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# MEADOWBANK MINE

## 2019 WILDLIFE MONITORING SUMMARY REPORT

FINAL

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## APPENDIX M

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### 2019 Migratory Bird Protection Report



MEADOWBANK GOLD PROJECT

**2019 Migratory Bird Protection Report**

In Accordance with NIRB Project Certificate No.008

Prepared by:  
Agnico Eagle Mines Limited – Meadowbank Division

March, 2020

## EXECUTIVE SUMMARY

Mitigation measures to reduce impacts of flooding on migratory bird nesting at the Whale Tail site were implemented in 2019 according to the Migratory Bird Protection Plan (July, 2018). Through collaboration with Trent University and ECCO, research studies were simultaneously initiated in 2018 and continued in 2019 to determine the effectiveness of these mitigation measures (audio and visual deterrents). This was the second of three study years, so preliminary results are available for some study objectives.

For the Whale Tail South flood zone, mitigation measures consisted of visual and audio bird deterrents deployed at four locations within the flood zone, covering a total of 24 ha. Regular sweeps of these areas plus an additional 24 ha within the flood zone were conducted by a team of four research personnel every four days during between June 16 and July 14, for a total of 148 hours of sweeps within the flood zone during the 2019 nesting season.

No deterrents were deployed within the Northeast flood zone, since water levels were already near their maximum predicted elevation (156.6 masl) at the beginning of the nesting season (156.3 masl on June 14, 2019).

Research studies continued in 2019 to assess the effectiveness of the audio and visual deterrents in mitigating impacts of flooding on nesting migratory birds. Nest surveys and assessments of behavioural responses were carried out between June 5 and July 14 at reference study sites along the Whale Tail Haul Road (without flooding, with and without deterrents), as well as at both flood-zone and upland sites throughout the Whale Tail South area.

Complete results will be provided upon study completion, following the final 2020 field season. However, results to date demonstrate that deterrents were not effective at deterring birds from nesting. In addition, deployment and maintenance of the deterrents was extremely time consuming. As a result, the study authors do not recommend the ongoing use of the tested deterrents for mitigating nest loss due to disturbance such as flooding in this region.

FEIS (2015/2016) and supplemental baseline surveys (2018) estimated that 50 – 98 nest sites occurred within the flood zones and would thus be impacted by flooding (28 – 56 nests/km<sup>2</sup>). However, significant flooding in both areas occurred prior to the nesting season in 2019. As a result, birds would not have tried to nest in the already flooded area and direct loss of active nests due to flooding would have been less than predicted (e.g. in 2019, estimated direct losses were 4 nests/km<sup>2</sup>). Indirect impacts of flooding on the nesting success of displaced birds is unknown. Studies to be conducted in 2020 will attempt to determine whether birds displaced by flooding are successfully nesting in new shoreline territories or adjacent areas.

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## **SECTION 1 • INTRODUCTION**

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In 2018, Agnico Eagle Mines Ltd. (Agnico) was issued NIRB Project Certificate No. 008 for development of the Whale Tail site, a satellite deposit at the Meadowbank Mine. Agnico has planned two water diversions as part of water management activities for this project.

The Whale Tail Lake (South Basin) diversion (Figure 1) was initiated through construction of the Whale Tail Dike to divert flow from Whale Tail Lake and tributary lakes through Lake A45, just south of Lake A16 (Mammoth Lake). Flooded tributary lakes include Lake A18, Lake A19, Lake A20, Lake A21, Lake A22, Lake A55, Lake A62, Lake A63, Lake A65, Pond A-P1, and Pond A-P53. In-water construction of the Whale Tail Dike was completed September 2018, and dewatering of the North Basin of Whale Tail Lake to advance flooding began in March, 2019. The rise in water levels from baseline (~152.5 masl) to 156.00 masl of this area will occur in 2019 and 2020, causing approximately 157 ha of terrestrial flooding.

The Northeast diversion (Figure 2) consists of construction of the Northeast dike to divert Lake A46 and tributary lakes through Lake C44 in the Lake C38 (Nemo Lake) watershed. Flooded tributary lakes include Lake A47, Lake A48, Lake A113, Pond A-P38, and Pond A-P68. The main construction activities for the Northeast dike were carried out from September 2018 to February 2019. Flooding of this area began in spring 2019, and the estimated total flooded terrestrial area is 18 ha.

Flooding of these two areas has the potential for incidental disturbance and destruction of migratory birds and their nests. As per Nunavut Impact Review Board (NIRB) Project Certificate No.008 Condition 34, the Migratory Birds Protection Plan (the Plan) describes how these impacts will be mitigated through use of visual and audio bird deterrents, and regular sweeps by personnel to discourage nesting. Mitigation was planned to be focused between 2018 and 2020, or until water levels reach their maximum flood plain.

Since flooding had not yet occurred in 2018, mitigation measures began in 2019 in consultation with academic research partners at Trent University. This report describes the mitigation measures that were implemented, and results of field studies conducted simultaneously in collaboration with Environment and Climate Change Canada (ECCC) and Trent University to understand the effectiveness of the various types of mitigation (deterrents).

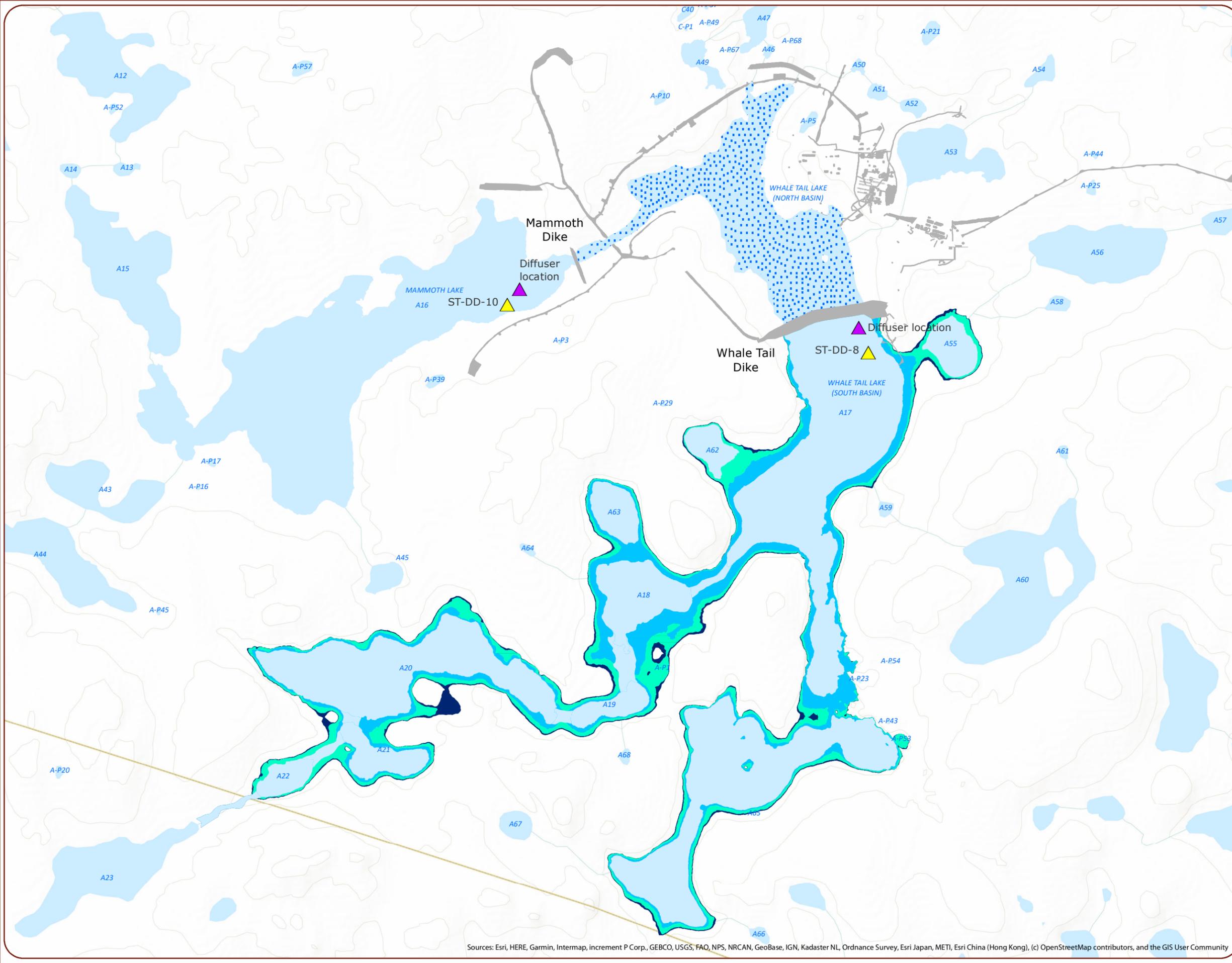


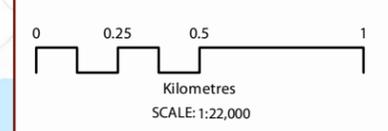
Figure 1: Whale Tail South Flood Zone Water Levels

**Legend**

-  Dewatering Monitoring Locations
-  Diffuser location
-  Infrastructure
-  Dewatered Lake

**South Whale Tail Lake Elevations**

-  Baseline Water Level
-  2019 Final Water Level (155.17 mas)
-  2019 Peak Water Level (155.84 mas)
-  Max Predicted Water Level (156 mas)



**AGNICO EAGLE**



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

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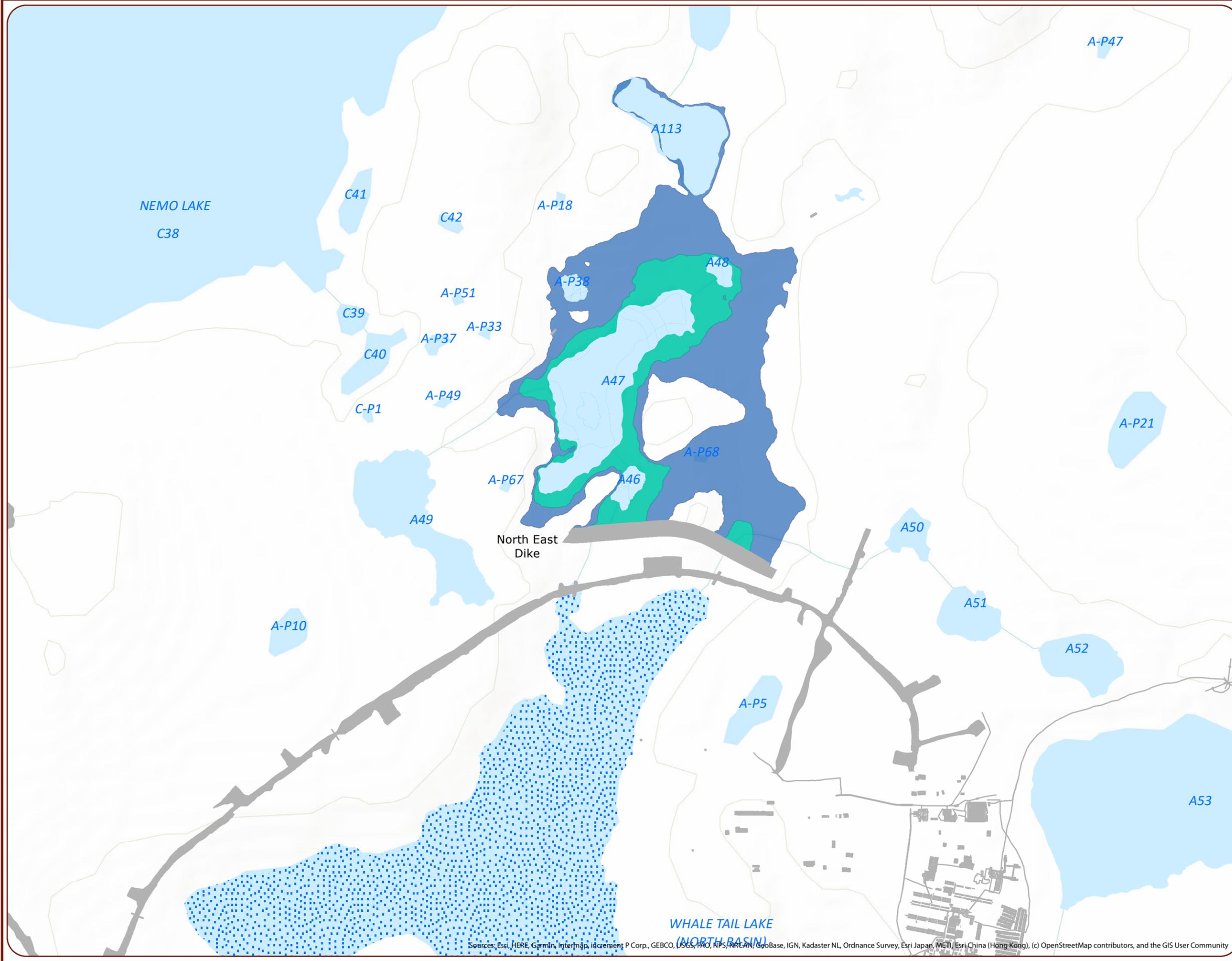
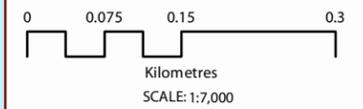


Figure 2: North East Diversion Flood Zone Water Levels

**Legend**

-  Infrastructure
-  Dewatered Lake
- North East Diversion Lake Elevations**
  -  Baseline water level
  -  Final 2019 water level (155.66 masl)
  -  Final predicted water level and peak 2019 water level (156.66 masl)



**AGNICO EAGLE**



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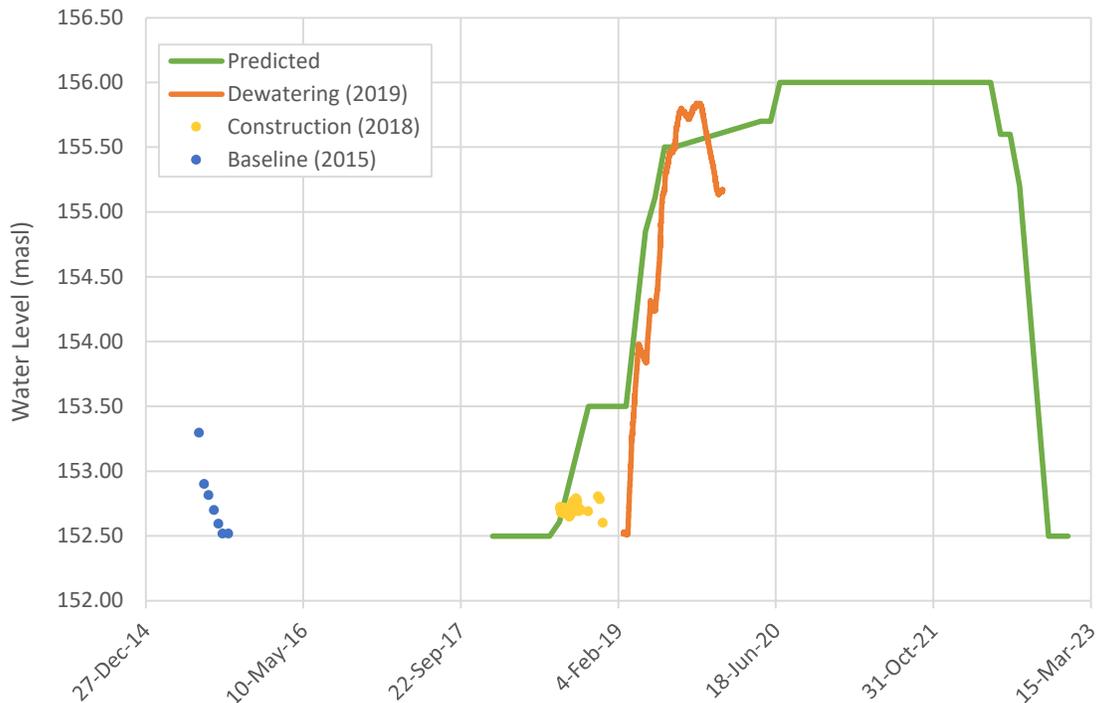
## SECTION 2 • WATER LEVELS

A complete discussion of dike construction and water level monitoring for the Whale Tail South flood zone is provided in the 2019 Water Quality Monitoring for Dike Construction and Dewatering Report. Results are summarized here.

In-water construction of the Whale Tail Dike was complete in September, 2018, and dewatering of Whale Tail Lake (North Basin) began in March, 2019, initiating the planned flooding of the Whale Tail South flood zone.

Maximum predicted water levels in the Whale Tail South flood zone are shown in Figure 3, along with measured peak flood levels in 2019, and final water levels (December, 2019). The progression of flooding in 2019 (measured water levels) is shown in Figure 3, in relation to FEIS predictions.

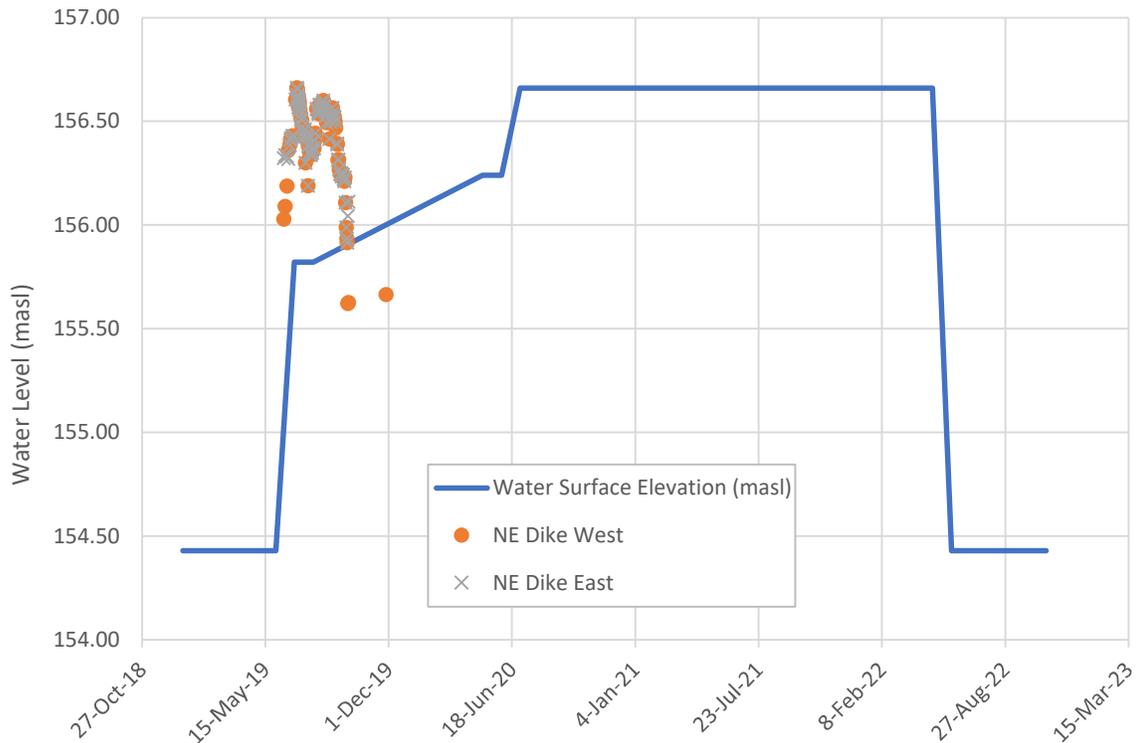
Due to record rainfall, peak water levels in 2019 exceeded predictions in July, but did not reach the maximum predicted final flood level of 156.0 masl, which is planned to occur in 2020. Following discussions with NWB, Agnico temporarily pumped non-contact water from the Whale Tail South (WTS) flood zone directly to Mammoth Lake, from October 21 to December 18, 2019. Construction of the South Whale Tail Channel (SWTC) began in late 2019, and is expected to be completed prior to freshet in 2020, which will ensure water levels remain within the maximum predicted range of 156.0 masl.



**Figure 3. Measured and FEIS-predicted water levels in Whale Tail Lake South. Predicted water levels from FEIS Appendix 6-F.**

The Northeast Dike was constructed from September 2018 to February 2019. Maximum predicted water levels in the Northeast flood zone are shown in Figure 4, along with measured peak flood levels in 2019, and final water levels (December, 2019). FEIS water management plans indicated that this flood water would increase to the maximum elevation of 156.6 masl, and then flow naturally through a tundra pond system to Nemo Lake.

The maximum predicted flood level in this area (156.6 masl) was reached on July 6, 2019 (Figure 4). At that point, it was observed that the topography toward Nemo Lake would not allow water to overflow naturally before overtopping the dike liner. As a result, water has been pumped out of that area since July 2019 (initially towards Whale Tail Lake North Basin and A-P5 Stormwater Management Pond, but then to Nemo Lake as non-contact water, beginning in August, 2019).



**Figure 4. Measured and FEIS-predicted water levels in the Northeast Diversion flood zone. Predicted water levels from FEIS Appendix 6-F.**

### SECTION 3 • MITIGATION MEASURES

According to the Migratory Bird Protection Plan (July, 2018), the following mitigation measures were planned to be implemented to deter nesting of waterbirds in the Whale Tail Lake and Northeast water diversion areas during flooding:

- Deploying visual and audio bird deterrents,

- Regular sweeps by Agnico Eagle staff to discourage nesting through human activity, and to move the visual and audio deterrents;
- While Agnico may in the future consider the feasibility of using habitat modification or exclusion techniques within the flood zone in consultation with ECCC and academic institutions, these methods are not part of the primary mitigation plan.

In the 2018 nesting season, no flooding had yet occurred. Mitigation measures were implemented in consultation with academic partners at Trent University during the 2019 nesting season.

The crew from Trent University deployed audio and visual deterrents throughout selected plots within the Whale Tail South flood zone (Appendix A, Figure 3) between June 16 and 17, 2019. These were the earliest dates logistically feasible, based on weather conditions (primarily the need to wait for snowmelt). At this time, water levels were at 154.68 masl in Whale Tail South Basin, or approximately 2 m above baseline levels.

Deterrents consisted of 20 x 20 m flash tape grids, and audio deterrents. Flood-zone plots were surveyed every four days between June 16 and July 14, for a total of 148 hours of sweeps within the flood zone during the 2019 nesting season.

No deterrents were deployed within the Northeast flood zone, since water levels were already near their maximum predicted elevation (156.6 masl) at the beginning of the nesting season (156.3 masl on June 14, 2019).

## **SECTION 4 • RESEARCH STUDY: EFFECTIVENESS OF THE MITIGATION**

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### **4.1 INTRODUCTION**

In order to determine the effectiveness of mitigation methods aimed at reducing impacts of Whale Tail site flooding on waterbirds, Agnico is conducting a study in partnership with Environment and Climate Change Canada (ECCC) and Trent University. Through this project, Agnico is also contributing to advancing the scientific understanding of conservation methods for at-risk species.

The complete objectives of the research are to assess the degree of risk posed to migratory birds by mining-induced flooding during the nesting period, to determine the most effective bird deterrents, and to determine the manner in which these deterrents should be applied.

Specifically, the study investigates the:

- i) breeding densities and timing of bird nest initiation at the Whale Tail study site,
- ii) relationship between nesting phenology and the timing of snowmelt,
- iii) degree to which deterrents can reduce nesting densities in specific areas,
- iv) individual behavioural responses to deterrent applications and changes in response over time,
- v) and the dispersal distance of deterred/impacted birds, to understand whether birds displaced from flooded areas nest nearby.

## **4.2 METHODS**

### **4.2.1 2018 Field Studies**

A complete summary of 2018 field studies prepared by the research team from Trent University was provided in the 2018 Migratory Bird Protection Report.

Briefly, the objectives of the 2018 field study were to collect preliminary data to assess the effectiveness of visual deterrents in changing bird behaviour during nesting. This portion of the study was carried out at test plots without flooding along the Whale Tail Haul Road (Objective 1). Researchers also collected baseline data on nest abundance in the water diversion flood zones (Objective 2).

#### **Objective 1 – Effectiveness of Deterrents**

The field team assessed 21 plots along the Whale Tail Haul Road between the Amaruq Camp and Kilometer 48 over a 6-week period, beginning June 4, 2018. Plots were chosen with the use of Ecological Land Classification maps and ground truthing. Plots are 200 x 300 meters (6 ha), covering a mix of low-lying wet sedge habitat types representative of the habitats that will be flooded around Whale Tail Lake. The purpose of the plots was to allow spatially-independent samples in which to test deterrents.

Deterrents were planned to be set up prior to bird arrival, to assess differences in nesting between sites, but delays in shipment meant they were not erected until late June. As a result, changes in behaviour of individual birds after set-up of deterrents was assessed. Due to delays in shipment of audio deterrents, their effectiveness could not be assessed in 2018.

#### **Objective 2 – Whale Tail Flood Zone Impact Assessment**

Research teams surveyed five general areas the eventual Whale Tail area flood zones over 8 days during peak incubation (June 24 – July 2, 2018). Within the North East Diversion flood zone, a total of 15 nests were found over two days of surveying and within the Whale Tail Diversion flood zone a total of 35 nests were found over 6 days of surveying (see figures in 2018 Migratory Bird Protection Report, Appendix A for locations).

Out of the 50 nests, 30 individual birds of 4 species were banded with individual markers so that they may be identified in the 2019 field season, to determine if they breed nearby once they are prevented from returning to their breeding territories by flooding.

### **4.2.2 2019 Field Studies**

A complete summary of 2019 field studies prepared by the research team from Trent University is provided in Appendix A. Data evaluation continues in preliminary stages.

#### **Objective 1 - Effectiveness of Deterrents**

At the beginning of the 2019 study season (June 5 – 14), audio and visual deterrents were placed in the same experimental plots established in 2018 along the Whale Tail Haul Road (n = 15 plots). Experimental plots (300 m x 200 m) were divided into two types of treatment and control plots. Treatment 1 consisted of audio deterrents playing a mix of predatory and distress calls paired with a 20 x 20 m grid of Mylar® flash tape and a Jackite© hawk kite effigy. Treatment 2 consisted of audio deterrents with the use of Jackite© (a hawk kite effigy) only. Control plots had no deterrents present.

Nest and territory densities were compared between 2018 and 2019 using a before-after control-impact design.

## **Objective 2 - Whale Tail Flood Zone Impact Assessment**

During the 2019 field season, sixteen (16) 6-ha plots within four study locations were assessed for migratory bird presence in relation to active flooding and presence of deterrents. Deterrents were placed in the treatment plots (n = 4) within the active flood zone between June 16 – 17, 2019, and nest surveys were conducted every four days until July 14.

## **Objective 3 – Behavioural Responses**

In 2019, monitoring was also conducted to assess behavioural responses to deterrents for the four main study species (Lapland longspur, horned lark, semipalmated sandpiper, and least sandpiper). Behavioural response metrics included territory mapping, nest fate/success, incubation duration, and distance of nesting relocation.

### **4.2.3 Planned 2020 Field Studies**

## **Objective 2 - Whale Tail Flood Zone Impact Assessment**

In 2020, the study will continue to determine the re-colonisation time of nest densities in the flooded area post-flooding. This will require the monitoring of the 16 plots within the flood zone surrounding Whale Tail Lake. The project is interested in visiting the 16 plots within the flood zone to determine nest densities post-flooding, and to understand how nesting birds react to the elimination of previously suitable habitat. Another focus will be to determine how bird densities change between years as the water line moves, and how elevation factors into the selection of nest sites. This will be accomplished by visiting at least 8 of the plots, located on the Eastern shore of Whale Tail Lake and its tributaries (WT1 and WT2).

## **4.3 RESULTS**

### **4.3.1 Objective 1 – Effectiveness of Deterrents**

Complete results describing the effectiveness of the tested deterrents will be provided upon study completion. However, results to date demonstrate that deterrents were not effective at deterring birds from nesting. In addition, deployment and maintenance of the deterrents was extremely time consuming. As a result, the study authors do not recommend the use of the tested deterrents for mitigating nest loss due to disturbance such as flooding. Further discussion is provided in Appendix A.

### **4.3.2 Objective 2 - Whale Tail Flood Zone Impact Assessment**

As described in the Migratory Bird Protection Plan (July, 2018), a total of 10 waterbird nests and 88 upland bird nests were predicted to be impacted by flooding ( $98 \text{ nests}/1.76 \text{ km}^2 = 56 \text{ nests}/\text{km}^2$ ). This prediction was made by extrapolating data from limited shoreline surveys conducted in 2015/2016.

Baseline surveys conducted by the University of Trent researchers in 2018 identified a total of 50 nests in the flood zones, consisting of 15 waterbird nests and 35 upland bird nests ( $28 \text{ nests}/\text{km}^2$ ). These results indicated that although the proportion of waterbird nests was higher than predicted, total impacts to nesting birds may be lower than predicted.

During the initial flood year (2019), significant flooding in both the Northeast and Whale Tail South flood zones occurred prior to the nesting season. For the Northeast flood zone, water levels had nearly reached their maximum flood elevation (156.3 masl of 156.6 masl) by June 14. For the Whale Tail South area, water levels were at +2 m (154.68 masl of 156 masl) by June 16. As a result, birds would not have tried to nest in the already flooded area and direct loss of active nests due to flooding would have

been less than predicted (e.g. in 2019, estimated direct losses were 4 nests/km<sup>2</sup>). However, indirect impacts of flooding on the nesting success of displaced birds is unknown. Studies to be conducted by Trent University in 2020 will attempt to determine whether birds displaced by flooding are successfully nesting in new shoreline territories or adjacent areas.

#### **4.3.3 Objective 3 – Behavioural Responses**

Behavioural responses of nesting birds to deterrents and flooding have not yet been analyzed, and will be provided upon study completion.

**APPENDIX A**

**2019 Trent University/ECCC Study Summary Report**

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# **Waterbird Mitigation Project, Agnico Eagle Mines Ltd**

## **2019 Field Season and Research Report**



**Gillian Holmes**

**MSc. Student, Trent University**

**Trent University, Environment and Climate Change Canada, Agnico Eagle Mines Ltd.**

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## **Introduction**

Mining and other forms of resource development frequently result in disturbance to wildlife that is difficult to avoid. Technological options to mitigate these impacts are therefore of great interest to resource developers and conservationists alike. Mining is an important economic driver in the north by providing jobs for people living in northern communities (Cameron and Levitan 2014; Belayneh et al. 2018). In Nunavut alone, 18% of the gross domestic product in 2014 was associated with resource extraction (AMAP 2017). Mineral, oil and gas exploration is expected to increase throughout the Arctic landscape (A.T. Kearney Inc. 2015), leading to land use changes and disturbance of critical habitat for wildlife (Wilson et al. 2013). Resource extraction can have detrimental impacts on habitat quality through the modification of landscapes, increased pollutants, human traffic and infrastructure (Reijnen et al. 1997; Johnson et al. 2005; Hassan 2016). Studies from Hof et al. (2017) have demonstrated that arctic-nesting birds are especially vulnerable to climate change; with the increase of resource extraction in arctic landscapes leading to additional loss in nesting habitat, there is an even greater probability of future species loss (Gajera et al. 2013; Bernath-Plaisted and Koper 2016). Finding a balance between conservation and economic growth is crucial in vulnerable landscapes such as the Arctic, particularly when faced with climatic change (Wauchope 2016).

The following report will outline the objectives fulfilled during the 2019 field season, the next steps for data analysis and plans for the 2020 field season.

## **Project Overview**

Agnico Eagle Mines Ltd. proposed, and has now built, the Whale Tail Project, approximately 130km North of Baker Lake, NU. The project included the construction of two dykes within the northern portion of Whale Tail Lake that diverted water from the Whale Tail mining pit into the surrounding lakes and tributaries. This resulted in flooding that elevated the water levels by 4 m above current levels over two year between 2019 and 2020, causing approximately 157 ha of flooded tundra during the time of birds' nest initiation. The Migratory Birds Convention Act (1994) prohibits the harm of migratory birds and the disturbance or destruction of nests and eggs. Therefore, the company is committed to avoiding or minimizing this harm and developing mitigation strategies.

As part of a collaboration between Trent University, Environment and Climate Change Canada and Agnico Eagle Mines Ltd., this project explored mitigation options for flooding during the construction phase of the Whale Tail Pit. Mitigation options sought to deter birds from nesting in high risk areas, so that the impacts from mining-induced flooding or other localized disturbances could be minimized.

Through experimentation with the use of deterrents, the objectives of the research were to (1) determine the most effective bird deterrents and the method in which these deterrents should be applied, (2) assess the degree of risk posed to nesting migratory birds by mining-induced flooding and estimate the number of nests and the species composition lost due to the flooding and (3) examine the behavioural response of flooding by birds to determine whether birds re-nested or moved after the flooding events.

### **Year Two - 2019 Overview**

The 2019 field season began on May 23<sup>rd</sup> with the arrival of Gill Holmes (MSc. Candidate) and technician, Sophie Roy. Late May tasks included the assemblage the audio deterrents and troubleshooting any problems that may arise in the field, testing visual deterrents in the field and gathering equipment used for deterrents and nest monitoring. Three more technicians arrived on the 1<sup>st</sup> of June and 3<sup>rd</sup> of June, Amy Wilson, Joanne Hamilton and Sarah Bonnett.

When the crew arrived on site, flooding had already occurred. Although Whale Tail Lake was frozen, there was a change in the riparian zone due to the late winter flooding of Whale Tail Lake southern basin. Snow melt occurred between the first week of June, with an unexpected snowstorm on the 9<sup>th</sup> of June, blanketing the landscape with an estimated 8 cm of snow. Whale Tail Lake began to thaw between early June to mid-June, showing more



Figure 1: Examples of the shoreline flooding due to the diversion into the southern basin of Whale Tail Lake. Top: A view ground view of the flooding at WT3 site, Amaruq Camp in the background. Bottom: An above view of the flooding at WT3 site.

obvious signs of water level changes on the land (Figure 1). Deterrent deployment was delayed due to late arrival of gear and the heavy snow fall. All deterrents were deployed between 6<sup>th</sup> and 17<sup>th</sup> of June. The field season ended on 19<sup>th</sup> of July with the entire Waterbird Mitigation Project crew, departing Meadowbank. The field season was a total of 57 days.

## Methods

### Objective 1. Efficacy of Deterrents

Deterrents were placed in experimental plots (300 m x 200 m, 6 ha) established during 2018 (n = 15). These plots were placed within 1 km of the Amaruq road between the 5<sup>th</sup> of June and 14<sup>th</sup> of June (Appendix 1). Experimental plots were divided into five sets of plots, with each set containing two treatment plots (Treatment 1 and 2) and one set of control plots. Treatment 1 consisted of audio deterrents playing a mix of predatory and distress calls paired with a Jackite® predator effigy placed in the centre of the plot, and Flash Tape covering the entire plot, with tape deployed every 20 m in both directions (Figure 1). Treatment 1 was chosen to potentially be the most effective at deterring breeding birds but was also the most labour-intensive. Treatment 2 consisted of audio deterrents and an effigy only and was selected as a less labour-intensive option (Figure 2). Control plots contained no deterrents.

As we did not set up deterrents in the plots in 2018 but we did obtain estimates of both territory and nest densities, we were able to use a before-after control-impact (BACI) statistical design. We compared nest and territory densities in control and treatment plots between years, using a general linear model, with Year and Treatment as factors, and testing for the interaction between these two factors. In this design, if there is a statistically significant interaction effect between the treatments and years, then the change in densities between 2018 (pre-treatment) and 2019 (post-treatment) should be greater in

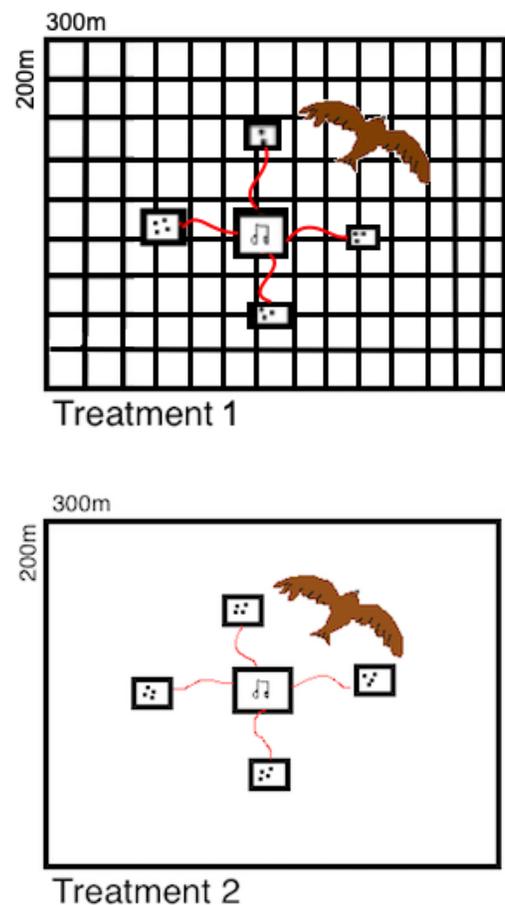
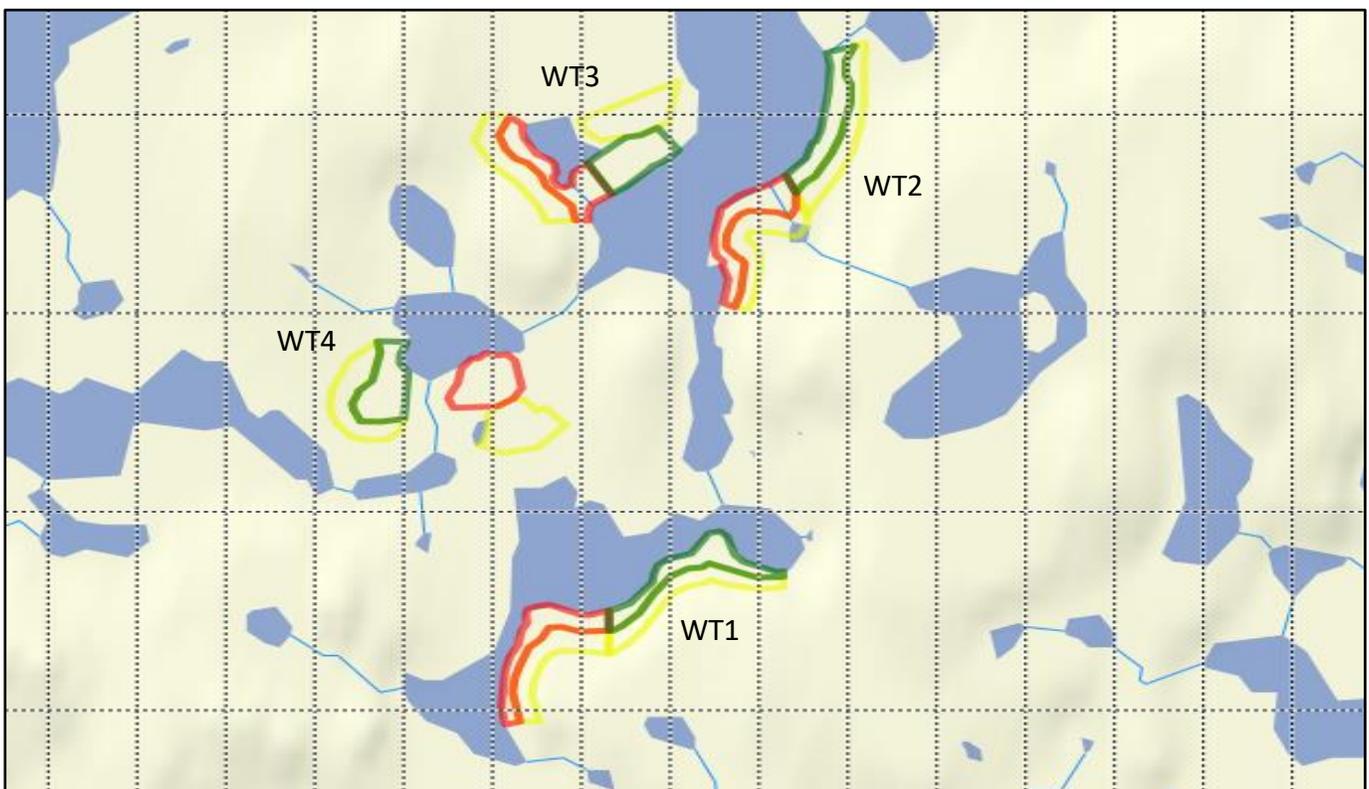


Figure 2: Illustrations of the two types of Treatment: Treatment 1 (top): audio deterrents, Jackite® predator effigy and 20 x 20 m grid of Flash Tape, and Treatment 2 (bottom): audio deterrents and Jackite® predator effigy. Used during the 2019 field season.

treatment plots than in controls. Because we analysed the same sites in both years, we also added a term to the model that represents random variation among sites (linear mixed-effects model, lmer in RStudio). We expected that both territory and nest densities would decline in the presence of the deterrent treatments, while there would be no change in either territory or nest densities between years in control plots. We also included hours spent nest searching and monitoring in the plots as an offset in the model to account for time spent in the plots. We spent substantially more time in plots assigned Treatment 1 than in other plots, while conducting maintenance of the deterrents. We conducted analyses on all birds, and the following subsets: terrestrial birds including Lapland Longspur (*Calcarius lapponicus*), Horned Lark (*Eremophila alpestris*), Savannah Sparrow (*Passerculus sandwichensis*), shorebirds including Semipalmated Sandpiper (*Calidris pusilla*), Least Sandpiper (*Calidris minutilla*), American Golden Plover (*Pluvialis dominica*), and the two most common species, Lapland Longspur and Semipalmated Sandpiper.



**Figure 3: Map of the four main study sites (WT1, WT2, WT3, WT4) around Whale Tail Lake and its connecting lakes and tributaries. The Flood plots (red) and Treatment plots (green) are within the proposed flood zone, and the Control (yellow) plots are adjacent to the proposed flood zone.**

## **Objective 2. Flood Zone Impact Assessment**

During the 2018 field season, diversion sites were surveyed for nests between 24<sup>th</sup> and 25<sup>th</sup> of June and 29<sup>th</sup> June – 2<sup>nd</sup> of July for a total of 40 search hours. These surveys were conducted to obtain an estimate of the densities of birds that would be exposed to the flooding event. The dates were limited due to limited access to the sites. After the initial 25<sup>th</sup> of June survey of birds, and habitat composition across all of the Whale Tail Diversion site, we divided the Whale Tail diversion site into four main flood zone areas (WT1, WT2, WT3, and WT4). These areas were selected based on habitat quality (predominately sedge meadow), and low elevation, so most likely to support breeding birds that would be impacted by the flooding.

The 2018 survey consisted of walking a transect with four surveyors spread out every 10 m parallel to the edge of the lake and to the proposed high flood line (within the proposed flood zone), as described in Appendix 6-F - Flooding During Phases report by Golder Associates and AEM. Surveyors walked together, while watching the ground, to observe flushing birds or other breeding activity. When a bird was observed, all surveyors stopped, and one or more surveyors attempted to find the nest by waiting for the bird to return to its nest, or by searching the area where the bird was initially observed. A Garmin© GPS was used to mark each nest found, and observations and notes were written in a field notebook. Nest densities around Whale Tail Lake were estimated based on nests found during the 2018 surveys, with an estimated 3.4 territories per hectare, within the proposed flood zone of 157 ha.

During the 2019 field season, the four main flood zone areas were divided into 4 separate 6 ha plots, two within the flood zone and two outside the flood zone to be used as control plots (Figure 3). The two flood zone areas were further divided into treatment and flood zone. Treatments included the flash tape grid and audio deterrents similar to Treatment 1, but without a Jackite© predator effigy. Plots outside the flood zone were considered control plots with no deterrents or flooding occurring. Deterrents were placed in the treatment plots (n = 4) between the 16<sup>th</sup> of June and 17<sup>th</sup> of June. Plots were surveyed every four days, between the 16<sup>th</sup> of June and 14<sup>th</sup> of July for a total of 148 search hours within the proposed flood zone.

### Objective 3. Bird Behavioural Responses

#### Nest and Territory Monitoring

Monitoring of nesting birds occurred throughout the 2019 breeding season between the June 6<sup>th</sup> of - 14<sup>th</sup> of July, within the experimental plots and the flood zone sites. For the study, there were four main study species; Lapland Longspur (*Calcarius lapponicus*), Horned Lark (*Eremophila alpestris*), Semipalmated Sandpiper (*Calidris pusilla*) and Least Sandpiper (*Calidris minutilla*) (Figure 4). These species are the most abundant at the study sites and the easiest species for both locating and monitoring nests.



Figure 4: Four main study species, left to right; Lapland Longspur, Horned Lark, Semipalmated sandpiper, Least sandpiper.

Territorial mapping occurred primarily at the beginning of the breeding season once male birds arrived and began to sing and display. Mapping was done by observing the locations of displaying males and marking the location with a waypoint using a Garmin© GPS, for a minimum of 10 points per visit to the territory. The locations of each singing male were given a waypoint.

Nest searching occurred by systematically walking plots and observing behavioural cues of breeding adults (e.g. flushing, mate courtship, alarm calls). Upon discovery of a nest, it was marked with a tongue depressor 5m from the nest in a random direction, labeled with a nest name, along with the distance and bearing to the nest from the marker. Within a notebook, the observer recorded the exact coordinates of the nest using the “average waypoint” function within the GPS unit, the species, number of eggs present, and date found. Each plot, and nests within plots were visited on a 4-day schedule until fates were determined. Methods to assess nest fate depended on the life history of each target species. Nests occupied by species with precocial young (i.e., *Calidris sp.*) with at least one hatched egg were considered successful, whereas nests occupied by species with altricial young (i.e., Passerines) with at least one fledged young were determined successful. Signs of predation (loss of a whole clutch, nest disturbance, large eggshell fragments or yolk) or abandonment (no sign of adults or cold eggs) (Mabee 1997) indicated failed nesting attempts.

Twenty Lapland Longspur nests received a temperature logger after the clutch was completed (i.e., 5 eggs), with 10 loggers placed within nests located in Treatment plots and 10 loggers placed within nests located in Control Plots. Temperature loggers were used in this study to monitor incubating females to detect any changes in incubation duration between Treatment and Control nests that might be attributed to the presence of the deterrents.

### Marking and Re-sighting

Birds of the four focal study species found within the flood zone areas (both Treatment and Control plots) were captured with the use of a bow net at the nest, and banded with individual colour markers. For nests found in the Treatment areas, banding was done to determine whether the disturbance of the treatments caused birds to re-nest in adjacent sites. Additionally, we banded birds in 2018 from the tundra area that was flooded in 2019, and we used these data to determine whether birds dispersed to adjacent non-flooded sites, potentially increasing the densities of birds in these adjacent sites. We also plan to return to the study site in 2020 solely to re-sight previously banded individuals. Re-sighting of previously banded birds from 2018 and birds caught on the nest as they were found in 2019 occurred throughout the breeding season as nests were found and disturbed due to flooding, deterrents or predators. Resighting occurred during every visit (every four days).

We captured adults once a nest was in the incubation stage (i.e., the number of eggs in the nest does not increase each day). We attempted to capture both members of the pair for species where both adult birds incubate (i.e., *Calidris sp.*). For species where only one adult incubates (i.e., Passerines), we captured the incubating bird, although in a few cases both adults were captured. When a bird was captured, we measured the head-bill length, tarsus length, and wing length to the nearest mm and weight to the nearest dg. Birds were banded with a standard Canadian Wildlife Service issued stainless-steel metal band that has a unique 10-digit serial number. Semipalmated Sandpipers were banded with a metal band, a white flag with a 3-letter alpha code, and a single plastic coloured band. Least Sandpiper were banded with a metal band, a white flag and 2 colour bands. Lapland Longspurs and Horned Larks were given a unique colour band combination comprised of 1 metal band and 3 plastic colour bands. Band combinations are read from left to right as per standard protocol and were recorded when re-sighting a previously banded bird.

## Results

### Objective 1. Efficacy of Deterrents

Our results suggested that deterrents did not significantly impact nest densities of all species, nor the subsets of terrestrial or shorebird species (Figure 5) as there were no significant interaction terms for any of these three analyses ( $P$ 's > 0.05). Similarly, there was no significant impact of the deterrents on either of Semipalmated Sandpiper or Lapland Longspur nest densities (Figure 6). In most cases, plots exposed to Treatment 1 had double the nest density of that of control and Treatment 2 in 2019, the year of deterrent deployment, a result that was opposite to our expectation. These results demonstrate that deterrents were likely not effective at deterring birds from nesting in possible at-risk areas.

### Cost and Maintenance of Deterrents

Deterrent deployment occurred over multiple days, with up to 200 person hours to deploy, not including the extra 120 hours to assemble and trouble shoot before deployment. In most cases, a crew of 6 – 8 people spent 4 hours deploying the flash tape grid, within a single Treatment 1 6-ha plot. Deterrent maintenance was done every 4 days, with the time spent in the plot ranging from 20 mins to 4 hours, depending on damage and needs. Examples of maintenance were ensuring that the hawk kite effigy poles were erect and that the kite was still intact, ensuring the fishing line holding together the flash tape grid was taut, ensuring flash tape was not tangled around hummocks or brush. In some cases, deterrents were completely destroyed, taking hours to fix or so damaged that we could not fix them. An

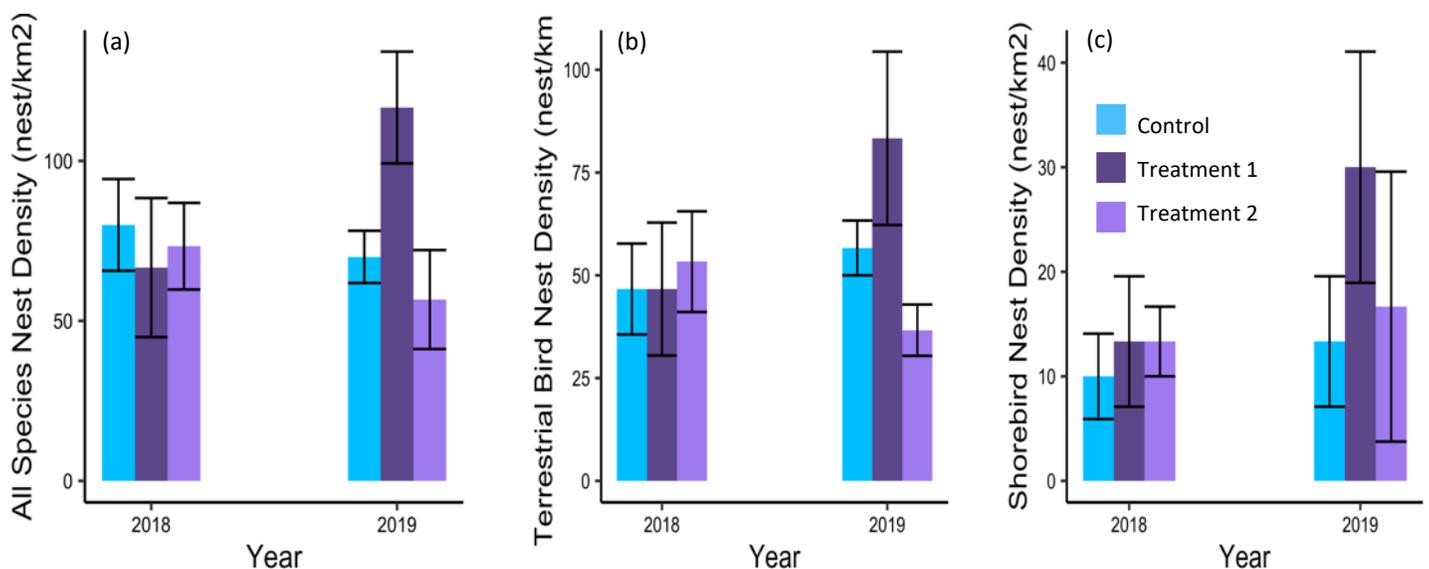


Figure 5: Nest densities (nests/km<sup>2</sup> ± SE) before (2018) and after (2019) deterrent deployment of two deterrents treatments, for all species present at the study site (a), only terrestrial bird species (b), only shorebird species (c) only.

example of this is where the Flash tape grid was dismantled due to disturbance by caribou or muskoxen, causing the entire grid to collapse and requiring maintenance and re-deployment. This re-deployment took hours and also demonstrated a possible risk to large arctic mammals who may have become entangled in the flash tape.

Financial costs for audio and visual deterrents and accessories included each Bird-X Super Bird X-peller Pro audio unit of \$509.99 CAD, with 14 purchased in 2019, for a total of \$7,139.06 CAD. This cost included audio chips for each audio unit (\$60.00 CAD each). To keep the batteries charged so the audio deterrents would run for up to 6 weeks, we purchased 14 solar panels, \$89.99 CAD each, for a total of \$1259.86 CAD. The 12V car batteries used to run the audio deterrents and hold the solar panel charge, were donated by Environment and Climate Change Canada. Visual deterrent costs came to a total of \$5,131.25 CAD, with Hawk Kite Effigies costing \$524.75 CAD for 12 Hawk Kites, with Fiber glass poles (10) totaling \$517.50 CAD and replacement strings (7) \$42.00 CAD. Flash tape rolls were \$5.40 CAD per roll, accounting to \$1,917.00 CAD for 355 roles. Fishing line was used to string the flash tape grid together, costing \$850.00 for 34 rolls of 100lb Hercules PE Braided Fishing Line 4 Strands. Lastly, the Aluminum Angle used to erect the flash tape grid, with 640 pieces of 1 m long angles, cost \$1,280.00 CAD. The complete cost of deterrents for this project was \$13,529.17 CAD.

**Objective 2. Flood Zone Impact Assessment**

During the 2018 Whale Tail Study survey we estimated 31 bird territories per km<sup>2</sup>, with an average initiation date of the 16<sup>th</sup> June. Given these dates, we concluded that the proposed flooding timeline outline in Terrestrial Ecosystem Management Plan - Version 4, by Golder Associates, would flood nests along the shore of

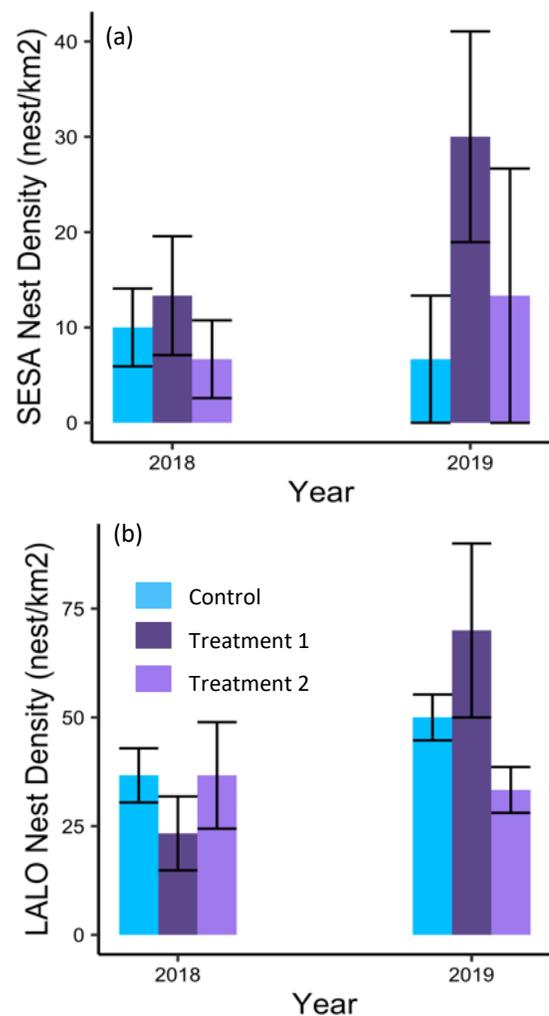


Figure 6: Nest densities (nests/km<sup>2</sup> ± SE) before (2018) and after (2019) deterrent deployment of two deterrents treatments for Lapland Longspur (a) or Semipalmated Sandpiper (b) only.

Whale Tail Lake. When we arrived at the Whale Tail Flood zone in 2019, we estimated a shoreline loss of 40 m, which occurred when Agnico Eagle Mines Ltd. flooded in late winter. Because of this loss, about half of the proposed flood area plots were under water. Despite this, birds continued to nest within the flood area with an average territory density of 21.9 territories per km<sup>2</sup>, while control plots surrounding the proposed flood zone within the Whale Tail Study area had an average territory density of 15.6 territories per km<sup>2</sup>. The densities surrounding Whale Tail Lake decreased by 10.9 territories per km<sup>2</sup> between 2018 (pre-flooding) and 2019 (post-flooding).

During the flooding, we documented 6 nests of 3 species that were lost due to direct impacts of the high water (Figure 7). We estimate an average loss of 3.8 nests per km<sup>2</sup> by taking the number of nests observed to be lost and dividing it by the total proposed flood zone of Whale Tail Lake (1.575 km<sup>2</sup>). The species that lost nests were Lapland Longspur (4), Semipalmated Sandpiper (1) and Herring Gull (1). Despite nest loss due to flooding and a significant amount of habitat loss, nests in the proposed flood zone had an estimated success rate of 56%.

### **Objective 3. Bird Behavioural Responses**

Birds nesting within the flood zone were captured and banded with unique band combinations. A total of 15 female Lapland Longspur were banded, while 8 Semipalmated Sandpipers were banded within the flood zone. Out of these 23 individuals, a single Lapland Longspur female re-nested after nest loss due to flooding, nesting approximately 125 m from the original nest and between 50 to 100 m away from the proposed flood zone. The original nest was estimated to be lost during the nestling stage due to flooding between July 1<sup>st</sup> - 3<sup>rd</sup> and we estimated that the bird initiated a new nest on the July 3<sup>rd</sup>.

### **Discussion**

Based on the results of the deterrent experiment, we conclude that our deterrents were not able to prevent birds from nesting.

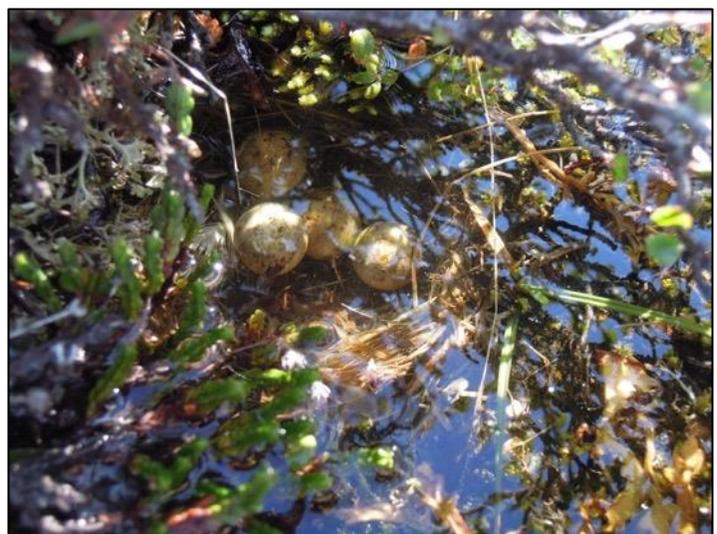


Figure 7: A Lapland Longspur nest with four eggs that was found within the Whale Tail Lake flood zone. It was found active, but later in the season became flooded.

Therefore, we do not recommend their use in future mitigations for nest loss of arctic-nesting birds. We are confident that the deterrents we used failed to deter birds from nesting in at risk areas, resulting in the loss of nests due to mining-induced flooding. There may be several possible reasons why the deterrents did not work, such as a bird's life history and the timing of deployment, and the risk that may be posed to other wildlife who occupy the same landscape.



**Figure 8: An extremely concealed Lapland Longspur nest with a piece of flash tape draped over it.**

Our sample is dominated by small, short-lived species such as Lapland Longspur. These species may be especially reluctant to abandon or forgo a breeding attempt in the presence of novel objects such as our deterrents, as they have fewer breeding opportunities compared to long-lived species. Previous studies have demonstrated the ability to deter birds from nesting with the use of a flash tape grid and other visual deterrents, such as done by Marcus et al. (2007) where these authors were successful in deterring Piping Plover and Least Tern from nesting within gravel pits. In the case of our study, Lapland Longspur showed no signs of obvious distress or disturbance during deterrent use. There were multiple occasions where a nest was found within 5 m of an audio deterrent speaker or directly under a piece of flash tape (Figure 8).

Treatments were applied during the early nest initiation period with an average nest initiation date of 13<sup>th</sup> of June, with the earliest initiation date estimated as the 3<sup>rd</sup> of June and as late as the 25<sup>th</sup> of June in 2019. Arctic-breeding birds nest very synchronously, due to their contracted breeding season. Delaying initiation or abandonment to establish a new territory could compromise reproductive success (Smith et al. 2010). Deploying deterrents before territories are established may be more effective but is logistically challenging. The challenges of deploying deterrents in a timely manner refers to the ability to erect deterrents during the late winter and early spring, when the ground is still frozen and there is still snow present on the landscape. These conditions made it difficult to travel with equipment on foot and the frozen ground made it difficult to hammer the aluminum angle in the ground, as well as making it difficult to ensure that the audio deterrent speakers stayed upright.

During the experiment there were a few instances where deterrents were damaged or destroyed due to mammals. In some plots where we found Arctic ground squirrels (*Spermophilus parryii*) or Arctic hare (*Lepus arcticus*) we anticipated that there might be some damage to the wires associated with the audio deterrent units. Damage by Arctic ground squirrels occurred on one occasion when a speaker cord was chewed, but we noticed and replaced the cord quickly. A more concerning issue arose as there was some noticeable impact on large ungulate species such as caribou and muskoxen. There were multiple occasions where visual deterrents were destroyed by caribou or muskoxen walking through the treatment plots, causing aluminum poles to be ripped out of ground and carried away. There was a case where fishing line was found to have blood on it, possibly from a caribou who may have gotten the fishing line caught around their mouth. This is a major concern, as we did not want to cause harm to wildlife.

The outcome of the project exhibited that arctic-nesting birds are not easily discouraged from nesting, especially in the case of visual and audio deterrent use. Based on the outcomes of the research, the amount labour and cost of deterrents, we would not recommend these methods for mitigating nest loss in the future.

## **Next Steps**

### **Objective 2: Flood Zone Impact Assessment**

In 2020, the study will continue to determine whether re-colonisation occurs in the flooded areas around Whale Tail Lake, as the flood waters recede. This will require the monitoring of the 16 plots within the flood zone surrounding Whale Tail Lake. We hope to understand how nesting birds react to the elimination of previously suitable habitat. How do bird densities change between years as the water line moves, and what role does elevation in the selection of nest sites? These objectives will be accomplished by visiting at least 8 out of 16 the plots within the proposed flood zone. We will select the plots located on the eastern shore of Whale Tail Lake and its tributaries (WT1 and WT2), as time and accessibility will limit the ability to visit the western shore of Whale Tail Lake.

### **Objective 3. Bird Behavioural Responses**

During the 2019 field season, 20 temperature probes were deployed on 20 nests within the experimental

treatment (n = 10) and control (n = 10) plots. While these data have not yet been analysed, results may provide whether there were subtle negative reactions by nesting birds to the presence of the deterrents.

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## APPENDIX I

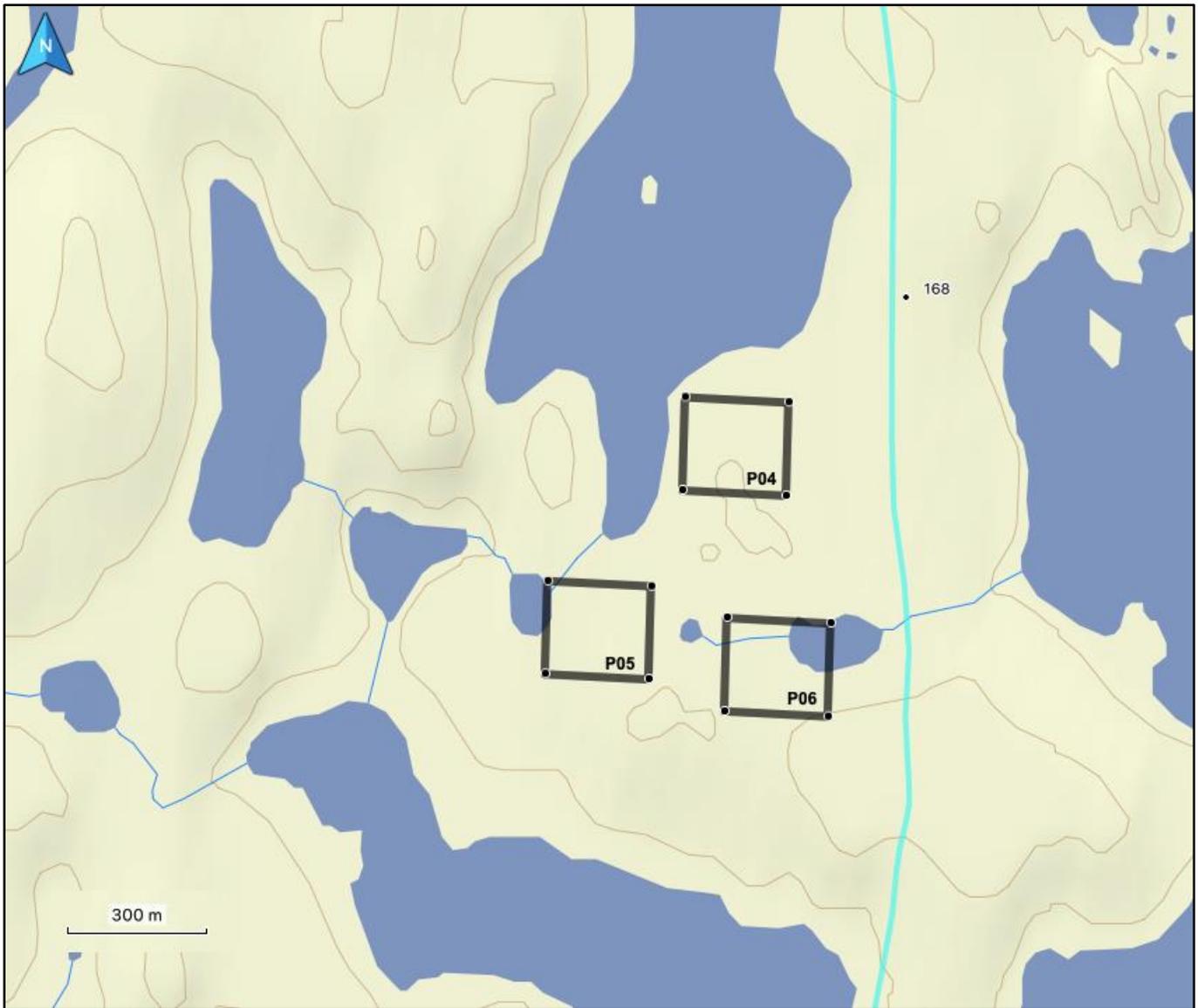


Figure 9: a map of Plot 4 (Treatment 2), 5 (Control) and 6 (Treatment 1), located on the west side of Kilometer 174 on Amaruq Road (light blue line)

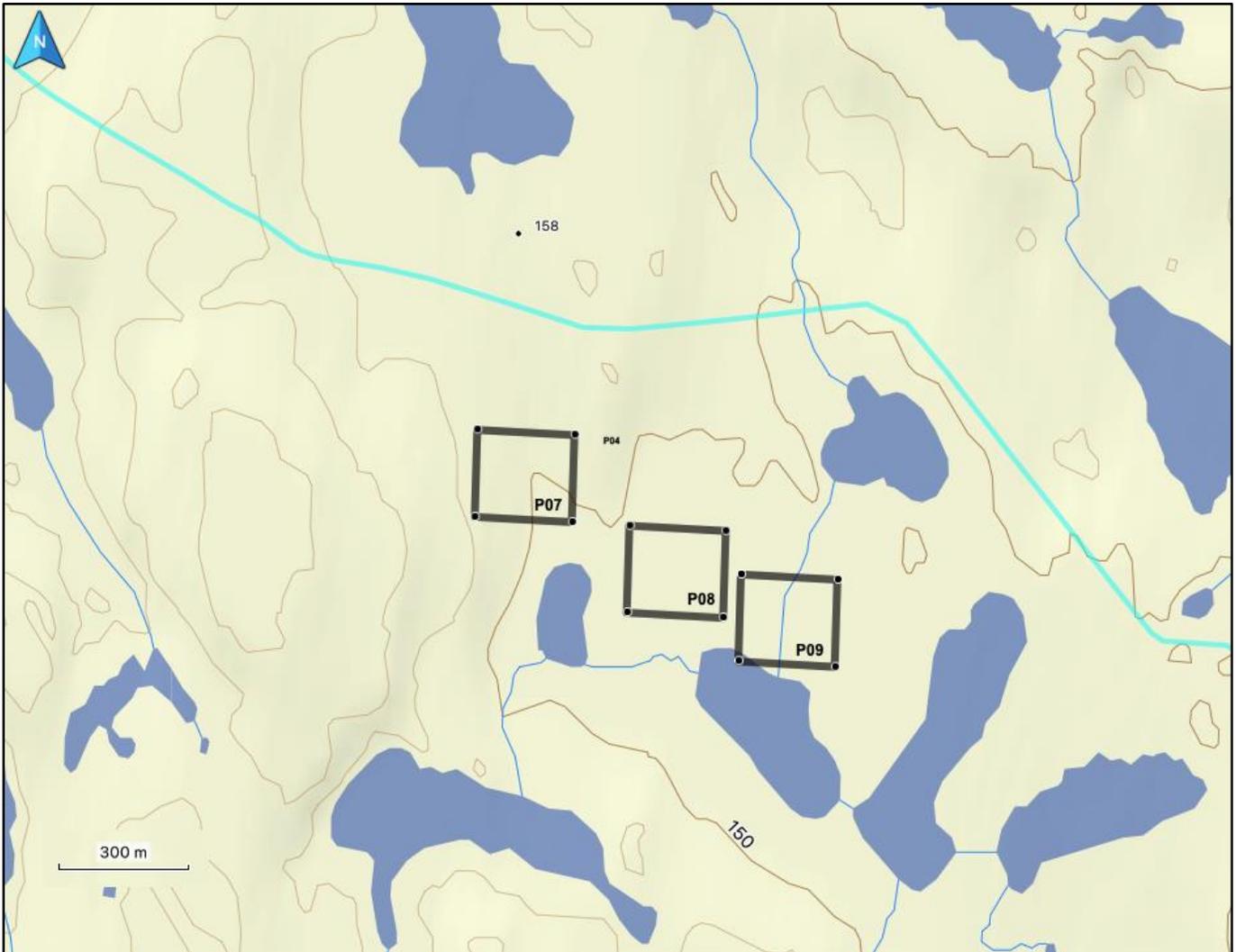
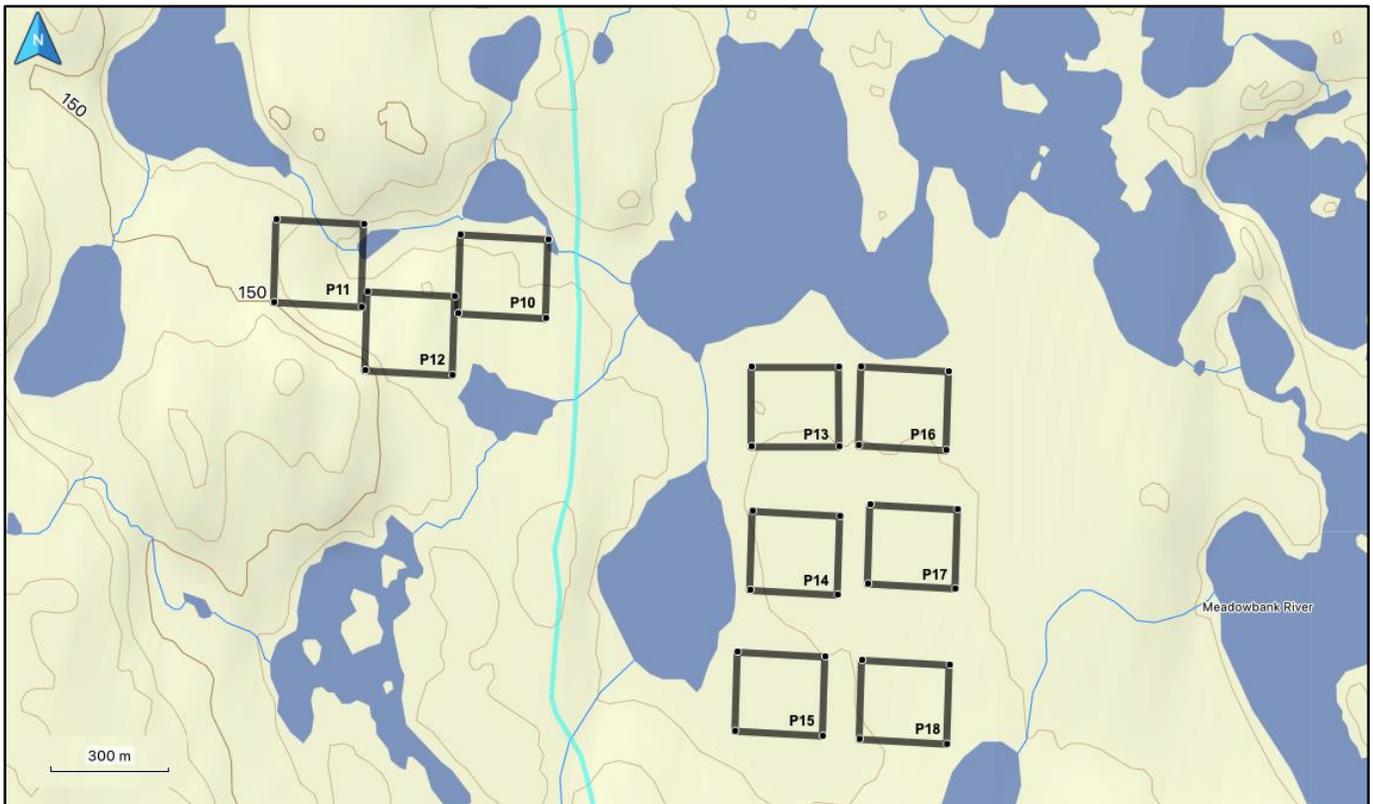


Figure 10: a map of Plot 7 (Control), 8 (Treatment 2), and 9 (Treatment 1), located on the south side of Kilometer 164 on Amaruq Road (light blue line)



**Figure 11: Figure 6: a map of Plot 10-12 located on the west side, and Plot 13-18 on the east side at Kilometer 160 on Amaruq Road (Light Blue Line). Plot 10, 13 and 16 (Treatment 1), Plot 12, 14, and 17 (Treatment 2), and Plot 11, 15, and 18 (Control).**

## APPENDIX II

Table 1: Nest density estimates (nest/km<sup>2</sup>) of all nests found within the three treatment plots between 2018 and 2019.

	2018	2019
Control	80.0	70.0
Treatment 1	66.6	116.6
Treatment 2	73.3	56.6

Table 2: Nest density estimates (nest/km<sup>2</sup>) of terrestrial birds (LALO, HOLA, SAVS) found within the three treatment plots between 2018 and 2019.

	2018	2019
Control	46.6	56.6
Treatment 1	46.6	83.3
Treatment 2	53.3	36.6

Table 3: Nest density estimates (nest/km<sup>2</sup>) of shorebirds (SESA, LESA, AMGP) found within the three treatment plots between 2018 and 2019.

	2018	2019
Control	10.0	13.3
Treatment 1	13.3	30.0
Treatment 2	13.3	16.6

Table 4: Nest density estimates (nest/km<sup>2</sup>) of Lapland Longspur nests found within the three treatment plots between 2018 and 2019.

	2018	2019
Control	36.6	50.0
Treatment 1	23.3	70.0
Treatment 2	36.6	33.3

Table 5: Nest density estimates (nest/km<sup>2</sup>) of Semipalmated Sandpiper found within the three treatment plots between 2018 and 2019.

	2018	2019
Control	10.0	6.6
Treatment 1	13.3	30.0
Treatment 2	6.6	13.3