017 WCAR includes detailed wildlife data analyses for barren-ground caribou (seasonal movement) and wolverine (distribution through time and space). The 2017 WCAR also addresses two of EMABs previous requests regarding caribou density and Mine activity indices. Other analyses are either awaiting the availability of sufficient data to perform the appropriate analyses (e.g., caribou behaviour), have had data collection suspended (e.g., caribou aerial surveys for evaluating Zones of Influence (ZOI)), or have adopted an alternative study design (e.g., grizzly bear hair snagging for evaluating abundance and distribution). Grizzly bear and wolverine hair snagging programs are not intended to assess Mine-related effects.

For the reader of this review, however, we re-state some of the highlights in the previous years' reviews, in addition to results from the current review, as this is the currently best available information on trends and data quality:

- The detailed analyses conducted in past years were generally well presented and informative. We would like to note that some of the recommendations made in previous years have been incorporated into past analyses. We would like to commend the authors for including more detail in the analytical results when sufficient data were available.
- Caribou habitat loss remains at or below the levels predicted. Based on previous detailed analyses, the finding for caribou was that there appears to be a ZOI for caribou occurrence where caribou are more likely to occur at about 14 km from the Mine than closer to the Mine. However, a 2016 analysis of caribou density implies that there may not be ZOI and we are left uncertain as to whether or not the zone of influence objective has been adequately tested. A potentially important finding from past detailed analyses was that caribou groups with calves spend less time feeding and resting within 5 km of the Mine than farther away. This suggests that caribou behaviour and potentially the energy balance of young caribou is affected within that distance. DDMI will undertake additional analyses of ground-based behavioural data when sufficient data are available.

Overall, caribou migration patterns are continuing as predicted, though in recent years the southern migration appears to have occurred further west and remained further north than anticipated.

- For grizzly bears, both mortality and habitat loss remain at or below the levels predicted. Incidental observations suggest there may be an increasing number of grizzly bear occurrences, number of days with bear visitations, and number of days with deterrent actions over time. The grizzly bear hair-snagging program DNA results could address a regional scale question about the bear population. The next Grizzly bear hair snagging data collection is scheduled for 2017.
- For wolverine, mortality remains low. A comprehensive analysis of wolverine track data was completed in 2016 which shows that the probability of wolverine occurrence has increased over time. However, occurrence is not related to the number of workers on site and is negatively related to the amount of waste rock hauled. Incidental observations of wolverine were lower in 2016 compared to 2015, but still notably higher than previous years. An understanding of overall wolverine abundance in the study area may shed light on these relationships; however, the wolverine hair snagging program was not completed in 2016 and it is not clear when the next analysis of wolverine hair snagging data will be available.
- Past monitoring data seemed to indicate that fox presence at the Waste Transfer Area (WTA) may be levelling off at a higher occurrence than has been recorded in early years; although in 2016, the number of fox observations in the WTA appears to have decreased compared to 2015. In 2016, misdirected waste was also reported for the A21 Area (new dike) and the underground area. There appeared to be a high number of misdirected food items for the A21 Area relative to the other inspected areas. Observations of fox and wolverine were highest for this area.
- For falcons, the new objectives seem reasonable as they potentially contribute to a better regional understanding of falcon populations. However, the CPFS was discontinued in the NWT in 2015; therefore, DDMI will no longer be providing nest site occupancy and productivity data to the Canadian Wildlife Service (CWS). Pit walls and other infrastructure are still monitored for nesting raptors and nest monitoring data are still contributed to ENR every 5 years.

While DDMI has incorporated some of our recommendations or questions from previous years, others remain unaddressed. Table 1 summarizes the current status of our 2016 recommendations.

Table 1: Actions by DDMI in Response to Recommendations that were developed in 2016 or carried over from previous years.

Recommendations/Questions in 2016	Action by DDMI
Vegetation and Wildlife Habitat	
The issues investigated in the Dust Deposition to Lichen study should be integrated with the WMR lichen study. We recommend that details of future monitoring plans for lichen be provided, such as frequency and timing of monitoring, and integrated	A 2013 and 2016 Comprehensive Vegetation and Lichen Monitoring Program reports address this recommendation. The 2016 report has recommended that monitoring frequency be reduced from every 3 years to every 5 years.

with the results provided in the WMR to form a comprehensive vegetation monitoring program.	
The 2013 Comprehensive Vegetation and Lichen Monitoring Program report concludes that "*the Mine may be having local-scale effects on plant species composition*". The report does not suggest any strategies that could mitigate these effects. Please consider if and how these potential project effects could be mitigated.	A comprehensive analysis of vegetation and lichen data was completed as an Appendix of the 2016 WMR. The same conclusion was reported, but no discussion of potential mitigation measures was provided.
The 2013 Comprehensive Vegetation and Lichen Monitoring Program report stated that mercury concentrations were statistically lower near the Mine than farther away in both 2010 and 2014. No discussion on this finding was presented. Please discuss possible causes of this pattern in mercury concentrations and what effects this may have on caribou ingesting lichen far from the Mine.	A comprehensive analysis of vegetation and lichen data was completed as an Appendix of the 2016 WMR. No discussion regarding this concern was provided and the results for mercury in Figure 3.3-2 appear to show that mercury is lower in the far field than near the Mine for 2010 (opposite of the results noted in the 2013 report). An explanation should be provided.
Barren-Ground Caribou	
Discuss the implications of a larger than expected effect on caribou for future environmental management.	No discussion was provided in the 2015 or 2016 WMR. During the Slave Geological Province Wildlife Monitoring Workshop (Dillon 2015), a meeting participant noted that monitoring ZOI has not changed how the mines operate. The CIMP indicated that they had proposed a project for 2015 that would "look at the mechanisms of ZOI and what mitigation methods could be used"; however, no further details on adaptive management were found. The discussion of potential adaptive management measures is still open.
What is the actual size of the larger caribou ZOI, 14 or 28 km?	Boulanger et al. (2012) conclude a zone of influence of 14 km. We question the interpretation of the "zone of influence". We think the 14 km distance actually demonstrates an aggregation of caribou that would not exist without the mines, a phenomenon much like the one found for woodland caribou (Fortin et al. 2013). In the 2017 WCAR, DDMI evaluated the caribou aggregation at 14 km using caribou density information. The new analysis of caribou density implies that there is no caribou ZOI or a small ZOI. We are left uncertain as to whether or not the 14 km ZOI is accurate and whether the WMP objective has been adequately tested. DDMI should collect new data and complete more rigorous analyses to evaluate the caribou ZOI.
What is the effect of Mine closure on caribou range re-establishment? Are data collected to date sufficient to show a change of caribou distribution in light of the uncertainty of the size of the large ZOI? Also current baseline (pre-disturbance) information is poor, rendering conclusions on changes from pre- to post-disturbance inconclusive. Does DDMI believe that the	The issue was discussed verbally in 2013 and DDMI admitted that it is possible that the currently observed ZOIs (14 km; Boulanger et al. 2012) may have always existed. DDMI confirmed that true baselines do not exist. Using TK instead was suggested for discussion. No further discussion provided in the 2016 WMR.

current data quality is sufficient to show a potential reversal of the effects after closure?	
Testing the changes in caribou behaviour will be critical for the new approach to testing the effects within the ZOI that was predicted in the EER (3-7 km). Please provide an analysis of the behavioural data and comment on whether or not behavioural data collected previously can be used. How can the information on behaviour be used to adapt management actions at the Mine and in the region? A detailed technical side-bar discussion may be useful for us to better understand the assumptions and expectations by DDMI.	Analysis of caribou behavioural data was last undertaken in 2010 using data from all years. Caribou with young feed and rest less within 5 km of the Mine. There was no update regarding caribou behaviour from 2013 to 2016. Data were insufficient for analysis. During the Slave Geological Province Wildlife Monitoring Workshop (Dillon 2015), ENR was tasked with identifying broad monitoring objectives and a terms of reference for a caribou behaviour monitoring task group. This group could potentially pursue regional collaboration on behavioural data and analyses. No timeline was provided on when this task group is expected to be in place. Diavik and Ekati are cooperating on behavioural data collection, but combined data and analyses have not been presented in the 2016 WMR or 2017 WCAR.
We recommend DDMI provide a more detailed explanation and justification as to why they propose postponement of aerial surveys "in favour of other studies". DDMI should also indicate what "other studies" would examine regarding mechanisms that may cause caribou to avoid the Mine.	In the 2016 WMR, DDMI indicated that it is still waiting for the recommendations and direction regarding caribou aerial surveys from the ZOI Technical Task Group. A ZOI Draft Guidance Document was developed in March 2015 that outlines the conditions under which monitoring ZOI is technically appropriate. Once finalized, this document may provide direction on when or if aerial surveys should be resumed or if other studies would better address the caribou ZOI issue. No timeline was provided on when this document is expected to be finalized.
We recommend that the ideas to evaluate caribou health and to ask traditional knowledge holders about the behaviours that should be included in the observation protocol should be carefully considered, particularly from the point of view that the health of wide ranging animals are a result of many factors that occur in the region through which they range. Future discussions about these ideas could be fruitful.	No discussion was provided.
Is group composition data not collected anymore?	Group composition data were collected in 2014, 2015, and 2016. Diavik will continue to collect data and further analysis will be undertaken when sufficient data are available. Data were insufficient within 5 km of mining activities. DDMI will coordinate activities with Ekati. This request is satisfied.
Testing the distribution and abundance of caribou with careful consideration of the confounding factors of land area and land pattern in each of the zones would be beneficial. A useful number to interpret the caribou abundance results may be a density of caribou on the land area. Is DDMI willing to present such numbers during the next presentation of results?	In the 2017 WCAR, DDMI evaluated the caribou aggregation at 14 km using caribou density information. The results showed that distance to a Mine footprint explained very little of the variation in caribou density. A power analysis would confirm this result. We recommend inclusion of potential confounding variables in future analyses.

DDMI concludes that 2,549 caribou were observed in the Diavik wildlife study area (in 2009). Please clarify if this number is based on the 15 % coverage. If so, then wouldn't this mean that there was a higher density of caribou observed in 2009 compared to previous years because in previous years a larger area was surveyed (having used a 4 km interval between transects before 2009)?	DDMI acknowledge verbally (phone conversation in Summer 2010) that this may be the case but no discussion of this potential confounding issue was presented in the 2016 WMR.
We suggest that an analysis of the indirect (in addition to the currently presented direct) footprint effect on caribou habitat may be useful for understanding the true effects on caribou and for determining future mitigation measures.	The WCAR (Golder 2014) objective was to complete a comprehensive analysis of radio-collared caribou data to examine indirect Mine-related effects. Consideration of caribou habitat (resource selection function (RSF) values) was guided heavily by previous research on caribou. As we have not had the opportunity to review these documents, we cannot determine whether or how indirect habitat loss from the Mine was addressed. No discussion is provided in the 2016 WMR or 2017 WCAR.
DDMI should justify the use of maximum average number of employees to reflect level of mining activity, possibly through correlation analyses with noise, construction, vehicle, and aircraft variables.	In the 2017 WCAR, DDMI evaluated Mine activity indices. The results showed the Full-Time Equivalents (FTEs; average number of employees per month at the Mine site) were significantly, positively correlated with the number of flights and the number blasts. There was a positive trend between FTEs and waste rock, though it was not significant. This request is satisfied.
DDMI should discuss potential causes and response action, if necessary, for a slight departure from predictions regarding caribou migration patterns.	In the 2015 and 2016 WMR, DDMI has suggested that there may be a heightened sensitivity of caribou during the post-calving period because calves are maturing and still dependent on their mothers. Therefore, the northern shift during this period may be a result of avoidance of industrial activities. DDMI did not address the second part of our request regarding response actions.
DDMI recommended a reduced survey frequency for the assessment of caribou occurrence relative to the Mine site, roads, rock piles, and Processed Kimberlite Containment (PKC). We suggest that these surveys continue at least bi-weekly to ensure no caribou are present in areas that are visually obstructed to on-site staff.	DDMI recommended reducing survey frequency because of the ineffectiveness of the surveys at detecting caribou at the Mine that were not already detected by other employees and pilots. In 2016, DDMI did not conduct road, PKC, and rock pile surveys on a scheduled basis because of their apparent ineffectiveness. We re-iterate our recommendation.
Regarding the 2014 WCAR (Golder 2014): A common concern with GPS collar data is that multiple samples from the same individual may not be statistically independent of each other. That is, one response from an individual affects the probability of another response from that same individual. Clarification is needed on how caribou GPS data independence was achieved.	No new information is presented regarding this specific analysis from the 2014 WCAR.
Regarding the 2014 WCAR (Golder 2014): Clarification is needed on whether the Government of the Northwest Territories (GNWT) Caribou Zone of Influence (ZOI) Technical Task Group is tasked with	In the 2016 WMR, DDMI indicated that it is still waiting for the recommendations and direction regarding caribou aerial surveys from the ZOI Technical Task Group.

developing new studies examining mechanisms that may cause caribou to avoid the Mine. If so, we recommend EMAB review the proposed approaches to ZOI monitoring to determine if and how they might be relevant to ongoing caribou monitoring for the Diavik Mine, specifically.	A ZOI Draft Guidance Document was developed in March 2015 that outlines the conditions under which monitoring ZOI is technically appropriate. This document may provide direction on when or if aerial surveys should be resumed or if other studies would better address the caribou ZOI issue. No timeline was provided on when this document is expected to be finalized.
Grizzly Bear	
We recommend that the hair sampling program be continued, even if other mines do not commit to it.	The 2016 WMR indicates that decisions regarding program frequency were anticipated to be determined collaboratively during wildlife monitoring workshops hosted by ENR in in 2016; however, decisions are now expected 2017. The program was not completed from 2014 to 2016, but sampling is expected in 2017.
Please give careful consideration to the possibility that bears may be becoming habituated and their presence on the site may be on the rise.	There still appears to be an increasing trend in the number of incidental grizzly bear observations over time, the number of days with bear visitations to East Island over time, and the number of days deterrent actions were utilized over time (see Section 3.3 of this report for more details). No discussion regarding the effectiveness of the deterrent system was provided. We reiterate our recommendation.
Given the increase in grizzly bear observations near the Mine, DDMI should increase vigilance and future years of data collection should be used to evaluate whether the re-instated deterrent system is effective at reducing grizzly bear presence near the Mine.	
Wolverine	
Please give careful consideration to the possibility that wolverine may be becoming habituated and their presence on the site may be on the rise.	The 2017 WCAR (Golder 2017b) presented detailed analyses that found that wolverine occurrence has increased over time. Considering all of the results currently available relating to wolverine, it is difficult to determine any cause or effect regarding apparent increases in the probability of wolverine occurrence over time. An understanding of overall wolverine abundance in the study area may shed light on these relationships; however, the wolverine hair snagging program was not completed in 2016 and it is not clear when the next analysis of wolverine hair snagging data will be available.
Regarding the 2014 WCAR (Golder 2014), it was not clear why caribou herd size was related to wolverine occurrence and how this specifically relates to objective of the WCAR "to examine indirect Mine-related effects". We recommend a brief explanation be provided.	No discussion was provided.
Waste Monitoring	
While fox observations looked to be steadily increasing in the WTA since 2009, they appear to have levelled off in 2013 (the tabular presentation of data in the 2013 WMR makes it difficult to confirm). We recommend DDMI evaluate whether this levelling-off of fox observations in the WTA persists in future years.	In 2014 through 2016, fox observations appear to have decreased in the WTA and landfill, but data are only presented in tabular form. The trend in the number of foxes should be confirmed with continued monitoring. We reiterate our recommendation.

3.0 Specific Observations

3.1 Vegetation and Wildlife Habitat

There was an increase in the Project footprint in 2016 of 0.67 square kilometres (km^2), resulting in a total footprint area of 11.22 km^2. The additional disturbance occurred at the extreme south end of the project footprint (A21 Area) where above-ground mining operations are expected to begin in 2018. The overall disturbance of vegetation types remained at or below predicted levels in 2016, with four ELC types, riparian shrub, esker complex, bedrock complex, and boulder complex, at or slightly exceeding the predicted loss.

A comprehensive analysis of vegetation and lichen data is completed every 3 years and this analysis has been included in the 2016 WMR as Appendix I. The vegetation and lichen monitoring programs assess if dust deposition from the Mine is altering the abundance and richness of plant species.

The vegetation monitoring program utilizes permanent vegetation plots (PVP) established adjacent to the Mine site (Mine plots) and on the West Island and mainland (reference plots). Dust deposition rates were found to be higher near the Mine than farther away; however, the dust deposition rates during open pit Mine construction and mining (2002 to 2005) and during open pit mining and underground Mine construction (2006-2009) were higher than during the underground mining phase (2010 to present). The permanent vegetation plot analysis suggests that vegetation composition is altered near the Mine. There is lower lichen cover (not statistically significant) and higher vascular plant species cover and richness near the Mine. The report concludes that "*the Mine is likely having local-scale effects on plant species abundance and composition*". The report does not suggest any strategies that could mitigate these effects. **Please discuss if and how these potential project effects could be mitigated.**

The lichen monitoring program evaluates metal uptake in lichen, near (near existing dustfall collector stations) and far (30-40 km) from the Mine site, due to dust deposition from mining activities. A far-far-field (~100 km from Mine site) sampling area was also sampled in 2016. There were another three sites selected by Elders in 2013 that fall between the near and far-field area in what they identified as important caribou habitat. There are four key predictions for lichen:

1. There will be metal update in lichen due to dust.
2. There will be a difference between concentrations of metals in lichen near the Mine versus 30 to 40 km from the Mine.
3. Concentrations in lichen are predicted to be similar over years.
4. Concentrations of metals in lichen will be within a safe level for caribou.

The analysis of metal concentrations in lichen found that nearly all assessed parameters were statistically higher near the Mine than farther away. These results support predictions 1 and 2 listed above. Most measured parameters had significantly lower concentrations in 2016 compared to 2010 and 2013. These results do not support prediction 3 above. This departure from the prediction is likely because the Mine has shifted completely to underground mining methods in recent years, thereby reducing dust deposition

on lichen. Most metal concentrations in the far-far-field sampling area were similar to concentrations in the far-field sampling area indicating that the far-field area provided a sufficient reference against which to compare near-Mine sites. DDMI concluded that "*given that the majority of metals concentrations have decreased below concentrations reported in the 2010 risk assessment, a follow up risk assessment based on 2016 data is not required*" (Appendix I, Section 3.6). However, in our review of the Dust Deposition to Lichen report (MSES 2011; also see Table 2 below), we commented that the risk assessment did not include information on any changes in the concentrations of metals present in caribou and humans pre- and post-exposure or how these levels of metals relate to the health of either caribou or humans. Given this information, the expectation that metal concentrations are within safe levels for caribou (and humans) is opinion and unsupported by data. **We recommend DDMI provide additional information that would support their conclusion that concentrations of metals in lichen are safe for caribou.**

The information collected through the vegetation monitoring program also is used to test and evaluate the predicted effects of the Mine. There are four key predictions for vegetation:

1. The predicted loss is 12.67 km^2 of vegetation/land cover.
2. Increased dust deposition may lead to potential change in vegetation.
3. No rare or endangered species or communities will be lost as a result of the proposed Project.
4. Community level richness is predicted to decrease by 14%; Species diversity and richness is predicted to decrease by 44%.

The effects of the Mine remain at or below predicted levels with regards to predictions 1 and 3. Prediction 2 is also accurate and it has been found that vegetation community structure, measured as plant species abundance and richness, has likely been altered due to dust deposition. With regards to prediction 4, vascular plant species richness was actually 54% higher on heath tundra plots and 9% higher on shrub Mine plots. This unexpected outcome is likely due to a higher number of graminoid species on Mine plots in the Heath Tundra and Shrub communities. The report does not suggest any strategies that could mitigate these unanticipated effects. **Please discuss if and how these potential project effects could be mitigated.**

DDMI has recommended that vegetation and lichen monitoring frequency should be reduced from once every three years to once every five years, with the exception that if dust deposition values exceed 400 mg/dm^2/y, then sampling frequency may resume on a 3-year cycle. Given that above-ground mining is anticipated at the A21 Area in 2018, we do not agree with this recommendation. Results of the vegetation and lichen monitoring programs indicated that dust deposition rates and metal concentrations decreased after mining activity shifted completely underground. With above-ground mining activities commencing once again, dust deposition and metal concentrations in lichen are likely to increase again. **We recommend that the established three-year timeframe be continued in order to capture changes in vegetation and lichen parameters.** In addition, **we recommend DDMI provide further justification for setting 400 mg/dm^2/y as a trigger for changing monitoring frequency as compared to using a trigger associated with dust deposition rates for reference stations** (as long as values are above the range of "baseline" (reference station) values, there is potential for associated impacts and monitoring should continue).

In late 2011, we had the opportunity to review the study addressing Dust Deposition to Lichen (MSES 2011). While some of the questions proposed in the Dust Deposition to Lichen review (MSES 2011) were

addressed in the 2013 and 2016 Comprehensive Vegetation and Lichen Monitoring Program reports, others remain unanswered. Table 2 presents a high-level summary of the current status of issues and concerns with the dust deposition to lichen study.

Table 2: Actions by DDMI in Response to 2011 Recommendations on the dust deposition to lichen study

Issues and Concerns (MSES 2011)	2016 Status (WMR Appendix I)
The finding that lichens sampled from four locations within 10 km of the EKATI diamond mine had mean metal concentrations greater than others sampled in the far-field suggests that it may be difficult to find locations in the study area that are remote enough to be unaffected by mine emissions. Monitoring the northwest quadrant of the far-field area could provide data on cumulative effects of diamond mining in the area. We recommend that cumulative effects of emissions be investigated.	Cumulative effects have not been evaluated. DDMI should compare near-field sites to EKATI-influenced sites to determine whether they resemble each other.
The study appears to assume that caribou ingest all lichen species at the same rate. Exposure risk values may be affected by caribou ingesting preferentially either high- or low-concentrating lichen species. We recommend that future studies investigate the possibility of selective foraging by caribou and how selective foraging may affect exposure values.	*"…the emphasis of the sampling method was to collect lichen that caribou eat, and not necessarily on obtaining the same ratio of species in each sample*." This suggests that the ingestion of different lichen species by caribou was taken into consideration in the sampling methods, to a degree. However, this approach does not allow for a quantitative evaluation of caribou ingestion rates for different lichen species. Quantitative data on caribou ingestion rates for lichen should be included in the analysis of risk exposure. This does not appear to have been addressed in the 2016 report.
We recommend that the rationale be provided for the selection of the far-field sampling area. How was the distance for the far-field sampling area determined? Is the far-field sampling area intended to represent a control area, beyond the limit of Mine dust carried by wind? Are there dustfall monitoring gauges in the far-field sampling area?	In 2016, DDMI included far-far field sites in their lichen sampling program (~100 km from Mine site). Most metal concentrations in the far-far-field sampling area were similar to concentrations in the far-field sampling area indicating the far-field area provided a sufficient reference against which to compare near Mine sites. This concern has been addressed.
Please discuss the implications of combining different lichen species into a single sample, the effect of the substrate on lichen metal concentrations, and the effect of the removal of lichen during sampling on future sampling/monitoring.	It appears that different lichen species are still combined, though only those identified by elders as potential caribou forage are collected. In 2016, soil samples were collected at the same locations as the lichen samples to evaluate exposure from inadvertent ingestion of soil by caribou, if necessary. In 2016, sampling sites were chosen within 1 km of the 2013 coordinates and determined after an aerial survey of the site for potential caribou feeding locations. Therefore, it is unlikely that the same location is sampled in subsequent years. The concerns regarding substrate and removal of lichen are addressed. No explanation was provided for how the different species may affect the average metal concentrations in

	the samples taken. This potentially obscures the exposure risk for caribou.
We recommend that the results of the two-tailed t-tests and Wilcoxon-Mann-Whitney tests be presented in the report. Further discussion regarding the source of variability in the relative percent differences (RPDs) would assist us in understanding whether metal concentrations were measured three times from identical lichen material or from three separate samples with different species mixes.	In 2016, results of the t-test and Mann-Whitney U test are presented in Appendix H. DDMI states that "*At each location, the sample was gently mixed to form a composite, and then split into two separate samples, which were analyzed separately for metals.*" Results of statistical analyses for Lichen Chemistry were provided. This request is satisfied; however, the methods described confirm the above concern about obscuring exposure risk for caribou because metal uptake and caribou ingestion rates may differ between lichen species.
We recommend that details of future monitoring plans for lichen be provided, such as frequency and timing of monitoring. It is not clear if either the cumulative effects of mine developments in the region or climate change will be assessed in future monitoring.	While the report recommends that monitoring of PVP continue and that methods for the lichen sampling remain consistent, no further details were provided and no indication was given that cumulative effects or climate change will be assessed in the future. The report has recommended that monitoring frequency be reduced from every 3 years to every 5 years.
The risk assessment does not include information on any changes in the concentrations of metals present in caribou and humans pre- and post-exposure or how these levels of metals relate to the health of either caribou or humans. Inclusion of this information would strengthen the report's conclusions.	This information was not included. The 2016 report concluded that "*given that the majority of metals concentrations have decreased below concentrations reported in the 2010 risk assessment, a follow up risk assessment based on 2016 data is not required*". The expectation that metal concentrations are within safe levels for caribou (and humans) is opinion and unsupported by data. A more accurate risk assessment that uses data from all years and is designed to assess the exposure from preferred forage lichen species is still required. The Elders documented observation that caribou do not use the near-field lichen sampling stations adjacent to the Mine to the same degree as they did prior to the development of the Mine serves to re-enforces our request for a better exposure risk analysis.

3.2 Barren-Ground Caribou

3.2.1 Habitat Loss

The 2016 WMR indicates that direct summer caribou habitat loss remains at or below predicted levels of 2.965 habitat units (HUs). No information is presented in the 2016 WMR or 2017 WCAR regarding indirect caribou habitat loss, but there is also no prediction associated with indirect caribou habitat loss.

3.2.2 Movement

The aerial survey schedule, three continuous years followed by two years off, was designed to test whether or not caribou occurrence (zone of influence) changes with changes in Mine activity. Boulanger et al.

(2012) concluded that there was a zone of influence of 14 km for caribou. A comprehensive analysis of caribou data was completed in 2014 (2014 WCAR - Golder 2014) and DDMI presented results relating to caribou GPS collar data with a focus on movement patterns. Please see Table 1 for a summary of previous recommendations that relate to caribou based on our review of the WCAR[1] (Golder 2014). No new information is presented in the 2016 WMR on changes to caribou movement and caribou movement was not analyzed in the latest WCAR (Golder 2017b).

Ekati and Diavik requested to omit the ZOI requirement for caribou monitoring in 2013. The request was approved by ENR and aerial surveys were last conducted in 2012. It appears that DDMI is still waiting for the recommendations and direction from the ENR led ZOI Technical Task Group (TTG) regarding caribou aerial surveys. A ZOI Draft Guidance Document was developed in March 2015 that outlines the conditions under which monitoring ZOI is technically appropriate (Caribou ZOI TTG 2015). The guidance document indicated that "*further analyses will be conducted to refine recommendations on sample sizes*" before report finalization. Once finalized, this ZOI Guidance Document may provide direction for when or if aerial surveys should be resumed or if other studies would better address the caribou ZOI issue. No timeline was provided for the finalization of this guidance document.

There is now a four-year gap in aerial caribou data collection (2012-2016) and still no clear indication as to whether aerial surveys will be resumed or how the ZOI prediction for the Diavik Mine will continue to be tested, monitored, and managed. There has been no analysis of caribou ZOI since 2012 (i.e. Boulanger et al. 2012). Furthermore, there has yet to be a fulsome discussion of why there is a larger than predicted ZOI or what is being done to reduce the impact. As such, it is not clear if or how the purpose and guiding principles in the Diavik Environmental Agreement are being met with regards to caribou movement.

- **Has the ZOI guidance document been finalized? If so, please provide the document to EMAB for their review. If not, please have ENR explain why not and when it is expected.**
- **What plans does DDMI have to address the caribou movement objective while they wait for guidance from ENR? Diavik should continue to monitor and verify the accuracy of the predictions in the environmental assessment and the effectiveness of mitigation measures (Article 1, 1.1(b), Diavik Environmental Agreement (2000)).**
- **While waiting for the ENR to determine best approaches to ZOI monitoring, will DDMI use all available caribou collar data to re-evaluate the ZOI associated with the Diavik Mine specifically?**

While DDMI did not address caribou movement predictions with new aerial survey data, they did evaluate the caribou aggregation at 14km using caribou density information, as requested by EMAB since 2012 (Golder 2017b). Using aerial survey data collected between 1998 and 2012 by Ekati and Diavik mines, caribou density (#/km^2) was calculated as the number of caribou observed in a 1.0 x1.2 km segment (from aerial survey transects) divided by land area (km^2; total land area per segment – water area per segment). A regression analysis evaluated the relationship between caribou density and nearest distance to the Ekati or Diavik Mine footprint. The results showed that distance to a mine footprint explained very little of the

[1] Please see MSES 2014 for a complete review of this material.

variation in caribou density. To confirm this result, **we recommend that DDMI present information on the power of the data to detect an effect.**

In order to understand the power of DDMI's analysis, we recommend that DDMI present information on the distribution of the data and the residuals from the model. There are a number of reasons to assume that the data do not meet the normality assumption of linear regression: 1) Ratio data (e.g. # caribou/area) are often not normally distributed and require transformation (e.g. log), 2) Based on review of Figure 2.1-1, it appears the dataset contains many zeroes (i.e. is zero-inflated), and 3) So many data points appearing to be below ~500 (or less) and relatively few above that threshold suggests the data are non-normal, potentially poisson or negative binomially distributed. Graphs displaying the frequency distribution of caribou density counts would be useful to address these concerns. As it is, we are left to speculate as to whether or not the assumption of normality is met, which if it is not, reduces the power of the analysis to detect a significant relationship. While it could be argued that not meeting the normality assumption for regression has a limited impact on the results, why use a potentially compromised analysis when other techniques that are better suited to the data and question at hand are available?

We have concerns about the use of a simple linear regression to examine the relationship between caribou density and distance from the mine footprint. Along with the background information we requested on the data used in the analysis**, we recommend that DDMI also provide additional details on why they chose the statistical methods they did so we can better understand the reasoning and justification underlying the analysis.** It is highly likely that the determinants of caribou presence/absence and abundance are much more complicated than simply the distance to the mine footprints, making the detection of a ZOI more nuanced than simply linear distance from the mine. Boulanger et al. (2012) recognized this and included a range of habitat predictor variables in their analysis. The DDMI analysis assumes that distance to the mine is the only thing that determines caribou habitat selection. **We recommend that future analyses using caribou density also include other potential confounding factors such as habitat associations, changes in mine activity over time, and the gregarious nature of caribou. We also recommend that DDMI evaluate the potential for non-linear relationships.**

If upon further review of the data and error distributions our suspicions are correct and the density of caribou is zero-inflated and non-normal, other statistical techniques are available that provide a more rigorous analysis of the data to address the question about the existence of a ZOI around the mines. A class of statistical models related to ordinary linear regression known as 'generalized linear models' allow for error distribution models other than a normal distribution would have more power than a linear regression that violates assumptions. This class of statistical models can also deal with zero-inflated data, which is common in ecology (Wenger and Freeman 2008). Statistical models that incorporate the zero-inflated structure of a data set can be viewed as two-part models where 1) the probability of species presence and 2) the abundance, given presence, are modelled from the same data (Wenger and Freeman, 2008). Utilizing statistical techniques such as this may alleviate concerns about the analysis presented here, and in Boulanger et al. (2012), where questions were raised about the use of presence/absence as the dependent variable in the analysis identifying a ZOI at 14 km from the mine.

The analysis of caribou density lends new insight to the topic of a caribou ZOI with respect to diamond mines. DDMI discusses some of uncertainties regarding how previous analyses (Boulanger et al. 2012) use

of caribou presence or absence over time may influence the calculation of a ZOI (bias in positive caribou detection further from the Mine) and how the new analysis of caribou density implies that there is no caribou ZOI (or a smaller ZOI than could be detected with the analysis).

As it stands, we are left uncertain as to whether or not the 14 km ZOI is accurate and whether the objective – to determine whether the zone of influence changes in relation to Mine activity - has been adequately tested. However, the Elders documented observation (WMR, Appendix I, Section 3.4.1) that caribou do not use the near-field lichen sampling stations adjacent to the Mine to the same degree as they did prior to the development of the Mine can be taken as evidence that there is some caribou ZOI associated with the Mine. Furthermore, the caribou ZOI may shift in response to the beginning of above-ground mining activities once again (expected in 2018). With a gap in aerial data collection growing, so do our concerns regarding adequate testing of the impact prediction. **This reinforces our recommendation above that DDMI continue to monitor and test predictions while they wait for feedback from ENR. Specifically, DDMI should collect new data (either more aerial survey data or a re-analysis including all collar data available to date) and complete more rigorous analyses to evaluate the caribou ZOI (e.g. present information on the distribution of the data and power of the analysis; evaluate potential confounding factors such as habitat associations, changes in mine activity over time, the gregarious nature of caribou, and evaluate the potential for non-linear relationships between variables).**

3.2.3 Behaviour

The ground-based behavior survey was designed to test changes in caribou behaviour as a function of distance from the Mine. In accordance with recommendations from a workshop in 2009 with ENR and other mines and monitoring boards (Handley 2010), DDMI adapted its monitoring program for caribou in 2010 by coordinating with BHP-Billiton's Ekati mine and implementing ground observations of caribou behaviour for 2010. Ground-based behavioural observations were conducted in 2016 in cooperation with the Ekati Mine. Observations were collected on 2 caribou groups, both >22 km from the Mine. No new analyses are presented in the 2016 WMR on changes in caribou behaviour and caribou behaviour was not analyzed in the latest WCAR (Golder 2017b) because there are insufficient data available within 5 km of the Mine (near-Mine). A comprehensive analysis of caribou behaviour data was last completed in 2011 (Golder 2011). A summary of the number of caribou groups observed at different distances from the Mine and the size, composition, and location of each caribou group were provided for 2016 (Appendix A of WMR). Appendix A does not provide any information on behavioural data collected by Ekati over 2016. DDMI indicated that they will undertake analyses of ground-based behavioural data, to assess how caribou behaviour changes with distance from the Mine, when sufficient data are available.

There is now a four-year gap in caribou behavioural data analysis (2012-2016) due to insufficient near-Mine data. We emphasize the importance of these data in understanding the influence of the Mine on caribou.

- **Please clarify whether or not Ekati and Diavik are using the same behavioural data collection methods and, if so, indicate when the mines began coordinating their methods.**

- **Given that the two mines have agreed to cooperate, please provide the current sample sizes for near and far behavioural observations for DDMI and Ekati combined. Please provide a summary of caribou group size near and far from the mine (this could assist in the interpretation of the caribou density analysis).**
- **If Ekati has sufficient data near-mine, please analyze a DDMI-Ekati combined dataset to test how caribou behaviour changes as a function of distance from the Mine. If data are still deemed to be insufficient, please present a power analysis indicating the target sample size for near-mine observations.**
- **Please describe if and how non-parametric statistics have or could be used in the analysis of the behavioural data.**
- **Given the insufficient Diavik data near-Mine, will DDMI collect data outside of autumn and use GPS collar information to collect data opportunistically? If this is already being done, please provide a summary of how much additional data have been collected using this protocol both near and far from the Mine.**
- **Please explain what triggers/criteria are used to initiate the collection of far from mine caribou behavioural observations.**
- **There was some discussion in the past about the Cumulative Impacts Monitoring Program (CIMP) leading a behaviour monitoring task group, but given the lack of information on the status of this group, we recommend DDMI continue with its own monitoring, coordination with Ekati, and data analysis until such a working group is established and operational.**

Given that analyses of change in behaviour with distance are still planned for the future, we re-state, for the record, that analyses of data should address the following:

- **Please discuss any limitations that might result from pooling of data across years, or use year as a variable in the analysis, and identify what, if any, assumptions were made.**
- **Reconcile behavioural observations with the occurrence of caribou: does behaviour change with distance as occurrence does, i.e. is behaviour "normalized" past the zone of influence of 14 km?**
- **How can the information gained from the various caribou analyses be used to adjust or develop mitigation measures if there is a larger than predicted effect of the Mine on caribou?**

While DDMI did not analyze caribou behavioural data, they did evaluate Mine activity indices, as has been requested since 2012 (Golder 2017b). DDMI tested for relationships between the monthly number of full time equivalents (FTE; average number of employees per month at the Mine site) and the monthly number of flights, monthly number of blasts, and monthly tonnes of waste rock hauled (proxy for number of trucks) using data from 2003 to 2016. The results showed that FTEs were significantly, positively correlated with the number of flights and the number of blasts. There was a positive trend between FTEs and waste rock, though it was not significant. DDMI speculated that the amount of waste rock may not be directly linked to FTEs due to the set number of FTEs required for the operation of the Mine. Overall,

the methods applied for these analyses are appropriate. We thank DDMI for presenting these analyses and we can now be confident that, in general, full time equivalents (average number of employees per month at the Mine site) are related to and likely representative of levels of mining activity and sensory disturbance.

3.2.4 Distribution

To evaluate changes in caribou distribution due to mining activities, DDMI used daily data on the geographic location of collared males and females as provided by ENR. Collars on male caribou were added in 2015; prior to this, only female caribou were collared. Analysis of caribou collar data with respect to seasonal movement was included in the 2017 WCAR. Using data collected from 1996-2016, DDMI statistically compared the proportion of caribou that moved west versus east of Lac de Gras; this was done separately for the both the northern (28 April through 30 June) and southern (1 July to 31 October) migrations (Golder 2017b). The analysis of the caribou migration in the 2017 WCAR includes collar data to the end of October, while the summary of caribou migration in the 2016 WMR includes collar data to the end of November.

In 2016, collared caribou distribution followed the predicted pattern for the northern (spring) migration; caribou deflected west of East Island (Golder 2017a). Across all years, DDMI found that significantly more caribou moved west past Lac de Gras during the northern migration (Golder 2017b). However, for the 2016 southern migration (and 2015; and 2014 for female caribou; July to 30 November), collared caribou travelled west around Lac de Gras, which does not support the prediction in the EER (Golder 2017a). However, DDMI found that overall, across all years, significantly more caribou (63%) travelled east during the southern migration, providing general support for the south migration prediction (Golder 2017b). The analysis used by DDMI to test the hypotheses about caribou movement during the northern and southern migrations is potentially flawed:

1) DDMI used a "two sample test for independent proportions" (Golder 2017b, pg. 9) to test the difference in the movement of collared caribou during their migrations, but it is not clear that they have independent samples, violating one of the assumptions of their chosen statistical test. The methods section notes that "data were obtained from the Wildlife Information Management System (courtesy of ENR), and used to track the locations of 7 to 50 cows during the northern and post-calving migrations from 1996 through 2016" (Golder 2017b, pg.9) However, it is not clear if the same animals were followed every year, or if new caribou were collared each year. This is important because if the same animals were followed from year to year, or for multiple years for a portion of the sampling period, then the samples should not be considered independent.

2) DDMI only analyzed the data once it was summed across all years. This overlooks potentially important interannual variation in migration movement by caribou during both the northern and southern migrations. There are some years when collared caribou movement patterns appear to run counter to DDMIs predictions that caribou would deflect west of East Island during the northern migration, and would move around the east side of Lac de Gras on their southern migration. Some years collared caribou use both sides of the feature, some years no caribou pass by, and some years collared caribou use the opposite side of the feature as predicted.

We recommend that DDMI provide more information on the pool of collared caribou used over the course of this study. How many separate caribou were collared? How many times did collaring occur? How many times do the same animals appear in annual counts?

We recommend that DDMI utilize statistical techniques that account for the issues noted above. Once more information on the sampling methods are provided it may be possible to identify other statistical techniques, such as mixed model approaches, that may be able to address the issues with sampling independence and annual variation noted above. Until then, the statistical results discussed in section 2.1.6 of the WCAR should not be considered conclusive.

Further to this point regarding changes in the southern migration, past analyses (Golder 2014) have found that for the southern migration from 2009 to 2013, collared caribou females remained further north than previously recorded and remained north of the Mine site through March 31st, 2014 (see MSES 2014 for complete review of this material). **Given the delayed southern migration in recent years, please redo the statistical analysis including data up to the end of November or later, if warranted (while also considering the issues noted above).** In previous years, we requested that DDMI discuss potential causes for this departure from predictions and whether or not any response action is warranted for this departure from predictions. In the 2016 WMR (and 2015), they have suggested that there may be a heightened sensitivity of caribou during the post-calving period because calves are maturing and still dependent on their mothers. Therefore, the northern shift during this period may be a result of avoidance of industrial activities. This shift could potentially become more pronounced as above-ground mining activities resume in 2018. DDMI did not address the second part of our request regarding response actions. Monitoring data have demonstrated that for the past 3 years at least, the prediction for the southern migration was not accurate. Therefore, one might conclude that the mitigation measures in place to manage impacts on caribou migration are not as effective as anticipated. An adaptive management process would identify and implement new mitigation measures to manage project impacts. As such, **we request that DDMI discuss their adaptive management process and their response action in light of this unanticipated, potential effect of the Project. DDMI should discuss the triggers for adaptive management (e.g., how many consecutive years without support for the prediction are necessary to trigger adaptive management?). If another tool is used to evaluate the importance of deviations from predictions, such as fragmentation of the caribou herd or changes to seasonal range use year to year, please describe how this evaluation is conducted Please comment on the possibility that the change in the southern migration could be an Ekati effect or a cumulative effect of industrial activities within the Bathurst caribou range.**

The 2016 WMR mentions that caribou that are most likely from the Beverly/Ahiak herd were present in the study area. **Please explain how the presence of caribou from the Beverly/Ahiak herd is managed during the collection and analysis of all caribou data.**

3.2.5 Mortality

As far as caribou mortality is concerned, the effect remains at or below predicted levels, which is that Mine-related caribou mortality is expected to be low. The methods applied for this part of monitoring are adequate. Overall, the mean population size of the Bathurst caribou herd has decreased between 1996

(349,000) and 2015 (16,000 to 22,000). To support recovery of all barren-ground caribou herds, the 2011 to 2015 NWT Barren-ground Caribou Management Strategy was developed. A new management strategy for 2016 to 2020 is under development.

3.2.6 Advisory

The caribou advisory level remained at "No Concern" in 2016. Caribou on East Island did not exceed 2 individuals at any given time. Ten incidental observations of caribou (totalling 12 individuals) were reported from February to August.

3.3 Grizzly Bears

The 2016 WMR indicates that direct terrestrial, grizzly bear habitat loss remains below the predicted level of 8.67 km^2 and mortalities associated with mining activities remain below the predicted range of 0.12 to 0.24 bears per year. The methods applied for this part of monitoring are adequate.

The monitoring objective for grizzly bear presence and distribution was revised from:

> *To determine if Mine-related activities influence the relative abundance and distribution of grizzly bears in the study area over time* (Handley 2010),

to:

> *To provide estimates of grizzly bear abundance and distribution in the study area over time* (GNWT 2013).

A grizzly bear hair snagging program is jointly completed by Ekati, Snap Lake, Gahcho Kue and Diavik mines to address this new objective. Sampling first occurred in 2012 and 2013, but the program was not undertaken in 2014 through 2016. The 2016 WMR indicates that the next sampling program is scheduled to occur in 2017. Decisions regarding program frequency were anticipated to be determined collaboratively during wildlife monitoring workshops hosted by ENR in 2016; however, decisions are now expected in 2017. Results of the 2012 and 2013 hair snagging program can be found in ERM Rescan (2014). This report was provided for review in June 2016. The objectives of the DNA program are to:

- "Generate a superpopulation[2] estimate of grizzly bears for the DNA Study Area as baseline data for trend monitoring;
- Describe the spatial and temporal distribution of grizzly bears in the DNA Study Area;
- Identify overlap with grizzly bears that were sampled in areas outside of the DNA Study Area by other surveys; and,
- Provide recommendations regarding a standard grizzly bear monitoring protocol for the NWT." (ERM Rescan 2014).

[2] In the context of mark-recapture DNA studies, the superpopulation is defined as the number of animals that inhabit the sampling grid and surrounding area (as opposed to the grid alone; Boulanger et al. 2004)(ERM Rescan 2014).

Essentially, the 2012-2013 hair snagging program is intended to provide a baseline against which future results would be compared. The 2012 and 2013 data analysis indicated a stable or increasing abundance of grizzly bears, as compared to monitoring information from the late 1990s. It should be noted that the grizzly bear data are sampled from a disturbed landscape and that this may hinder data interpretation if information on the impact of mining activity on grizzly bear abundance and distribution is wanted. We support DDMI's continued involvement in the grizzly bear hair-snagging program which is designed to address the new, regional scale question about the bear population and we look forward to seeing the results of 2017 data analyses.

There appears to be an increasing trend in the number of incidental grizzly bear observations over time (Figure 1A), the number of days with bear visitations to East Island over time (Figure 1B), and the number of days that deterrent actions were utilized over time (Figure 1C). DDMI has indicated that the number of incidental observations of grizzly bears does not appear to be influenced by the number of people on site (WMR, Section 4.2.2.2). We reiterate our previous recommendations that, **given the increase in grizzly bear incidental observations near the Mine over time, DDMI should increase vigilance and future years of data collection should be used to evaluate whether the current deterrent system is effective at reducing grizzly bear presence near the Mine**. **DDMI should discuss their adaptive management process and their response action in the case that the current deterrent system is found to be ineffective.** Current data on the abundance and distribution of grizzly bear (hair snagging program) would help inform this potential issue of increasing grizzly bear observations over time.

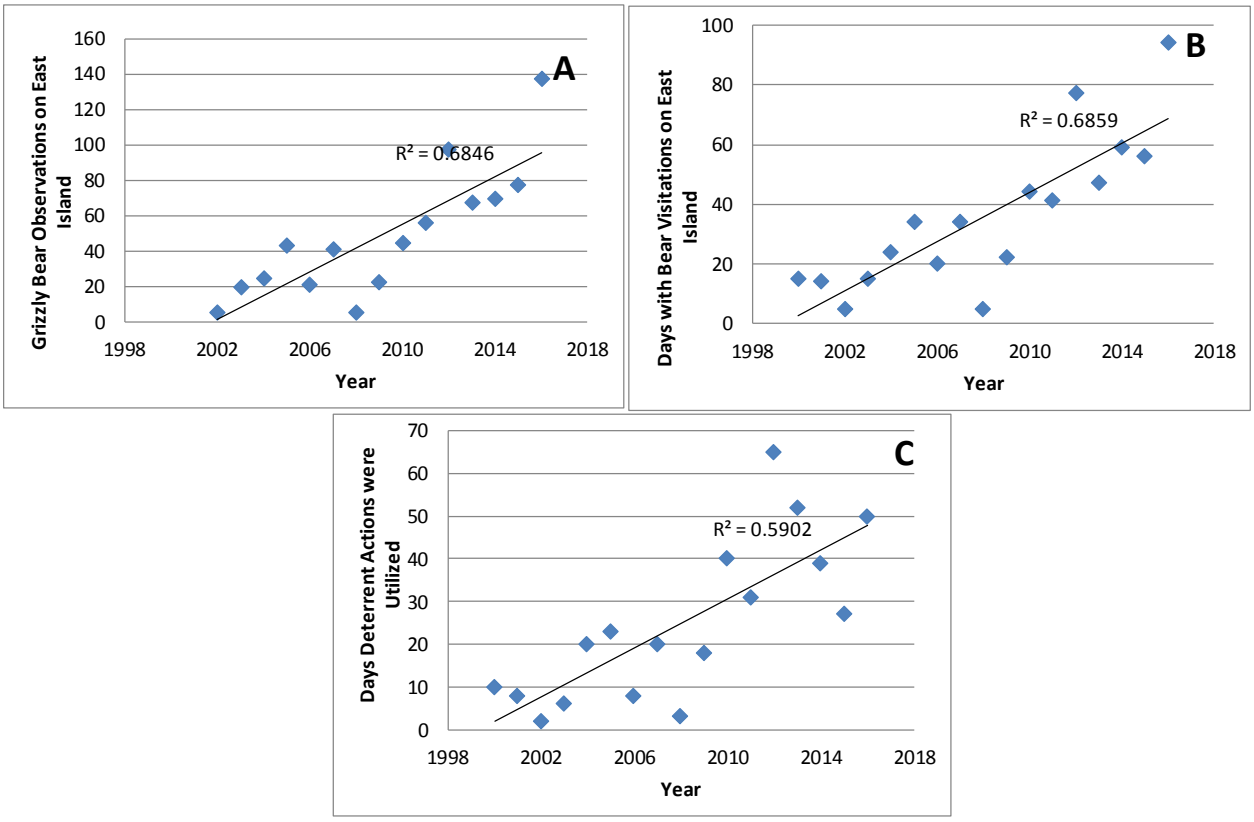

Figure 1: A) Grizzly bear observations related to observation year. B) Days with bear visitations to East Island related to observation year. C) Days deterrent actions were utilized related to observation year (data from Tables 5 & 6 of the WMR 2016).

3.4 Wolverine

The most recent objective of the WMP related to wolverine is:

> *To provide estimates of wolverine abundance and distribution in the study area over time* (Handley 2010).

Wolverine presence around the Mine is monitored using snow track surveys, hair-snagging, and incidental observations.

Snow track surveys for wolverine were completed in 2016 and a comprehensive analysis of data from 2003-2016 has been completed to examine indirect Mine-related effects (Golder 2017b). Since 2015, each winter track transect is surveyed twice instead only once, as in previous years. Data collected in this manner will help identify whether snow track detection rates vary through time.

Analysis of wolverine data was completed using nominal logistic regressions and Pearson product-moment correlations. Logistic regressions were designed to examine the relationship between wolverine track occurrence and explanatory variables including year, nearest distance to the Mine, habitat, and weather.

Pearson correlations were designed to examine the relationship between wolverine track densities and occurrence with Mine activity and caribou herd population size.

For wolverine logistic regression analyses, a habitat index was estimated for each transect that considered resource selection within a 1.25 km buffer around each transect. The 1.25 km buffer is based upon a study of movement rates of radio-collared wolverine that indicated that wolverine movements in the course of 1 to 5 days range predominantly within 3 km. The results of the analysis indicate that the probability of wolverine track occurrence is positively correlated with time and transect length (occurrence of snow tracks have increased through time from 2003 to 2016). However, in general, the models explain very little variation in snow track occurrence.

With respect to the Pearson product-moment correlation analyses for wolverine, Track Density Index (TDI) was negatively correlated with Bathurst caribou herd size and the amount of waste rock hauled and wolverine probability of occurrence was negatively correlated with the amount of waste rock hauled. Wolverine indices were not related to the number of workers on site.

The 2016 WMR reported one mortality, two relocations, and six deterrent actions for wolverine on-site in 2016 (Table 9). There were 73 days with wolverine visitations on East Island; this is slightly down from 2015. DDMI believes that many of the incidental observations of wolverine reported were of the same individuals that were relocated in March 2016. In 2016, there were four incidents of wolverine being trapped in bins, with one incident resulting in mortality.

The wolverine hair snagging program was not completed in 2015 or 2016. It was last completed in 2014. Last year DDMI anticipated that the next wolverine hair snagging survey would occur in 2017, though the long-term frequency of this program has not been determined. Decisions regarding program frequency were anticipated to be determined collaboratively during wildlife monitoring workshops hosted by ENR in 2016; however, decisions are now expected upon completion of the 2014 data summary analysis report from ENR. Given that there may be a reluctance to continue the program without results from previous collection years, **ENR should indicate when they expect to complete the 2014 wolverine hair snagging data analysis. If more data collection and analysis is not anticipated for 2017, DDMI should describe alternative plans for evaluating wolverine abundance in the study area.** In the absence of hair snagging results for wolverine, results from the ongoing snow track surveys for wolverine provide information on the distribution of wolverine. However, it is difficult to gauge wolverine abundance using track data and this gap would remain until more current hair snagging results become available. We support DDMI's continued involvement in the wolverine hair-snagging program which is designed to address the new, regional scale question about the wolverine population.

Considering all of the results currently available relating to wolverine, it is difficult to determine any cause or effect regarding apparent increases in probability of wolverine occurrence over time (however, please see Section 3.6 regarding Area 21 attractants and wolverine observations). Although wolverine probability of occurrence is positively correlated with time, it is not related to the number of workers on site (an index of Mine activity) and it is negatively related to the amount of waste rock hauled (and index of continuous, low intensity sensory disturbance). It could be that recent increases in occurrence are related to an increase in abundance of wolverines in the study area. If so, the 2016 information on wolverine abundance in the study area (hair snagging program) could shed critical light on this potential issue. The

high numbers of wolverine incidental observations and relocation requirements for wolverine for two consecutive years suggests that there may be an issue with attractants for wolverine on-site. Although, if the increase in wolverine occurrence is associated with an increase in wolverine abundance, it may be that waste management has generally been successful relative to the wolverine population size. DDMI has already responded to wolverine incidents with re-education of area staff on waste and bin management. There may be opportunities for more systematic site surveys/checks for wolverines and waste management to mitigate instances of wolverines in waste bins. For instance, **could waste collection bin checks be included in already scheduled waste inspections at the Waste Transfer Area (WTA) and Landfill?** Adaptive management is critical to manage wolverine mortalities and relocations. Also, please see Section 3.6 of this report regarding waste management and recommendations.

Given that there have only been five wolverine mortalities reported since 2000, there appears to be support for the prediction that mining related mortalities are not expected to alter wolverine population parameters in the Lac de Gras area. However, it is not clear precisely how this prediction is being tested as there has been little information provided on wolverine population parameters over time in the WMRs. **We recommend DDMI elaborate on how they are testing this particular prediction given the absence of data on population size.**

3.5 Falcons

Monitoring of raptor nest occupancy and success in the study area were removed from the WMP in 2010. However, DDMI contributes nest monitoring data to ENR every five years and last collected these data in 2015; the next survey is scheduled for 2020. DDMI also remains focused on data collection and mitigating effects to raptors nesting in open pits and on Mine infrastructure. One active peregrine falcon nest was observed on a sites service building and there was one peregrine falcon mortality reported at the Mine in 2016. The cause of death could not be determined.

We concur with DDMI's recommendation to continue Pit Wall/Mine Infrastructure monitoring for nesting raptors. DDMI will discuss options with ENR for future monitoring. The CPFS was discontinued in the NWT in 2015; therefore, DDMI no longer provides nest site occupancy and productivity data to the Canadian Wildlife Service (CWS).

3.6 Waste Management

In 2016, the attractants (food and food packaging) appear to be more or less consistent with 2015 levels on the Waste Transfer Area (WTA) and lower in the Landfill area compared to 2015 levels. In 2016, misdirected waste was also reported for the A21 Area (new dike) and the underground area. There appeared to be a high number of misdirected food items for the A21 Area (relative to the other inspected areas) and observations of wildlife (fox and wolverine) were highest for this area (WMR, Table 12). While the overall effect of waste management appears to be positive (fox numbers at the WTA are lower than previous years), the new A21 Area appears to be attracting higher numbers of wolverine and fox. Furthermore, there seems to be an increasing trend in the number of grizzly bear observations and wolverine probability of occurrence over time. We commend DDMI for its efforts which probably led to

the low attraction effect on wildlife in the past and concur with there commitment to carry out employee education programs related to waste handling to decrease misdirected waste. **DDMI should explore the reasons for the higher levels of misdirected food waste in the A21 Area as this may be contributing to wildlife (particularly wolverine) presence and possible habituation near the Mine site.**

3.7 Waterfowl

As expected, no waterfowl information was presented in the 2016 WMR. In past years, DDMI has evaluated predictions relating to waterfowl habitat loss, presence, and habitat utilization. The 2012 WMR recommended a review and evaluation of the current waterfowl program to see if any improvements could be implemented. A meeting was held between DDMI and the Canadian Wildlife Service (CWS) in December 2013 to discuss the waterfowl program. It was agreed that the waterfowl monitoring program would be discontinued at this time, but CWS did recommend that DDMI re-start the waterbird/shorebird monitoring program at the Mine reclamation stage.

We are in agreement with the recommendation to discontinue the waterbird/shorebird monitoring program and concur with the CWS recommendation regarding reinstating the waterbird/shorebird monitoring program at the Mine reclamation stage.

3.8 Windfarm

As expected, no windfarm associated bird mortality information was presented in the 2016 WMR. Given the low likelihood of avian-turbine strikes, due to location and size of the wind farm, and the absence of bird mortalities in 2013, we agreed with DDMI's recommendation to discontinue monitoring the wind farm using 2013 methods and to instead monitor for bird mortalities as part of the overall site compliance monitoring program.

4.0 Closure

The review of the 2016 WMR and 2017 WCAR reported herein presents the conclusions arrived at by MSES. While some recommendations and requests were addressed, we note that several from previous years were not responded to by DDMI (Table 1). The responses to our questions and recommendations are necessary to maintain and improve the understanding of the effects of the Mine on wildlife. Some of our recommendations may be best addressed during detailed data analyses using multiple years of new data. We hope that future communications will lead to further clarification on several details of the 2016 WMR and 2017 WCAR. Our views are submitted to EMAB for its consideration of potential recommendations and actions.

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