MEADOWBANK MINE

2019 WILDLIFE MONITORING SUMMARY REPORT

FINAL

APPENDIX L

2019 Whale Tail Raptor Report

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Background

Abundance and distribution of raptor nesting sites in the region surrounding the Whale Tail Project was unknown prior to 2015. The purpose of the raptor monitoring program from 2015 – 2017 focused on searching for nesting sites located near to, and far from proposed or existing infrastructure. Monitoring of raptors is outlined in the Agnico Eagle Meadowbank Division Terrestrial Ecosystem Management Plan (TEMP; Agnico Eagle Mine 2019). The TEMP outlines requirements for avoiding and managing disturbance to nesting raptors, as follows:

- Develop a nest-specific response plan for identified raptor nests within areas of concern to ensure that nesting success is not affected by development activities
- Follow GN-DoE guidelines for avoiding disturbance to raptor nests
- Discourage raptors from establishing nests on artificial structures, pit walls, or other facilities
- Active raptor nest monitoring

In addition, the TEMP also outlines the general monitoring approach, as follows:

- document and map raptor nesting sites (see Term or Condition 33)
- evaluate the success of mitigation to prevent disturbance to raptors or raptor nests,
- estimate project-related disturbance effects.
- develop nesting site-specific management plans for nests within 1.5km of project infrastructure, including minimum "no disturbance" buffers (see Commitment 32). In the event of deterrence of removal of a nest, AEM must contact the GN, and secure the required permits (see Term and Condition 36).

The GN provided additional raptor-specific feedback from information provided in 2018 Annual Report, as follows:

- the current monitoring does not have the power to detect and mitigate Project-related effects on raptor nesting success.
- the study design does support analysis that would allow detection of project-related nest failures (e.g., by examining nest success as a function of intensity of project-related disturbance.

Species Descriptions

Peregrine Falcon (*Falco peregrinus tundrius*)

The Arctic peregrine falcon (Figure 1) is medium- to large-sized falcon. It has a dark hood and face with distinct dark malar stripe, cream to white throat, slate-grey back; barred belly, legs, and tail. Long pointed wings, stocky body. Plumage of immature birds brown rather than grey, and the breast is streaked rather than barred. In adults, the cere and orbital ring are yellow, and bluish in immature birds. Compared with gyrfalcons, the peregrine is smaller and less stocky. In flight, the wings of peregrines appear narrower and more pointed. In peregrine falcons, wing tips extend to bottom of the tail when perched, while in gyrfalcons, wing tips extend two-thirds down the length of tail

F. p. tundrius breeds mainly north of the treeline from Alaska east throughout northern Canada to Greenland. It breeds throughout the taiga and tundra wherever suitable nesting habitat and sufficient prey are present. In Nunavut, peregrines appear to have their highest densities in the Kivalliq and

Kitikmeot regions. Highest breeding density on record is on the western shores of Hudson Bay in the Kivalliq Region.

F. p. tundrius is a long-distance migrant, wintering mainly throughout South and Central America, but also in southern United States and Mexico. Northern-breeding American and Arctic peregrines are highly migratory (Yates et al. 1988, Schmutz et al. 1991, Fuller et al. 1998), and although fall migration occurs over a broad geographic range (Fuller et al. 1998), Yates et al. (1988) indicated that “separate and distinct autumn migratory populations pass through the east and Gulf coasts” of the United States.

Peregrine falcons usually nests on cliffs and rocky outcrops, but also nest on hilltops, river canyons, rock screes, and on occasion directly on the ground (Court et al. 1988, Ratcliffe 1993). They prefer nesting in locations close to water in south-facing, rugged terrain. Hunting habitat includes rugged coastline areas and rolling tundra that consists of raised beaches, dry tundra, sedge meadows, wetlands, and lakes that are inhabited by a diversity of breeding songbirds and shorebirds.

Peregrine Falcons do not build a nest but make a depression (called a scrape) in the substrate on a cliff ledge. Scrapes are usually approximately 20 cm in diameter and 4 cm deep. Females usually do the majority of incubation, and brooding of small young. Males provision incubating females and provide most of the prey when nestlings are small. Thereafter, females do most of the feeding, beginning to hunt after young are large enough to thermoregulate on their own. Clutch size is typically 3 or 4 eggs in Nunavut. In Rankin Inlet and Igloolik, the median incubation period of the first egg was 36 days, and decreased 1 day for each additional egg. The incubation period of the 4th egg (33 days) was similar to what has been reported elsewhere (Burnham 1983).

The Arctic peregrine falcon is a generalist predator with a diverse diet that includes passerines, shorebirds , ducks , gulls, terns, jaegers, black guillemots, and, when available, collared lemmings, brown lemmings, and Arctic ground squirrels. Bradley and Oliphant (1991) indicated that, around Rankin Inlet, small birds (64% of prey items) represented the greatest portion of prey items, followed by microtine rodents (25%), large birds (8%), and Arctic ground squirrels (4%). The most important prey measured by percent biomass were large birds (43%), followed by small birds (25%), microtine rodents (18%), and Arctic ground squirrels (15%).

In Nunavut, the earliest documented arrival for Peregrine Falcons is 10 May at a known breeding site near Rankin Inlet. Although arrival timing varies with spring conditions, the majority of sites are occupied during the 3rd week of May. Median laying date in Rankin Inlet (9 June) is typically earlier than Igloolik (15 June) and northern Baffin Island (16 June). Median date of hatching ranges from 14 July at Rankin Inlet to 18 July on northern Baffin Island and 20 July at Igloolik (Jaffre et al. 2015). Birds depart the breeding grounds from mid-September through early October, arriving on the wintering grounds throughout Central and South America in November.

Gyrfalcon (*Falco rusticolus*)

The gyrfalcon (Figure 2) is large with pointed wings, but more rounded and broader than the wings of other falcon species. The tail is relatively long. When perched, wings extend 2/3 down the tail. The body is thick and powerful, particularly in females. Adults have yellow ceres, eye-rings and legs. As in all falcons, the eyes appear black. Three main color morphs occur: black, grey and white. White adults have almost pure white breasts and bellies, with dark wingtips (dipped-in-ink appearance). Grey adults have slate-colored back, with white underparts mottled with gray arrowhead-shaped markings. Dark adults are dark-grey overall above and dark-streaked breasts and belly. There is extreme reverse sex dimorphism, with males being approximately 2/3 the size of females (Ferguson-Lees et al. 2001).

Gyrfalcons distribution extends throughout the circumpolar Arctic. Most of the breeding range occurs north of 60°N, but breeding pairs are known to exist as far south as 55°N, mainly along sea coasts in eastern Canada. Many adults remain within the breeding range throughout the year, but some disperse southwards in winter, small numbers reaching the norther. United States (Cade 1982, Poole 1987). Immature birds are much more likely to winter to south of breeding range, and females are thought to disperse more widely, with many males remaining relatively close to breeding territories throughout the year.

Ptarmigan are often cited as the most important prey species by biomass, but Arctic ground squirrel and Arctic hare are also important, as well as small mammals (mice and voles) and other birds (ducks, sparrows, buntings). In central Nunavut, Poole and Boag (1988) identified eleven species of birds and five species of mammals among the prey. Birds accounted for three quarters of the diet, and adult rock ptarmigan were the most common. Arctic ground squirrel and arctic hare, made up the bulk of mammalian prey.

Males occupy and defend nesting territories as early as the end of January, with females arriving in mid-March. In Nunavut, laying typically begin in the first week of May with most pairs laying by the end of the second week in May. Nestlings typically hatch in mid-June but hatching can occur throughout June. Nestlings fledge in late July or early August after 7 weeks in the nest. In Nunavut, gyrfalcon usually nest on cliff ledges, ideally beneath sheltering overhang; sometimes nests in trees or on man-made structures. Nests are generally on rock ledges or abandoned rough-legged hawk or common raven nests. Use of alternate nest sites is not uncommon. Pairs do not necessarily attempt breeding every year, depending on food supply. Typical clutch size is 3-4 eggs (Booms et al. 2008) that are incubated for 34-36 days mostly by the female (ca. 80%). The North American population including Nunavut is considered to be stable (Clum and Cade 1994, Kirk and Hyslop 1998). Although low spring temperatures are associated with later arrival at nesting territories in Nunavut (Poole and Bromley 1988), there was no effect on laying dates. However, (Poole and Bromley 1988) indicated that increased spring precipitation (snow) reduced reproductive success.

Rough-legged Hawk (*Buteo lagopus)*

The rough-legged hawk (Figure 3) is a medium-large bird of prey, with a fairly small beak, predominantly brown in colour and often mottled. Plumage is highly variable with recognized light and dark morphs. Extensive field experience is required to distinguish between males and females, and between adults and juveniles based on plumage alone. A broad chest band is evident in most plumage variations, and in flight, a dark carpal patch is characteristic in light morph individuals. One or more dark terminal bands appear on the tail. The wing tips are long enough to reach or extend past the tail when the animal is perched. Legs are feathered to feet (Ferguson-Lees et al. 2005).

Widespread throughout North America, breeding from the Aleutian Islands, the interior of Alaska, Yukon, northern Mackenzie, and across Nunavut to northern Labrador and Newfoundland and south to Manitoba and southeastern Quebec. In Nunavut, rough-legged hawks are present over most of the territory except for islands without lemmings (Bechard and Swem 2002).

Regularly hovers, or "kites" while facing into the wind scanning for prey. Soars with wings raised in a slight dihedral (V-shape). It is a diurnal raptor that still-hunts from prominent perching structure on both breeding and wintering grounds. Prey is captured on the ground. Courtship involves soaring and calling, with the male engaged in a flight display of repeated undulating stoops rising upward to mid-air stall. It is gregarious on migration, often travelling in large flocks, but small groups or individuals are not uncommon.

During the summer, breeding pairs prefer rugged terrain areas with steeper slopes in areas associated with primary production (i.e., vegetation), and were most likely to nest in large, productive valleys surrounded by high-elevation plateaus (Galipeau et al. 2016). It is widely distributed in winter, usually found in open habitat resembling the tundra such as prairies, plains, coastal marshes, agricultural fields, and airports (Johnsgard and Johnsgard 1990). More common in wintering areas typified by short growing seasons and low precipitation, with highest densities in the northern United States, Great Basin area, and the western shortgrass prairies (Bock and Lepthien 1976, Bock et al. 1977).

The rough-legged hawk is a small mammal specialist; thus, its breeding activity is generally associated with local abundance of ground squirrels, voles, or lemmings (Hanski 1991, Potapov 1997). It will prey on birds when small mammals are scarce, particularly juvenile passerines and shorebirds, and will resort to consuming carrion opportunistically (Watson 1986). Usually reproductively mature at 2 years of age. Stick-nests are built soon after arrival on territory, typically on cliffs, on bluffs, or on the ground. Clutch sizes are variable (1-7 eggs), depending on food availability, but 3-5 eggs are usual and laid in May. Incubation 31-33 days, provided almost entirely by the female. Nestling period is 35-40 days, and fledglings remain dependent on adults for another 2 weeks. The male provisions the young and the female, which feeds the young. Pairs show nest site fidelity, and in locations where ground squirrels are entirely absent, they may forgo breeding or have small broods when lemmings are low, in contrast to Snowy Owls, which are truly nomadic (Bechard and Swem 2002). Bechard and Swem (2002) indicated that egg-laying date was associated with spring temperatures and snow-free ledges, but Potapov (1997) reported no effect of snow melting date or spring/summer temperatures on number of nesting pairs.

Methods

Terminology

The terminology used throughout this report follows (Franke et al. 2017). The following terms are highlighted in an effort to clarify terminology used in this report, and/or to distinguish terms used from similar terms that have distinct meaning:

nest — The structure made or the place used by birds for laying their eggs and sheltering their young (Steenhof and Newton 2007) regardless of whether eggs are laid in the nest in a given year or in any year (Millsap et al. 2015, Steenhof et al. 2017), see Scrape for Gyrfalcons.

nesting site — The substrate which supports the nest or the specific location of the nest on the landscape (Ritchie and Curatolo 1982, Millsap et al. 2015, Steenhof et al. 2017).

alternative nesting site — One of potentially several nests within a nesting territory that is not a used nest in the current year (Millsap et al. 2015).

nesting territory — An area that contains, or historically contained, one or more nests within the home range of a mated pair: a confined locality where nests are found, usually in successive years, and where no more than one pair is known to have bred at one time (Newton and Marquiss 1984, Steenhoff and Newton 2007). Note that a nesting territory may or may not be defended (Postupalsky 1974), and probably does not include all of a pair's foraging habitat (Newton and Marquiss 1984, Steenhoff and Newton 2007).

occupancy — The quotient of the count of occupied nesting territories and the count of known nesting territories that were fully surveyed in a given breeding season (Franke et al. 2017).

brood size — The actual number of young hatched from a single nesting attempt by a pair of birds. For studies in which mortality that occurs between hatching and the first observation of the brood is unknown, it is appropriate to report brood size (i.e., number hatched) only for broods equal to, or less than 10 days of age. For broods older than 10 days of age, see Brood Size ≥10 days. Report mean and standard error, or standard deviation.

brood size ≥ 10 days — The number of young hatched from a single nesting attempt by a pair of birds. For studies in which mortality that occurs between hatching and the first observation of the brood is unknown, and nestlings are equal to, or greater than 10 days of age, but less than Minimum Acceptable Age for Assessing Success. Report mean and standard error, or standard deviation.

minimum acceptable age for assessing success — A standard nestling age at which a nest can be considered successful. An age when young are well grown but not old enough to fly and after which mortality is minimal until actual fledging. Typically 80% of the age that young of a species normally leave the nest of their own volition for many species, but lower (65–75%) for species in which age at fledging varies considerably or for species that are more likely to leave the nest prematurely when checked (Steenhof and Newton 2007).

nest survival — The probability that a nesting attempt survives over the complete nesting period. When Daily Survival Rate (DSR; Dinsmore et al. 2002) is assumed to be constant over time and E is the nesting period (usually expressed in days), nest survival is DSR^E; otherwise nest survival is the product of each estimated DSR. For raptors, nest survival is the equivalent of nesting success for egg-laying pairs (Steenhof et al. 2017).

productivity — The number of young that reach the minimum acceptable age for assessing success; usually reported as the number of young produced per territorial pair or per occupied territory in a particular year (Steenhoff and Newton 2007, Steenhof et al. 2017).

total production — The total number of young detected.

Field Surveys

Structured surveys were conducted from 2015 – 2017, and in 2019. The focus of these surveys was to search known nesting sites for the presence of cliff-nesting raptors. In addition to the structured surveys, favourable habitat was searched opportunistically when ferrying between known sites, camps or other mine infrastructure and when raptors or signs of site use (e.g., whitewash, orange-colored lichen, and unused nests) were observed. Sites were considered occupied if one or more adults displayed territorial or reproductive behavior (e.g., vocalization and/or flight behavior associated with defense of breeding territory or presence of nest building, nest, or eggs). Locations with partially built or unused nests without detection of breeding aged adults were noted as such (e.g., old stick nest; no birds detected). Raptor monitoring in 2019 involved one helicopter survey (13 – 17 June), and ground -

monitoring of potential nesting habitat (natural cliffs, quarries and borrow pits) along the Haul Road. A second survey to evaluate reproductive success, and provide an estimate of detection error was planned for 7 – 10 August, but was cancelled due to weather, and limitations associated with helicopter availability and travel logistics.

Data Exploration

Nearest Neighbour Distances

Nearest neighbour distances (NND) were calculated in R (R Development Core Team 2017) using the sp, rgeos, and geosphere packages to transform nesting site locations into spatial objects, calculate pairwise distances, and identify the shortest distance between known neighbouring nesting site locations.

Distance to disturbance

Spatial objects (lines and polygons) describing the project footprint were acquired from Agnico Eagle. Euclidean distances from nesting sites to the nearest spatial object were calculated in R (R Development Core Team 2017) using the sp, rgeos, and geosphere packages. Summary data were generated using the hist, boxplot and summary functions in R.

Assigning Nesting Sites to Nesting Territories

In the absence of marked individuals, it can be challenging to definitively identify alternative nesting sites. Failure to account for alternative nesting sites can lead to underestimating demographic parameters such as annual productivity. To address this problem, a rule-based approach was used to estimate the number of alternative nesting sites within the study area (Figure 4):

- If two species-specific nesting sites were separated by a distance of ≤ 1 km they were considered alternative nesting sites in a single nesting territory.
- If two nesting sites within 1 km of each other were occupied by the same species in a given year, they were considered separate territories.
- If multiple species-specific nesting sites were within 1 km of one another, discrete geographic landforms or discontinuities in cliff structure were used to separate or combine sites into territories.

Temporal patterns of multi-species occupancy were used to assess the plausibility of decisions based on the application of the three rules listed above. For example, if two nesting sites were located within 1 km of each other and were occupied by two different species in alternating years, these nesting sites were identified as distinct alternative nesting sites for each species.

Assigning Identification Numbers (ID) to Nesting Territories was conducted according to the following rule set:

- Nesting Territory IDs were assigned within species only (e.g., Nesting Territory IDs for PEFA and RLHA were never shared).
- Nesting Territory IDs were assigned using the Identification Number of one of the Nesting Sites in the cluster according to the following rule set, in order of priority:

    i. Length of tenure (i.e., nesting sites with the longest tenure)

    ii. First tenure (i.e., nesting sites with the first tenure in the event length of tenure was equal).

Occupancy

Although it is not possible to estimate detection error without multiple surveys (i.e., fully surveyed), point estimates without corresponding estimates of error can be calculated as the quotient of the count of occupied nesting territories and the count of known nesting territories that were surveyed in a given breeding season, even if they were not fully surveyed. For each species separately, we first tallied the total count of known nesting sites across all surveys combined. We then adjusted the year-specific count of known nesting sites to account for nesting sites that were not known in that year (i.e., had not been found). Using the methods to assign nesting sites to nesting territories described in the previous section, we tallied the number year-specific nesting territories. We then calculated the year-specific proportion of known nesting territories that were occupied as a proportion of the known nesting territories that were surveyed. For visualization purposes only (i.e., no statistical assessment of trend was attempted), we then used Loess Regression to smoothen the available time series

Results

Data Exploration

Across five different surveys (see Table 1), one-hundred and fourteen locations considered to be typical of raptor nesting habitat were surveyed at least once from 2015 – 2017, and 2019 (n.b., no surveys were conducted in 2018). Of the 114 locations surveyed (Figure 5), nesting raptors have been detected at 58 nesting sites (Table 2). Peregrine falcons have been documented at 43 nesting sites, rough-legged hawks at 23 nesting sites and gyrfalcons have been documented at six nesting sites. The mean nearest neighbour distance (i.e., occupied sites only) was 1.15 km (range = 0.11– 5.36 km). Mean distance from known occupied nesting sites to the haul road was 13.05 km (range = 0.06 – 29.02 km); one nesting site fall within 1.5 km of the Haul Road, and is considered a candidate for development of a site-specific management plan (see Management Plans). A second survey location falls with the “no disturbance” buffer, but nesting raptors have not been detected at this location to date. Mean distance from known occupied sites to the Whale Tail footprint was 17.46 km (range 0.66 – 51.66 km). Two nesting sites fall within 1.5 km of the Whale Tail footprint, and are considered candidates for development of a site-specific management plan (see Management Plans). However, neither are with the 600m limit identified in Government of British Columbia (2013).

After applying the rule-based approach to assign nesting sites to nesting territories, we assessed one peregrine falcon nesting site to be an alternate site within one nesting territory resulting in total of 41 peregrine falcon nesting territories. For rough-legged hawks and gyrfalcons, two nesting sites for each species were considered to alternates, resulting in 21 nesting territories for rough-legged hawks and four for gyrfalcons.

Point estimates for occupancy indicate that peregrine falcons (mean = 0.63) and gyrfalcons (0.63) have been stable (Table 1, Figure 6). For rough-legged hawks, mean occupancy was equal to 0.46, however, data indicate that a peak occurred in 2017 (0.76), which is a well-known for small-mammal specialists which respond to microtine rodent cycles (Gilg et al. 2006).

Discussion

This report retroactively applies GN-DoE guidelines (Government of British Columbia 2013) to assess potential disturbance to known nesting sites that have been identified over the course of five survey-years (i.e., active baseline monitoring). Agnico Eagle has developed nest-specific response plans for raptor nesting sites within areas of concern to evaluate potential effect of development activities on breeding success. To date, Agnico Eagle has not detected instances of raptors establishing nests on artificial structures, pit walls, or other facilities along the Haul Road or Whale Tail site. Furthermore, mitigation of disturbance has not been necessary as Agnico Eagle has not detected any raptor nests within 1.5km of existing infrastructure.

To date, monitoring has focused on searching for, documenting and mapping nesting sites for three raptor species (peregrine falcons, rough-legged hawks, and gyrfalcons). Study design has been limited to single surveys conducted annually since 2015 (except for 2018), which does not allow for estimation of detection error in estimates of occupancy (i.e., project-related disturbance effects). To address this limitation, starting in 2020, the study design shall be updated to incorporate multiple surveys annually, and will take advantage of the distribution of known nesting sites to monitor occupancy and reproductive success as a function of distance to project-related disturbance, and other covariates as available (e.g. small mammal abundance).

This report meets Term and Condition 33 by documenting and mapping raptor nesting sites (Figure 5, Table 2), and presenting site-specific management plans (see below) for nests within 1.5km of project infrastructure, including minimum “no disturbance” buffers (see Commitment 32).

Management Plans (Commitment 32)

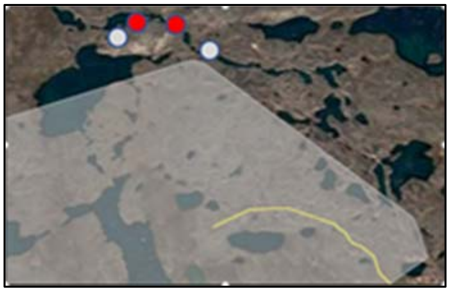
Nesting Site 42

This nesting site (red circle) is located 0.488 km from the Haul Road (yellow line) at latitude 65.110917, longitude -96.104477 (road marker km 121). It was checked in 2015 and 2017, but raptors were not detected. It was occupied by peregrine falcons in 2019 (post Haul Road construction). Ongoing monitoring will be required to determine whether this nesting site is regularly occupied in future years. It is located in a narrow gulley between two rock outcrops, and is not within direct view of the road. Direct disturbance risk (access by people, noise from road traffic) is considered to be low.

Site 43

This site (grey circle) is located 1.005 km from the Haul Road (yellow line) at latitude 65.273917, longitude -96.450046 (road marker km 153). It has no history of use, and is not considered to be at risk of disturbance due to it distance from the Haul Road (i.e., >600m), and its history of use. It is within the 1.5 km “no disturbance” buffer, but greater than the 600m buffer recommended in Government of British Columbia (2013). Agnico Eagle will continue to monitor this potential nesting site annually for presence of nesting raptors, but a management plan is not considered necessary for this cliff.

Sites 58 and 119



Both sites have been checked annually since 2015, and have been regularly occupied (119 by rough-legged-hawks, and 58 by peregrine falcons). Both sites are on the same cliff, and are located within 1.5 km of the expected Whale Tail Project footprint. Both sites are located beyond the 600m buffer (119 = 825m and 58 = 661m) recommended in Government of British Columbia (2013). Furthermore, the nesting cliff faces north, and direct exposure of incubating birds and nestlings to the Whale Tail Project footprint is minimal. Agnico Eagle will continue to monitor these nesting sites annually for presence of nesting raptors, but a management plan is not considered necessary for this cliff.

Tables

Table 1

Table 1. Survey effort and occupancy for peregrine falcons, rough-legged hawks and gyrfalcon breeding near the Whale Tail Project, Nunavut from 2015 – 2019.

Survey effort

Year	2015		2016		2017		2018		2019	
Type	Occupancy	Productivity	Occupancy	Productivity	Occupancy	Productivity	Occupancy	Productivity	Occupancy	Productivity
Date	28 – 30 May	N/A	May 18 - 20	Jul 21 -23	28 – 30 May	N/A	N/A	N/A	13 – 15 Jun	cancelled
Hours	12	N/A	10	10	12	N/A	N/A	N/A	10	cancelled

Occupancy metrics

Year	2015			2016			2017			2018	2019		
	occupied	known	occupancy	occupied	known	occupancy	occupied	known	occupancy	N/A	occupied	known	occupancy
PEFA	24	30	0.80	22	37	0.59	23	41	0.56	N/A	23	41	0.56
RLHA	4	14	0.29	9	20	0.45	16	21	0.76	N/A	7	21	0.33
GYRF	4	4	1.00	2	4	0.50	2	4	0.50	N/A	2	4	0.50

Table 2

Table 2. Geographic coordinates (decimal degrees), distance to nearest neighbour (D2NN), distance to road (D2RD), and distance to footprint (D2FP) for 58 occupied nesting sites surveyed between 2015 and 2019.

	site	latitude	longitude	D2NN (km)	D2RD (km)	D2FP (km)	Mgt. Plan
1	4	65.26865	-96.2974	2.49	4.716	20.0762	No
2	5	65.43728	-96.5821	0.3	4.347	3.471654	No
3	8	65.44396	-96.6014	0.12	4.677	3.495891	No
4	9	65.45078	-96.6041	0.43	5.351	4.010533	No
5	10	65.44697	-96.6058	0.18	4.933	3.62981	No
6	14	65.44189	-96.7278	0.25	5.283	2.493361	No
7	16	65.44494	-96.7334	0.24	5.711	2.898658	No
8	21	65.53657	-96.9563	2.96	20.159	16.49045	No
9	23	65.54697	-96.7894	0.91	17.052	14.48342	No
10	24	65.54884	-96.7702	0.91	16.94	14.41999	No
11	25	65.56906	-96.82	0.43	19.867	17.26577	No
12	26	65.57202	-96.8261	0.43	20.281	17.66797	No
13	27	65.5984	-96.9029	0.75	24.467	21.5935	No
14	28	65.60489	-96.9071	0.75	25.198	22.33922	No
15	32	65.11769	-95.8505	0.51	9.003	46.83729	No
16	34	65.28798	-96.3603	0.23	2.266	16.49749	No
17	38	65.48439	-96.1955	1.36	21.47	20.86524	No
18	39	65.52728	-96.298	1.15	20.527	19.67945	No
19	40	65.57981	-96.2658	0.69	25.839	24.98003	No
20	42	65.11092	-96.1045	2.15	0.488	39.34663	Yes
21	44	64.9376	-96.2774	2.53	0.059	51.65769	Yes
22	46	65.34242	-96.4942	0.25	1.643	7.833974	No
23	49	65.26724	-96.3507	1.56	2.678	18.5599	No
24	51	65.09825	-96.1389	0.63	2.592	39.5332	No
25	52	65.07079	-96.152	2.49	1.654	41.63656	No
26	54	65.1041	-96.2826	2.51	8.472	35.12121	No
27	55	65.28111	-96.6848	2.36	9.379	9.346625	No
28	58	65.43157	-96.6778	0.54	3.186	0.661308	Yes
29	59	65.47422	-96.7106	1.72	8.174	5.653718	No
30	61	65.17494	-95.8958	5.36	10.453	41.11073	No
31	63	65.11243	-96.3323	2.51	10.638	33.07526	No
32	65	65.20558	-96.6023	0.48	7.011	18.36187	No
33	67	65.20154	-96.6061	0.48	7.371	18.75303	No
34	68	65.21639	-96.7209	0.79	11.656	16.49884	No
35	73	65.45661	-96.7737	0.45	7.88	4.730445	No
36	74	65.4548	-96.7583	0.29	7.277	4.309077	No
37	75	65.45524	-96.7645	0.29	7.491	4.448234	No
38	77	65.44382	-96.6637	0.79	4.357	1.987167	No
38	78	65.45267	-96.4856	1.45	8.503	7.655634	No
40	79	65.45624	-96.3541	4.49	13.675	12.88288	No
41	83	65.50426	-97.2294	3.45	28.553	24.04926	No
42	85	65.50109	-97.0226	0.56	19.917	15.65364	No
43	86	65.50602	-97.02	0.56	20.128	15.91137	No
44	87	65.5096	-97.0309	0.22	20.77	16.55399	No
45	89	65.52295	-97.0726	0.14	23.203	18.98755	No
46	90	65.52388	-97.0747	0.14	23.342	19.1282	No
47	91	65.46928	-96.4458	1.63	11.116	10.26902	No
48	92	65.49034	-96.2212	1.36	20.91	20.10259	No
49	94	65.45977	-96.9551	1.72	14.928	10.47587	No
50	95	65.51802	-97.1627	2.82	26.451	22.05913	No
51	97	65.57796	-96.9643	0.28	23.99	20.65109	No
52	99	65.5352	-96.7453	1.91	15.141	12.6275	No
53	107	65.21393	-96.7367	0.79	12.44	16.80833	No
54	108	65.53874	-97.1977	0.11	29.011	24.67434	No
55	109	65.5396	-97.1966	0.11	29.017	24.6861	No
56	116	65.54353	-97.1504	0.65	27.465	23.22592	No
57	117	65.44444	-96.9512	0.55	14.114	9.563901	No
58	119	65.43146	-96.6896	0.34	3.397	0.824742	Yes

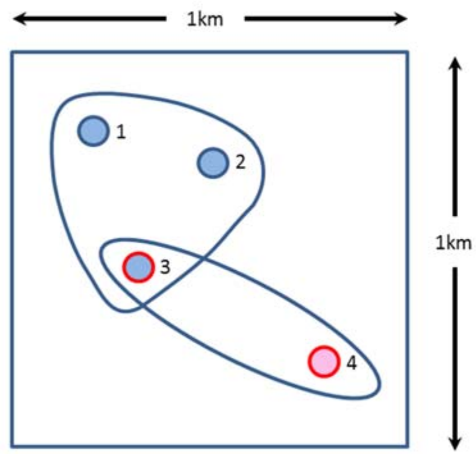
Figures

Figure 1

Figure 2

Figure 3

Figure 4



NS ID	PEFA NT ID	RLHA NT ID	2011	2012	2103	2014	2015	2016	2017
1	**1**	**-**	PEFA	PEFA	NBD	NBD	NBD	PEFA	PEFA
2	1	-	NBD	NBD	PEFA	NBD	PEFA	NBD	NBD
3	1	4	NBD	NBD	NBD	PEFA	RLHA	RLHA	NBD
4	-	4	RLHA	RLHA	NBD	RLHA	NBD	NBD	RLHA

Figure 5

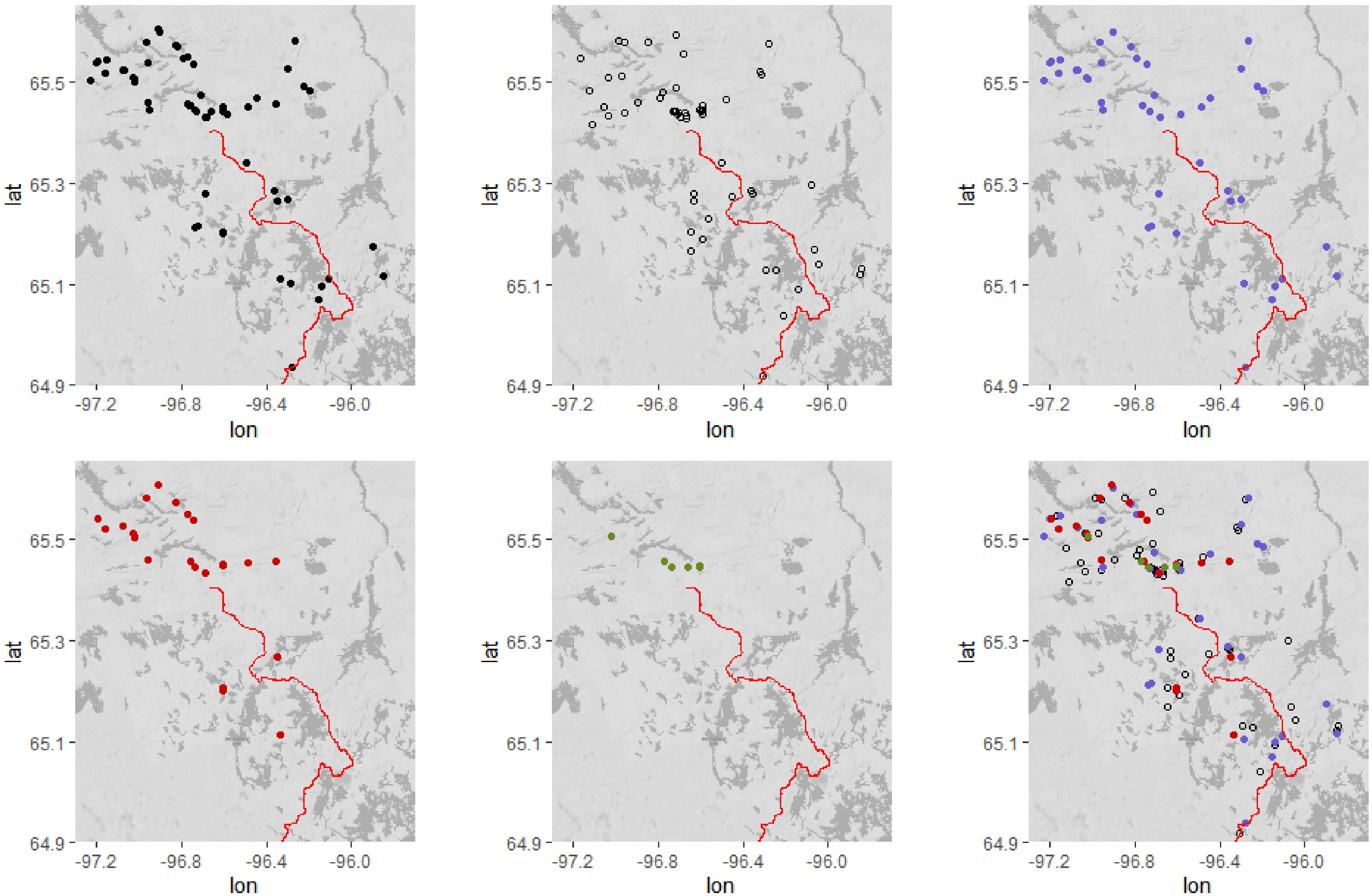
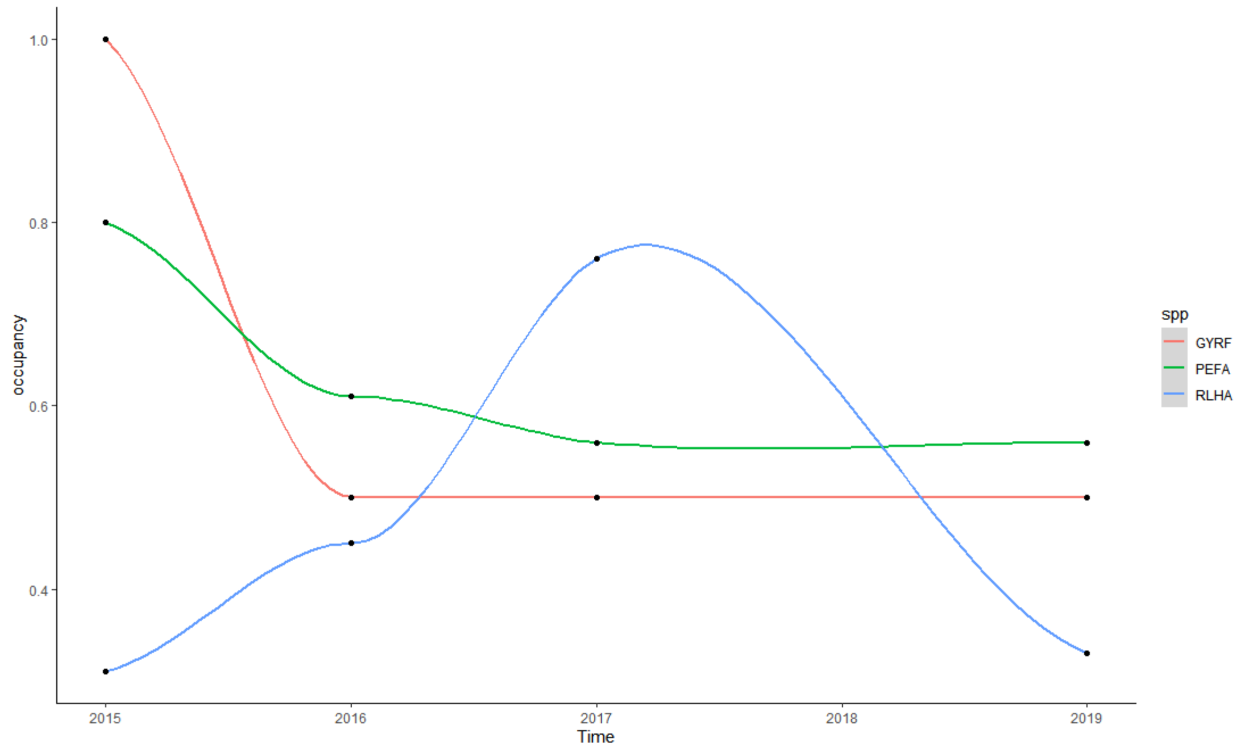


Figure 6



1.0
0.8
0.6
0.4
occupancy
2015
2016
2017
2018
2019
Time
spp
GYRF
PEFA
RLHA

Captions

Figure 1. Adult male peregrine falcon. Note the dark hood and face with distinct dark malar stripe, white throat, slate-grey back, and barred belly, legs, and tail. Wing are long and pointed. Note the yellow legs, cere and eye ring.

Figure 2. Adult female gyrfalcon. Note that wings are more rounded and broader than the peregrine falcon. The tail is relatively long. When perched, wings extend 2/3 down the tail. The body is thick and powerful, particularly in females. Adults have yellow ceres, eye-rings and legs.

Figure 3. Adult male rough-legged hawk. Note predominantly brown in colour and mottled. A broad chest band is evident, and dark carpal patches (not evident here) are characteristic in light morph individuals. One or more dark terminal bands appear on the tail. The wing tips are long enough to reach or extend past the tail when the animal is perched. Note that legs are feathered to feet

Figure 4. Rule-based approach used to assign nesting sites to nesting territories. A cluster of four nesting sites within 1 km of one another that exhibit a site occupancy history among seven years for two species (PEFA and RLHA). Nesting Sites 1 and 2 (blue circles with blue borders) have been occupied solely by PEFA. Nesting Site 4 (red circle with red border) has been occupied solely by RLHA. Nesting Site 3 (blue circle with red border) has been occupied by both PEFA and RLHA. In this example, Nesting Sites 1, 2 and 3 are grouped into a single PEFA Nesting Territory and assigned Nesting Territory ID 1 based on PEFA–specific tenure length (Nesting Site 1 has the longest tenure) and first tenure. Nesting Sites 3 and 4 are grouped into a single RLHA Territory and assigned Nesting Territory ID 4 based on RLHA–specific tenure length (Nesting Site 4 has the longest tenure) and first tenure. Unique nesting locations are ultimately defined by a Nesting Territory ID and a Nesting Site ID (E.g., NT ID 1, NS ID 2). NBD = no birds detected.

Figure 5. Distribution (2015 – 2019) of nesting sites occupied at least once (black circles, upper left panel), potential nesting sites with no history of occupancy (open circles, upper middle panel), nesting sites occupied by peregrine falcons (purple circles; upper right panel), nesting sites occupied by rough-legged hawks (red circles; lower left panel), nesting sites occupied by gyrfalcons (green circles; lower middle panel), all species combined (lower right panel). The Haul Road (red line), Whale Tail Project footprint (grey polygon), and regional study area (black line) are shown relative to the distribution of nesting sites.

Figure 6. Trend (visualizations purposes only, loess smoothing) in occupancy for peregrine falcons (green line), rough-legged hawks (blue line), and gyrfalcons (red line) from 2015 – 2019. Annual occupancy point estimates for each survey year (black circles) are also presented (see Table 1 for details).

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APPENDIX M

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 ECCC, 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^2). 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^2). 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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APPENDICES

LIST OF FIGURES

SECTION 1 • INTRODUCTION

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).

PROJECT: DA11-062-08

CLIENT: Agnico-Eagle Mines Ltd. Meadowbank Division

DATE: 12, March 2020

DRAWN BY: Janel Sauder

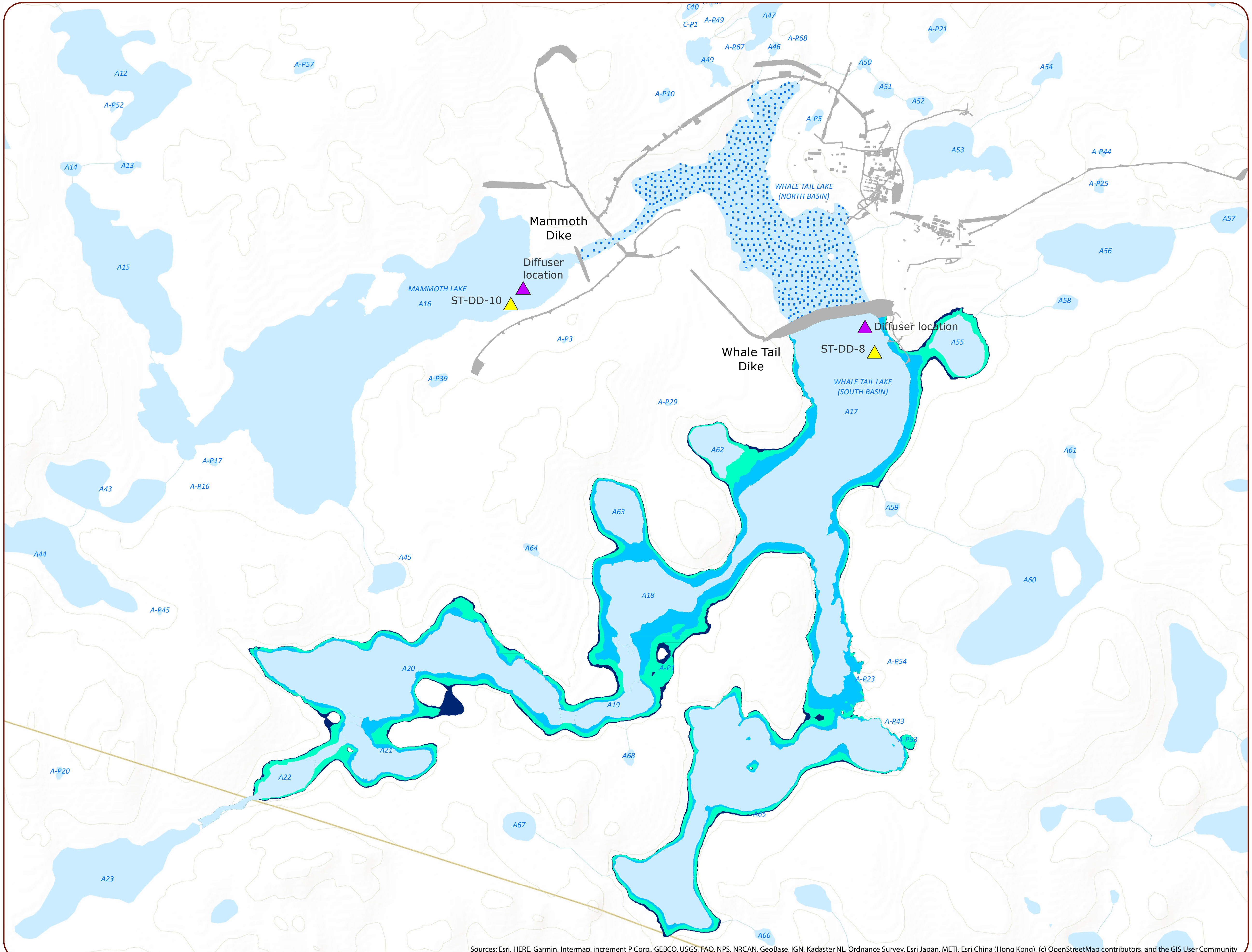

Figure 1: Whale Tail South Flood Zone Water Levels

Legend

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

South Whale Tail Lake Elevations

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

0 0.25 0.5 1

Kilometres

SCALE: 1:22,000

N

UTM Zone 17N NAD83

AGNICO EAGLE

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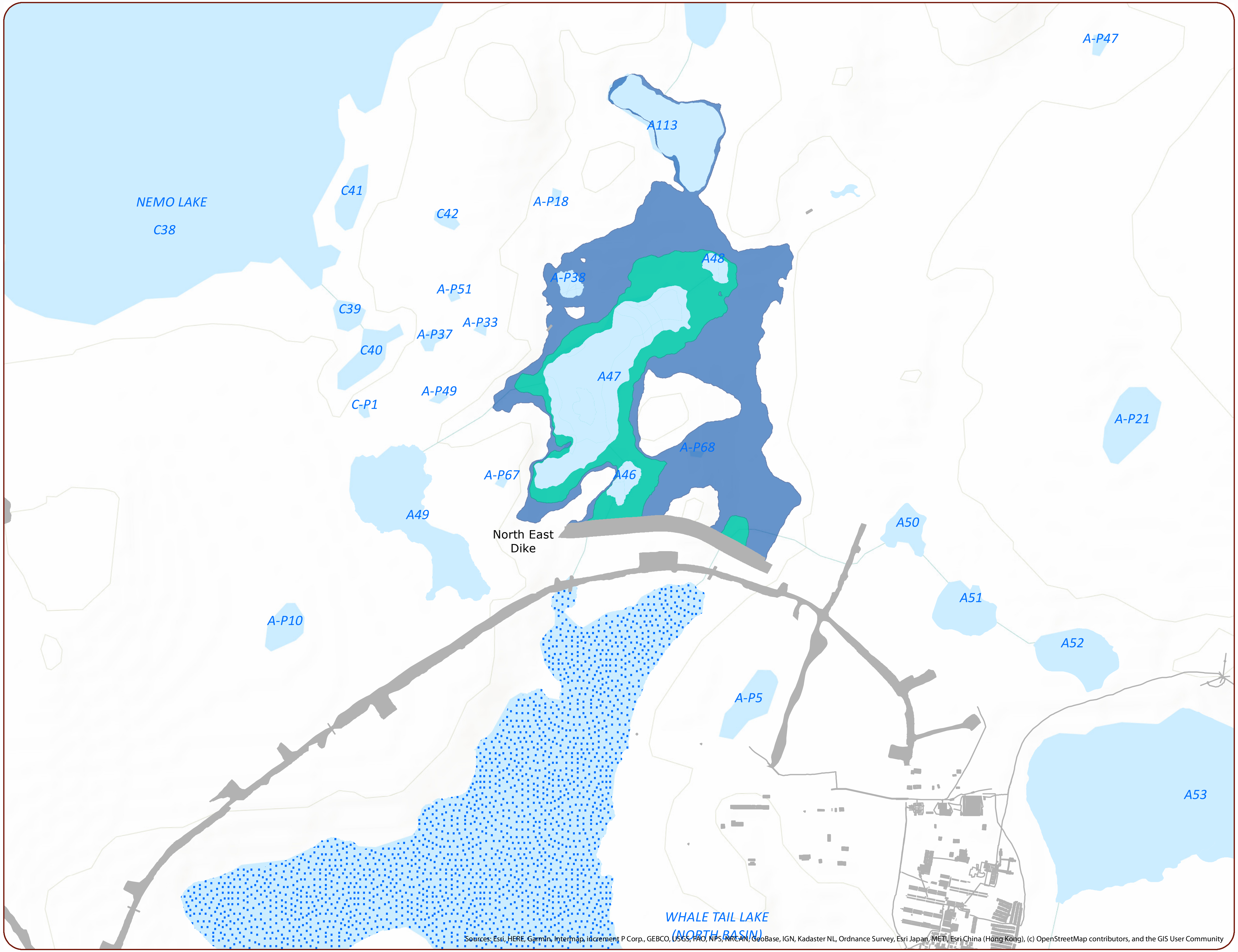
Disclaimer:
The information displayed on this map has been compiled from various sources. While every effort has been made to accurately depict the information, this map should not be relied on as being a precise indicator of locations, features, or roads, nor as a guide to navigation.

PROJECT: DA11-062-08
CLIENT: Agnico-Eagle Mines Ltd. Meadowbank Division
DATE: 12, March 2020
DRAWN BY: Janel Sauder

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)

0 0.075 0.15 0.3
Kilometres
SCALE: 1:7,000

N
UTM Zone 17N NAD83

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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.

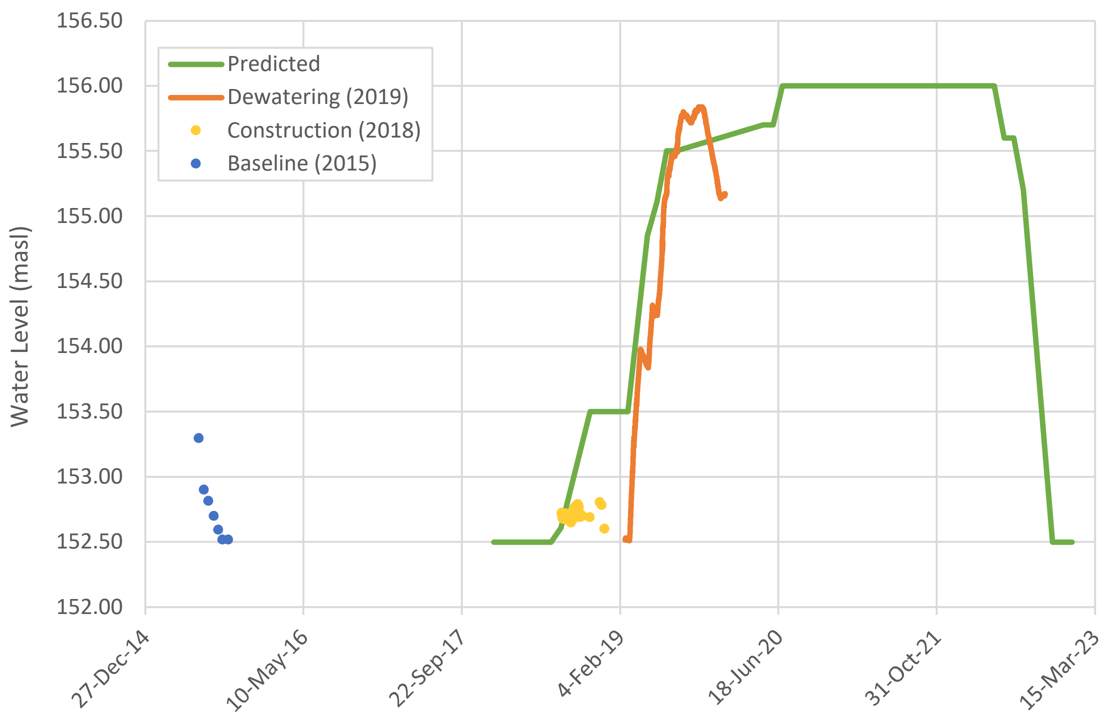

Figure 3. Measured and FEIS-predicted water levels in Whale Tail Lake South. Predicted water levels from FEIS Appendix 6-F.

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).

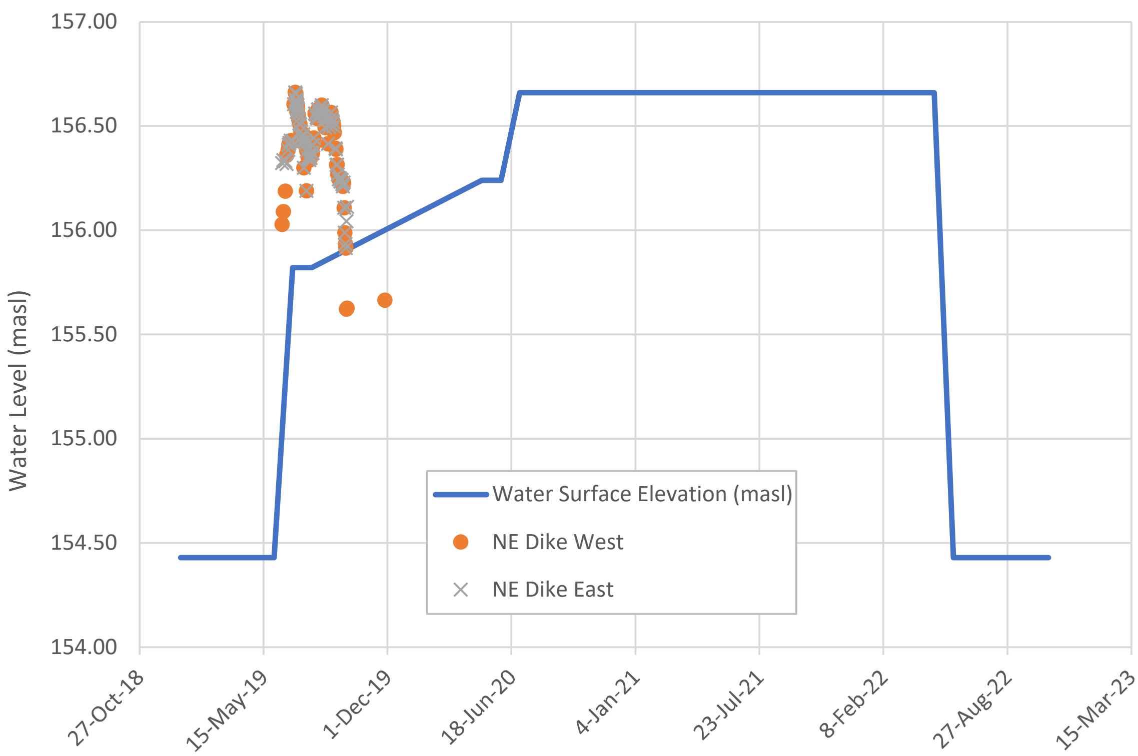

Figure 4. Measured and FEIS-predicted water levels in the Northeast Diversion flood zone. Predicted water levels from FEIS Appendix 6-F.

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

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 lakr, 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 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 nests/1.76 km^2 = 56 nests/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 nests/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 Tai 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^2). 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

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 23rd 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 1st of June and 3rd of June, Amy Wilson, Joanne Hamilton and Sarah Bonnett.

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.

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 9th 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 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 6th and 17th of June. The field season ended on 19th of July with the entire Waterbird Mitigation Project crew, departing Meadowbank. The field season was a total of 57 days.

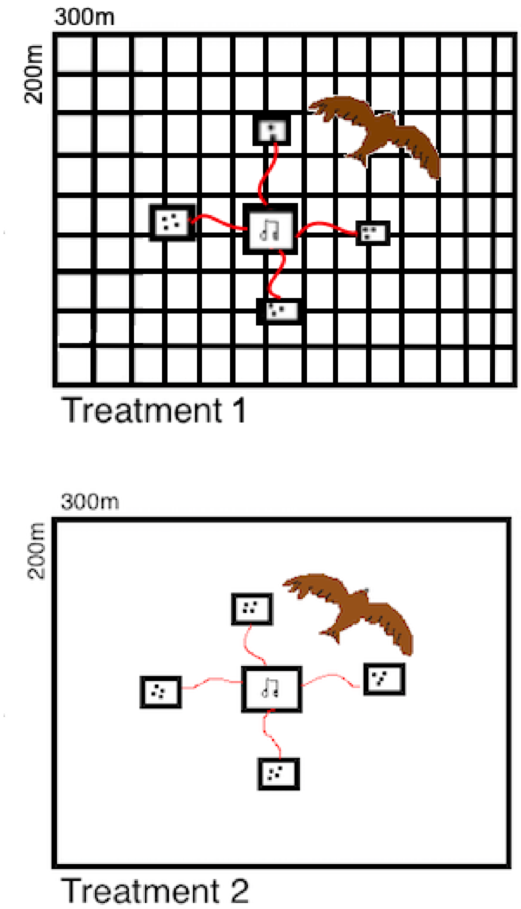

Figure 2: Illustrations of the two types of Treatment: Treatment 1 (top): audio deterrents, Jackite© predator effigy and 20 x 20 m grid of Flash Tape, and Treatment 2 (bottom): audio deterrents and Jackite© predator effigy. Used during the 2019 field season.

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 5th of June and 14th 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 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.

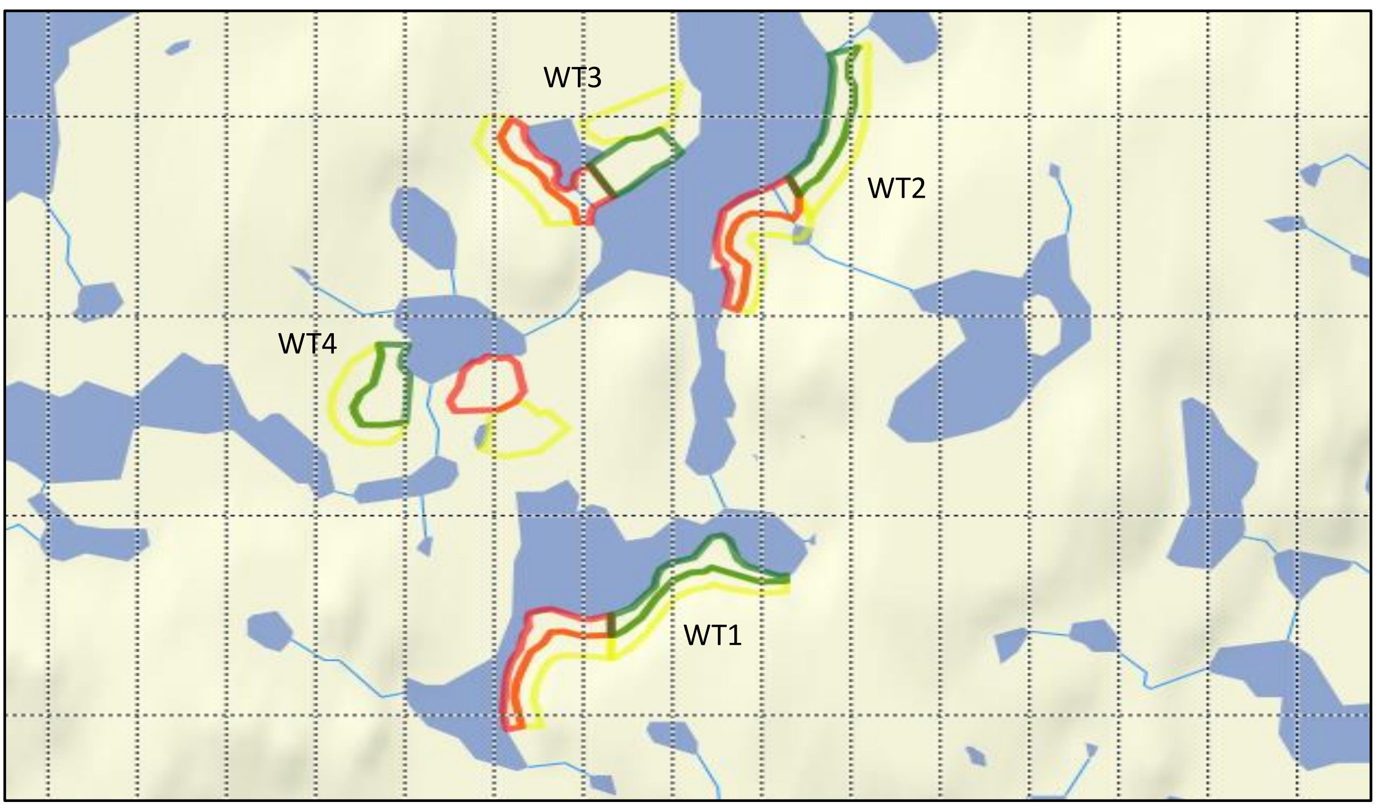

Figure 3: Map of the four main study sites (WT1, WT2, WT3, WT4) around Whale Tail Lake and its connecting lakes and tributaries. The Flood plots (red) and Treatment plots (green) are within the proposed flood zone, and the Control (yellow) plots are adjacent to the proposed flood zone.

Objective 2. Flood Zone Impact Assessment

During the 2018 field season, diversion sites were surveyed for nests between 24th and 25th of June and 29th June – 2nd 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 25th 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 16th of June and 17th of June. Plots were surveyed every four days, between the 16th of June and 14th of July for a total of 148 search hours within the proposed flood zone.

Objective 3. Bird Behavioural Reponses

Nest and Territory Monitoring

Monitoring of nesting birds occurred throughout the 2019 breeding season between the June 6th of - 14th 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 be 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

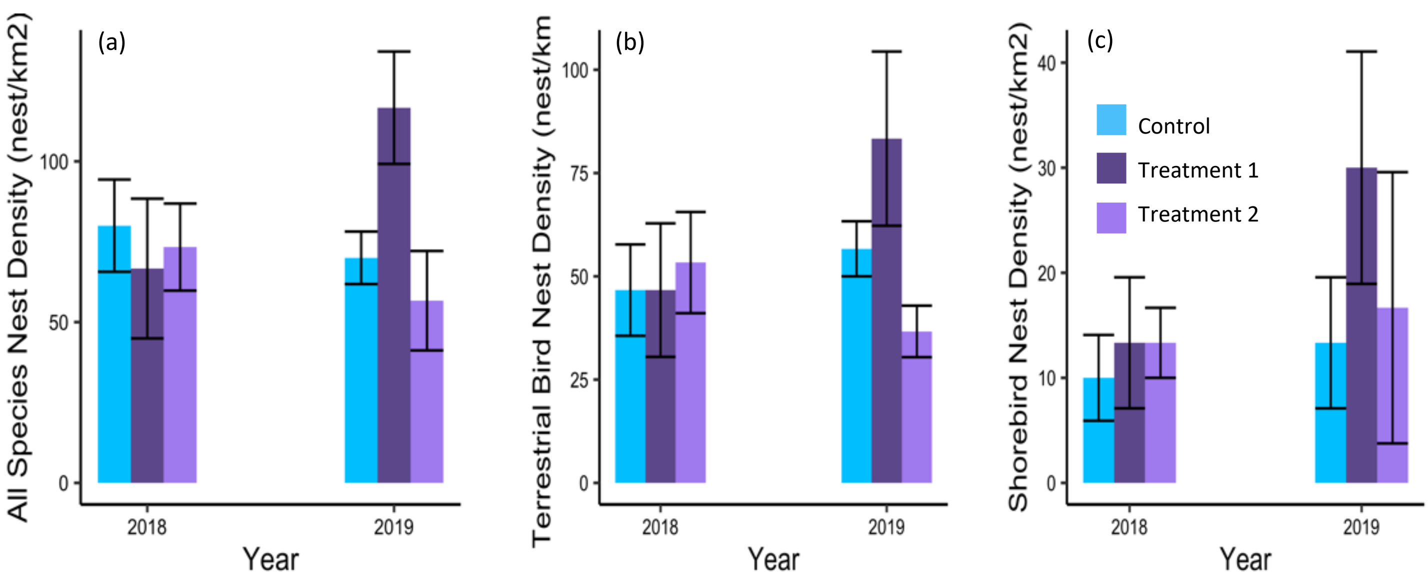

Figure 5: Nest densities (nests/km² ± SE) before (2018) and after (2019) deterrent deployment of two deterrents treatments, for all species present at the study site (a), only terrestrial bird species (b), only shorebird species (c) only.

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.

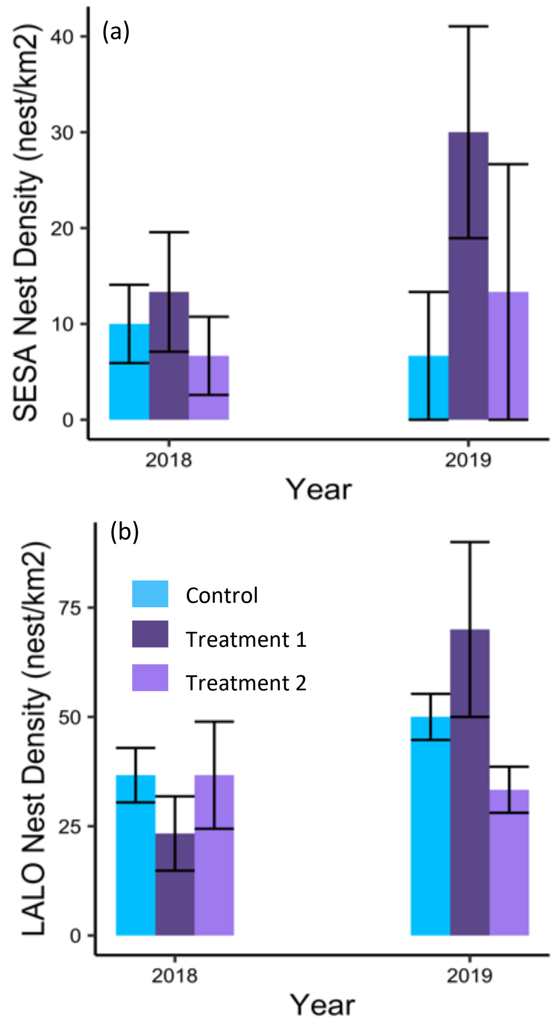

Figure 6: Nest densities (nests/km^2 ± SE) before (2018) and after (2019) deterrent deployment of two deterrents treatments for Lapland Longspur (a) or Semipalmated Sandpiper (b) only.

Objective 2. Flood Zone Impact Assessment

During the 2018 Whale Tail Study survey we estimated 31 bird territories per km^2, with an average initiation date of the 16th 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

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 where under water. Despite this, birds continued to nest within the flood area with an average territory density of 21.9 territories per km^2, 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^2. The densities surrounding Whale Tail Lake decreased by 10.9 territories per km^2 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^2 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^2). 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 1st - 3rd and we estimated that the bird initiated a new nest on the July 3rd.

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.

Discussion

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

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 13th of June, with the earliest initiation date estimated as the 3rd of June and as late as the 25th 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

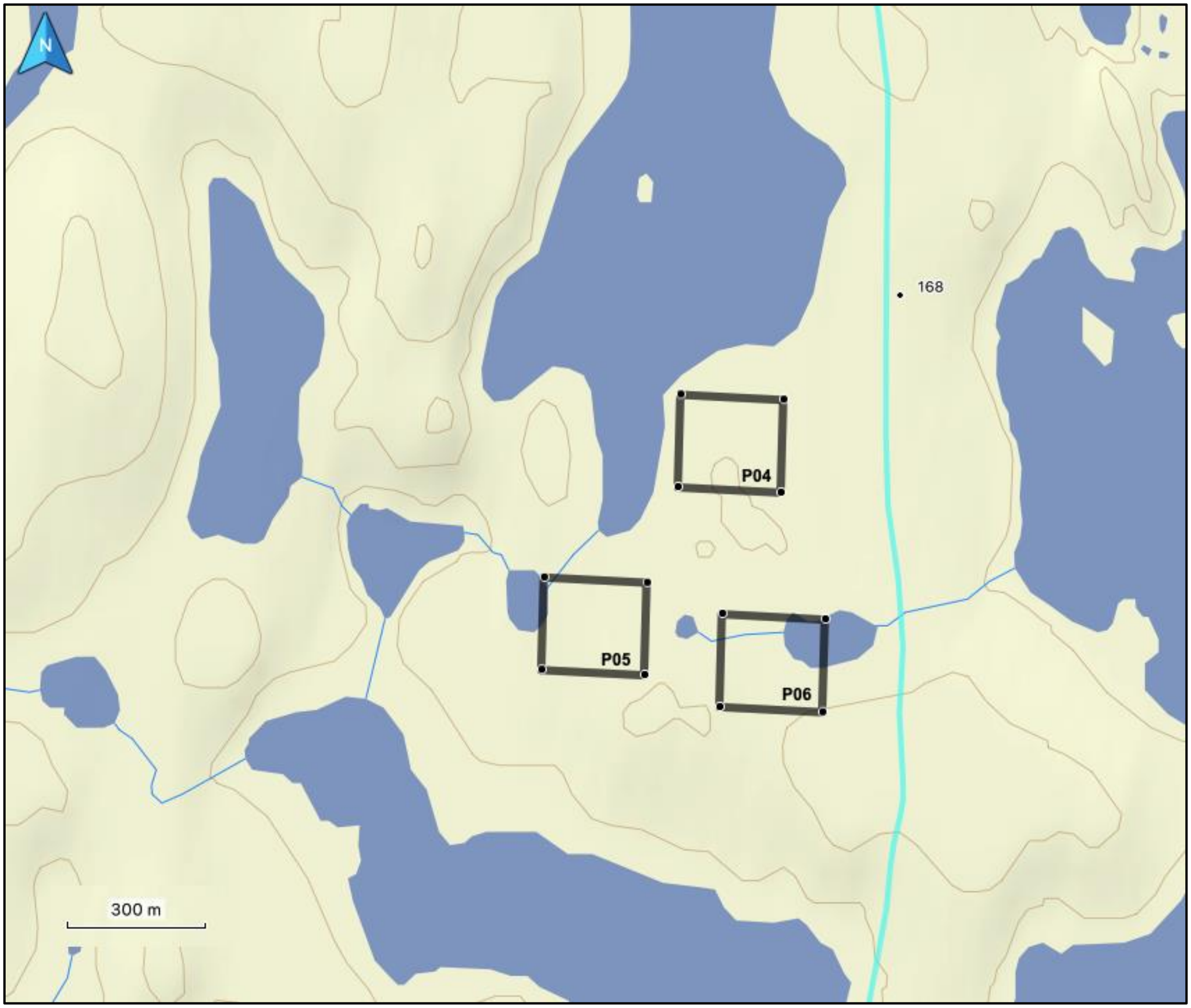


Figure 9: a map of Plot 4 (Treatment 2), 5 (Control) and 6 (Treatment 1), located on the west side of Kilometer 174 on Amaruq Road (light blue line)

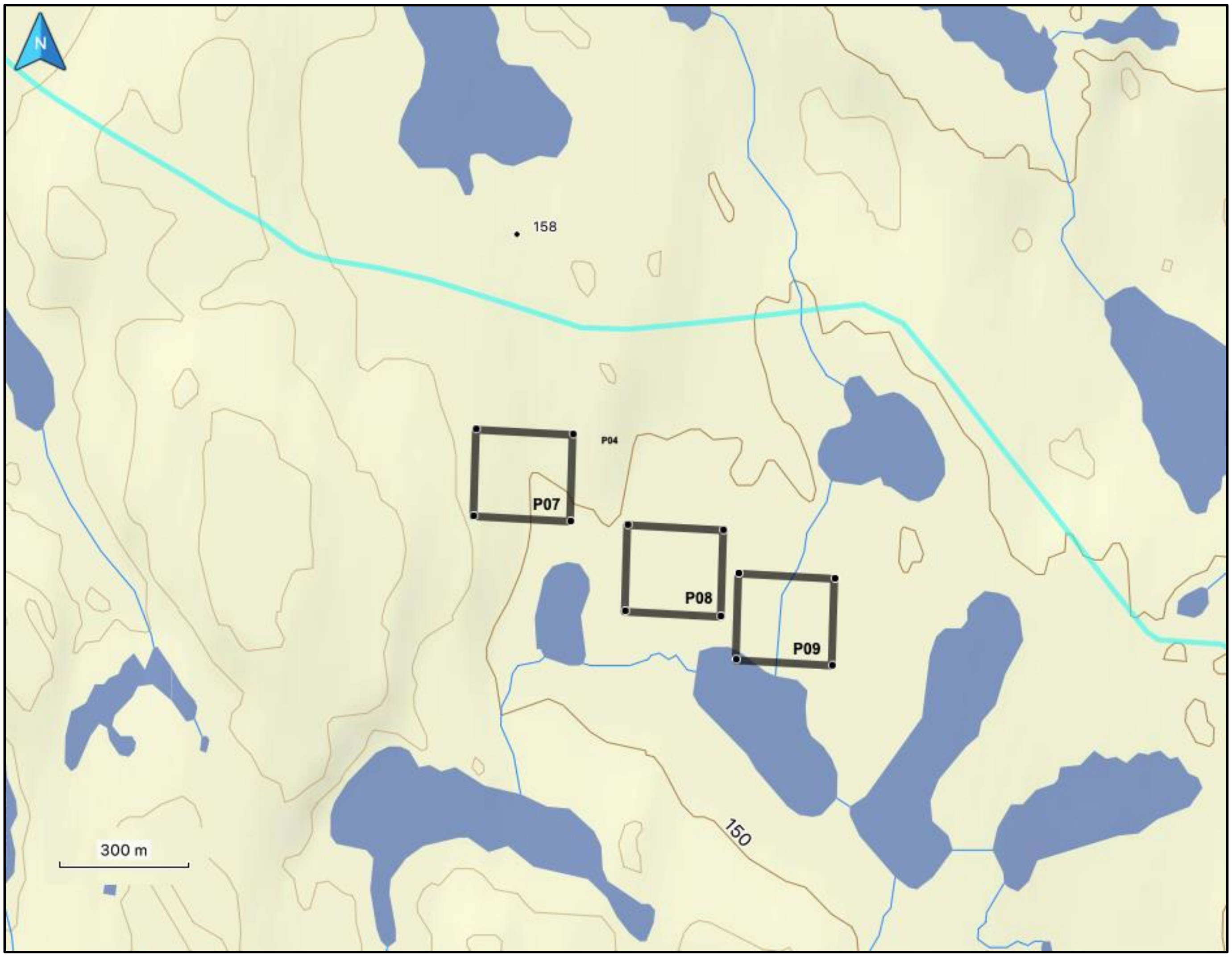


Figure 10: a map of Plot 7 (Control), 8 (Treatment 2), and 9 (Treatment 1), located on the south side of Kilometer 164 on Amaruq Road (light blue line)

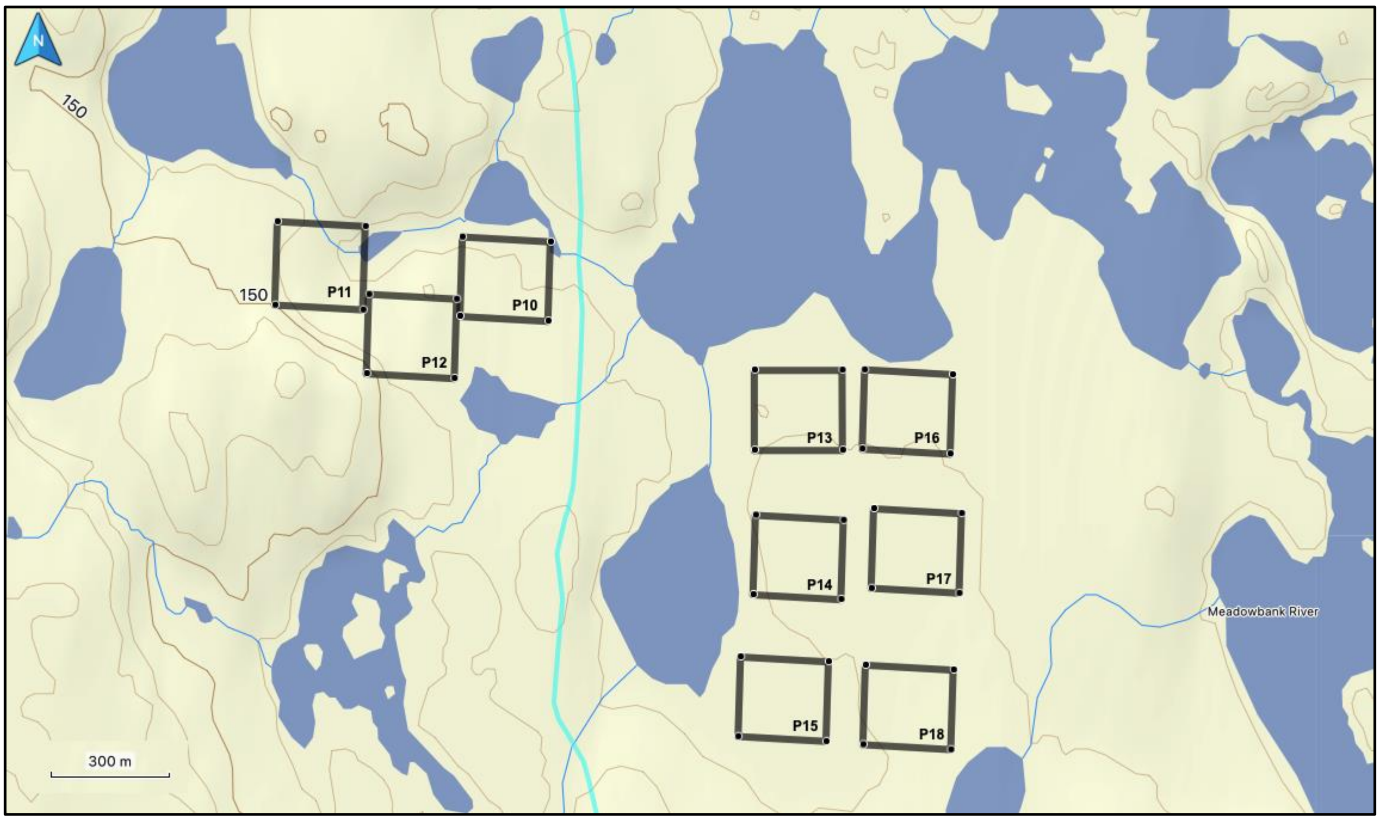


Figure 11: Figure 6: a map of Plot 10-12 located on the west side, and Plot 13-18 on the east side at Kilometer 160 on Amaruq Road (Light Blue Line). Plot 10, 13 and 16 (Treatment 1), Plot 12, 14, and 17 (Treatment 2), and Plot 11, 15, and 18 (Control).

APPENDIX II

Table 1: Nest density estimates (nest/km2) 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/km2) 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/km2) 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/km2) 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/km2) 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

APPENDIX N

2019 Meadowbank Non-Native Plant Monitoring Study

GOLDER

TECHNICAL MEMORANDUM

DATE 10 March 2020 **Project No.** 19124290-468-TM-Rev0

TO Robin Allard
Agnico Eagle Mines Limited

CC Carolina Leseigneur Torres, Corey De La Mare, Valerie Coenen, Jen Range

FROM Chris Shapka, Danielle Mai **EMAIL** cleseigneurtorres@golder.com, jrange@golder.com

2019 MEADOWBANK NON-NATIVE PLANT MONITORING STUDY

1.0 BACKGROUND

The goal of the 2019 non-native plants surveys is to assess/monitor for the potential introduction of non-native plant species, including weeds or invasive species. Surveys were completed per the monitoring approach outlined in the Terrestrial Environment and Monitoring Plan (TEMP) for the Meadowbank Complex. The Government of Nunavut (GN) and Environment and Climate Change Canada (ECCC) define a non-native species as 'an organism that is not normally found in a region (CESCC 2010). Any introductions of non-native plant species must be promptly reported to the GN Department of Environment.

Non-native plant surveys targeted areas with a high potential of occurrence for the Meadowbank Complex (i.e., areas of disturbance where colonization by non-native species is most likely). The non-native plant information collected provides an understanding of the presence or spread of non-native plant species and inform on the efficacy of current cleaning and protection measures on site per the TEMP. The results may serve as a basis for the development of a non-native plant management plan, if needed, over time. For the 2019 survey period, no non-native plants were recorded for the Meadowbank Complex.

2.0 METHODS

Surveys at the Meadowbank Complex were conducted by a Golder Ecologist between 9-16 August 2019. The Meadowbank Complex area includes the All Weather Access Road (AWAR), the Whale Tail Haul Road (haul road) and Whale Tail (Amaruq deposit), and Meadowbank Mine footprint areas.

The Canadian Endangered Species Conservation Council (CESCC) identified 17 species not normally found in Nunavut with a potential for becoming established, 14 of which are vascular (non-native) plants to the region (CESCC 2010; Table 1). This survey focused on the 14 non-native vascular plant species and excluded the two bird species and one butterfly species considered non-native species in Nunavut (CESCC 2010). Species were documented as they were encountered. Non-native plant surveys consisted of targeted surveys focused within high-priority or potential areas. The high-potential areas were identified as the Project area perimeter, along existing roads/trails or areas of disturbance within the Project area, as well as adjacent to the Haul Road (Amaruq).

Given the length of the haul road, the road will be travelled via vehicle at slow speeds, while observers look for obvious signs of weed infestations along road margins. Periodic stops should be undertaken to complete meanders in areas with high potential (pull-outs, work areas etc.). Use a GPS to collect a trackfile of the meander route, and when non-native/invasive species are encountered, the following information will be recorded: ϒsite ID; ϒsurveyor name; ϒGPS coordinates; ϒphotos of the occurrence / infestation; ϒspecies name; ϒestimated area of infestation (e.g., 10 m x10 m); ϒestimated number of plants (e.g., <10, 10 to 100, 100 to 1,000, >1,000) of each species; ϒestimated cover of bare ground; ϒgrowth stage (i.e., seedling, in bud, seed set, expired) of each species; ϒrecommended action for each species; and ϒrecord of any hand pulling completed.

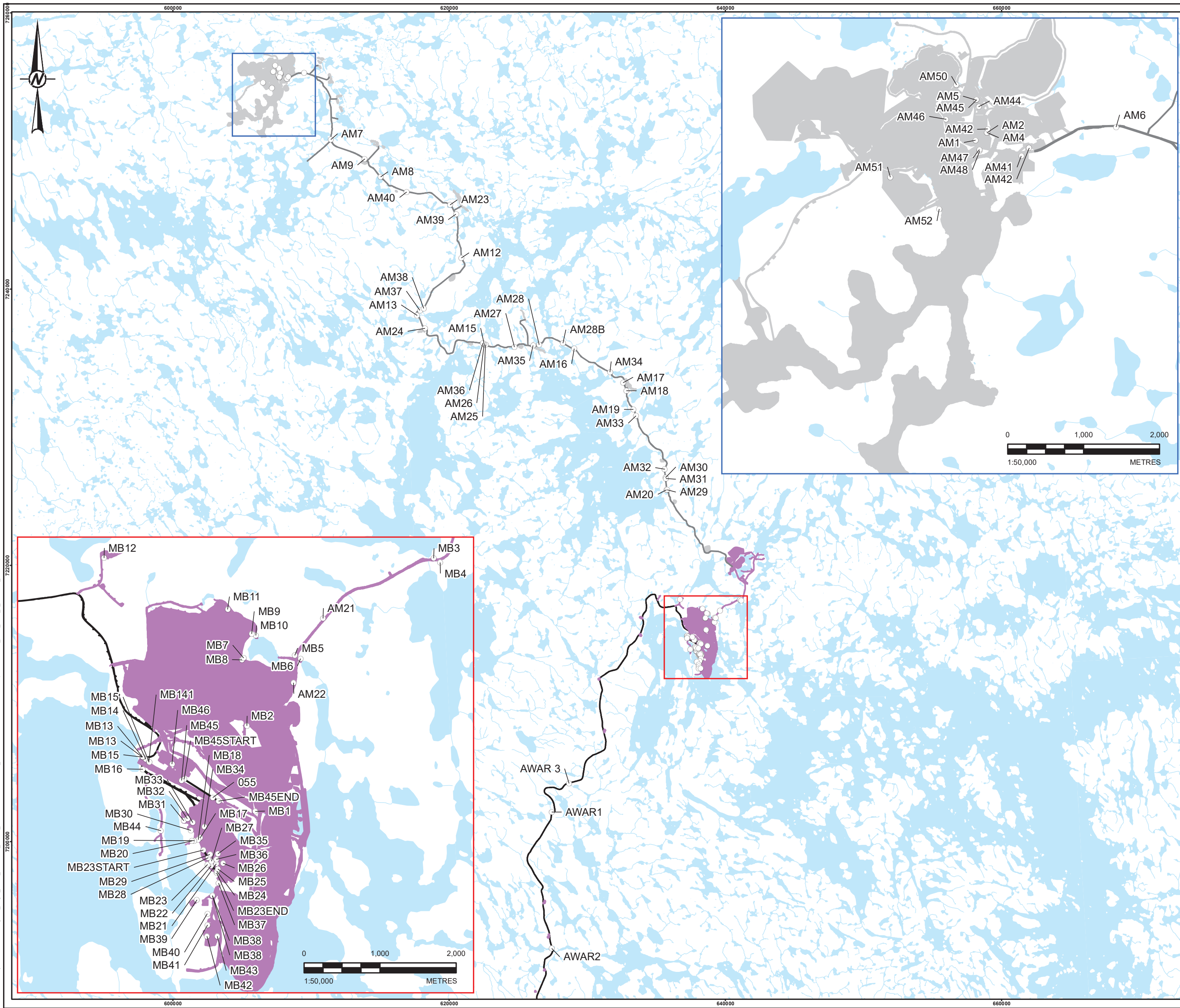
Table 1: Government of Nunavut, Department of Environment Non-native Species

CESCC Status (2010) [1]	ACIMS Scientific Name [2]	Common Name
Non-native	*Amaranthus retroflexus*	green amaranth
Non-native	*Barbarea vulgaris*	yellow rocket
Non-native	*Capsella bursa-pastoris*	shepherd’s purse
Non-native	*Carum carvi*	wild caraway
Non-native	*Hordeum vulgare*	common barley
Non-native	*Leucanthemum vulgare*	oxeye daisy
Non-native	*Papaver somniferum*	opium poppy
Non-native	*Plantago major*	common plantain
Non-native	*Polygonum aviculare*	prostrate knotweed
Non-native	*Puccinellia distans*	spreading alkali grass
Non-native	*Sonchus arvensis*	field sow thistle
Non-native	*Taraxacum officiniale*	common dandelion
Non-native	*Thlaspi arvense*	field pennygrass
Non-native	*Vicia cracca*	tufted vetch

[1] CESCC = The Canadian Endangered Species Council.
[2] ACIMS = Alberta Conservation Information Management System (2018).

Due to the large extent of the Meadowbank Complex area, non-native plant surveys were executed as targeted surveys focused within high-priority or potential areas. High-potential areas were identified including highly trafficked areas (i.e., fuel station), wastewater discharge area, areas surrounding buildings, shipping containers and the dump, for example. Due to time constraints the AWAR was surveyed from the Meadowbank Mine site to Kilometer (KM) 70 only at slow speed, while observing for weed infestations along road margins. Periodic stops were undertaken to complete meanders in areas with high potential (pull-outs, work areas etc.). A GPS was used to collect a trackfile of the meander route.

A total of 107 locations were surveyed (Figure 1). Locations assessed included the sides of the haul roads, as well as both Whale Tail and Meadowbank Mine footprint areas.



LEGEND

- SURVEY LOCATION
- TRANSECT
- WHALE TAIL MINE SITE
- HAUL ROAD
- MEADOWBANK MINE SITE
- ALL WEATHER ACCESS ROAD
- WATERCOURSE
- WATERBODY

0 5,500 11,000

1:275,000 METRES

REFERENCE(S)
1. INFRASTRUCTURE OBTAINED FROM AGNICO EAGLE MINES LIMITED.
2. WATERCOURSE AND WATERBODY DATA OBTAINED FROM NATURAL RESOURCES CANADA.
DATUM: NAD 83 CSRS PROJECTION: UTM ZONE 14

CLIENT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED:
MEADOWBANK DIVISION

PROJECT
WHALE TAIL PIT - EXPANSION PROJECT

TITLE
2019 NON-NATIVE PLANT SURVEY LOCATIONS

CONSULTANT
GOLDER

YYYY-MM-DD	2019-11-22
DESIGNED	AZ
PREPARED	CDB
REVIEWED	
APPROVED	

PROJECT NO.	CONTROL	REV.	FIGURE
19124290	8000/8010	A	1

The AWAR and haul road were travelled via vehicle at slow speeds, while observers looked for obvious signs of non-native plant occurrences along road margins. Obvious signs included showy inflorescence, fruiting structures, and other key characteristics that distinguished non-native species from endemic plant species. Periodic stops were undertaken to complete meanders in areas with high potential (pull-outs, work areas etc.). The following information was recorded when non-native species were encountered:

- site ID;
- surveyor name;
- GPS coordinates;
- photos of the occurrence / infestation;
- species name;
- estimated area of infestation (e.g., 10 m x10 m);
- estimated number of plants (e.g., <10, 10 to 100, 100 to 1,000, >1,000) of each species;
- estimated cover of bare ground;
- growth stage (i.e., seedling, in bud, seed set, expired) of each species;
- recommended action for each species; and
- record of any hand pulling (if completed).

3.0 RESULTS

No non-native plants, as identified by the CESCC, were recorded along the haul road, AWAR, Whale Tail and Meadowbank Mine footprints.

Although not listed as a non-native species by the CESCC, populations of flixweed (*Descurainia sophia*) and scentless chamomile (*Matricaria perforata*), both non-endemic to the Arctic, were observed within the surveyed locations. Table 2 provides a summary of the non-native plant survey findings from the August 2019 surveys at locations shown on Figure 1. Detailed survey results are presented in Appendix A and representative photographs are presented in Appendix B.

Table 2: Summary of Key Non-native Vegetation Survey Findings

	Number of Survey Locations	Percent of Total
Non-Native Occurrences	0	0%
No Non-native Vegetation Observed[1]	106	99%
Species of Special Concern	1	1%
Total	107	100%

[1] These sites may require subsequent visits to confirm continued absence of non-native species.

Scentless chamomile is listed as Secondary Noxious and Noxious in the Canadian Weed Seeds Order (*Seeds Act* 2016). A single plant was observed near a building close to the water at the Meadowbank Mine site (at location MB32 shown on Figure 1, refer to Appendix A and Photograph 5 in Appendix B). The most effective method of treatment is hand pulling (Government of Alberta 2007); the plant was hand pulled and disposed of safely by an Agnico Eagle employee on 15 August 2019.

Flixweed is an introduced agricultural weed from Europe, Asia and North Africa (Dickinson 2006; ABMI 2019) and is non-native to Nunavut. Flixweed was observed on the Meadowbank Mine site (at locations MB13, MB15, MB23, and MB41 shown on Figure 1, refer to Appendix A and B). Infestations of flixweed were found to be most dense along the perimeter of the airstrip, and the southwest edge of the Meadowbank Mine site. The southwest border of the airport runway was found to have the tallest and densest population of flixweed, assessed as exceeding the largest population density category of >1000. The southwest edge of the Meadowbank Mine site was also observed to have high densities of this species, especially around the workshop and shipping container storage areas. Observed flixweed populations have not encroached onto the tundra, and all observations were limited to disturbed areas (see representative photographs in Appendix B). It follows that disturbed areas on the Meadowbank Mine site were highly likely to have occurrences of flixweed.

4.0 CONCLUSION AND RECOMMENDATIONS

No non-native plant species for Nunavut, as identified by the CESCC, were recorded during the 2019 surveys for the Meadowbank Complex, though two plant species which are non-endemic to the Arctic were detected:

- Although not listed as a non-native plant by the CESCC, the noxious weed scentless chamomile should be continually monitored to prevent further infestations. The Government of Alberta states that noxious weeds have the ability to spread rapidly, degrade habitats and reduce biodiversity, and must be controlled to prevent further establishment and spread (Government of Alberta 2012).
- Flixweed has not migrated from the Meadowbank Mine site through the haul road or to the Whale Tail Mine site. Although flixweed is also not on the CESSC species list, it should be controlled to contain the infestation to the Meadowbank Mine site and AWAR and prevent spread north to new locations.

Efforts for non-native plant management, including identified non-endemic species, should continue and added diligence should be undertaken with regards to areas of high traffic.

Continued and thorough cleaning of equipment and materials prior to entering the site, per the TEMP, will prevent seed of non-native species from being introduced. Surveys for the 14 non-native plant species identified by CESCC as well as other non-native species should continue to be completed annually. Mechanical control such as mowing or hand pulling, as appropriate for the site setting, is recommended for any identified non-native plant species. If hand pulling with a shovel, the plant material should be collected in bags and disposed of at an offsite location. Mowing is a viable option if the following conditions are met:

- there is access for a mowing unit;
- the terrain is not too steep or hazardous; or
- if the phenology of the plant stage is not at risk for greater seed dispersal (consult with a vegetation ecologist prior to mowing).

Chemical herbicide treatments are not recommended to be used at this point as the tundra is a very sensitive ecosystem. As a further measure of prevention, the CESCC (2010) has developed posters that show non-native species in Nunavut. These can easily be displayed at the Meadowbank Complex and incorporated into on-boarding materials, which could be used to supplement non-native plant information and posters used on-site.

A management plan for non-native plant species employing adaptive management may be implemented if the non-endemic and other non-native plant species continue to be observed and/or are observed to spread further within the Meadowbank Complex area. A non-native plant management plan would describe the methods for the eradication, control and/or minimization of the encroachment of non-native plant species into new areas, and outline additional measures such as on-boarding and training in the identification of non-native plant species for the area.

5.0 CLOSURE

We trust this meets your needs and if you have any questions or concerns, feel free to contact the undersigned at your convenience.

Regards,

Golder Associates Ltd.

Chris Shapka, B.Sc., P. Biol., P.Ag.
Terrestrial Ecologist

Valerie Coenen
Senior Terrestrial Ecologist

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Principal, Senior Ecologist

DM/CS/VC/CLT/CDLM/jr

https://golderassociates.sharepoint.com/sites/110051/project files/5 technical work/05_reporting_data_mgmt/invasive plants reporting/rev0/19124290-468-tm-mbk_2019invasiveplants-rev0.docx

Attachments:

Appendix A – Meadowbank Complex – 2019 Non-Native Plant Survey Results
Appendix B – Meadowbank Complex – 2019 Non-Native Plant Survey Representative Photographs

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APPENDIX A

Meadowbank Complex - 2019 Non-Native Plant Species Survey Results

Table A-1: Non-native Plant Survey Results

Survey Location	Plot ID	Scientific name	Common name	No of Plants	Population Description	Population Size (m^2)	Latitude	Longitude
AWAR	MB19DMW053	*Descurainia Sophia*	Flixweed	>1,000	continuous occurrence of a species with few gaps in distribution	6000	64.830528	-96.31408
Meadowbank Mine Site	MB19DMW021	*Descurainia Sophia*	Flixweed	>1,000	continuous dense occurrence of a species	300	65.029533	-96.08618
Meadowbank Mine Site	MB19DMW023	*Descurainia Sophia*	Flixweed	>1,000	continuous occurrence of a species with few gaps in distribution	400	65.028863	-96.084373
Meadowbank Mine Site	MB19DMW025	*Descurainia Sophia*	Flixweed	<10	few sporadically occurring individuals	n/r	65.028082	-96.086278
Meadowbank Mine Site	MB19DMW028	*Descurainia Sophia*	Flixweed	>1,000	continuous occurrence of a species with few gaps in distribution	500	65.019387	-96.072845
Meadowbank Mine Site	MB19DMW029	*Descurainia Sophia*	Flixweed	>1,000	continuous occurrence of a species with few gaps in distribution	600	65.019337	-96.073485
Meadowbank Mine Site	MB19DMW030	*Descurainia Sophia*	Flixweed	10-99	several sporadically occurring individuals	10	65.016522	-96.066998
Meadowbank Mine Site	MB19DMW031	*Descurainia Sophia*	Flixweed	>1,000	continuous occurrence of a species with few gaps in distribution	500	65.016507	-96.069418
Meadowbank Mine Site	MB19DMW032	*Descurainia Sophia*	Flixweed	100 to 499	continuous dense occurrence of a species	25	65.015647	-96.066913
Meadowbank Mine Site	MB19DMW033	*Descurainia Sophia*	Flixweed	500 to 999	continuous uniform occurrence of well-spaced individuals	500	65.015898	-96.066555
Meadowbank Mine Site	MB19DMW034	*Descurainia Sophia*	Flixweed	10 to 99	a few patches or clumps of species	1	65.016563	-96.065065
Meadowbank Mine Site	MB19DMW035	*Descurainia Sophia*	Flixweed	500-1000	continuous occurrence of a species with few gaps in distribution	400	65.016858	-96.068308
Meadowbank Mine Site	MB19DMW036	*Descurainia Sophia*	Flixweed	100 to 499	continuous occurrence of a species with few gaps in distribution	10	65.017272	-96.069137
Meadowbank Mine Site	MB19DMW037	*Descurainia Sophia*	Flixweed	100 to 499	continuous uniform occurrence of well-spaced individuals	20	65.017648	-96.06860
Meadowbank Mine Site	MB19DMW039	*Descurainia Sophia*	Flixweed	10 to 99	continuous uniform occurrence of well-spaced individuals	5	65.021773	-96.075445

Survey Location	Plot ID	Scientific name	Common name	No of Plants	Population Description	Population Size (m^2)	Latitude	Longitude
Meadowbank Mine Site	MB19DMW040	*Tripleurospermum inodorum*	Scentless chamomile	1	single individual	0.25	65.022007	-96.074423
Meadowbank Mine Site	MB19DMW041	*Descurainia Sophia*	Flixweed	>1,000	continuous occurrence of a species with few gaps in distribution	50	65.021492	-96.073017
Meadowbank Mine Site	MB19DMW042	*Descurainia Sophia*	Flixweed	10 to 99	several sporadically occurring individuals	n/1	65.020958	-96.069835
Meadowbank Mine Site	MB19DMW043	*Descurainia Sophia*	Flixweed	>1,000	continuous occurrence of a species with few gaps in distribution	400	65.017702	-96.066375
Meadowbank Mine Site	MB19DMW044	*Descurainia Sophia*	Flixweed	500 to 999	continuous occurrence of a species with few gaps in distribution	100	65.017038	-96.066917
Meadowbank Mine Site	MB19DMW045	*Descurainia Sophia*	Flixweed	10-99	a single patch or clump of species	4	65.014245	-96.066593
Meadowbank Mine Site	MB19DMW046	*Descurainia Sophia*	Flixweed	10-99	several sporadically occurring individuals	5	65.012790	-96.068462
Meadowbank Mine Site	MB19DMW048	*Descurainia Sophia*	Flixweed	<10	rare individual; single occurrence	0.25	65.010675	-96.070085
Meadowbank Mine Site	MB19DMW049	*Descurainia Sophia*	Flixweed	>1,000	continuous dense occurrence of a species	7500	65.009357	-96.070187
Meadowbank Mine Site	MB19DMW050	*Descurainia Sophia*	Flixweed	>1,000	continuous occurrence of a species with few gaps in distribution	250	65.008037	-96.070547
Meadowbank Mine Site	MB19DMW051	*Descurainia Sophia*	Flixweed	10-99	a single patch or clump of species	2	65.007975	-96.06762
Meadowbank Mine Site	MB19DMW055	*Descurainia Sophia*	Flixweed	>1,000	continuous occurrence of a species with few gaps in distribution	~10000	65.026552	-96.075548
Meadowbank Mine Site	MB19DMW056	*Descurainia Sophia*	Flixweed	10-99	a single patch or clump of species	25	65.02853	-96.07802
Whale Tail Mine Site	MB19DMW026	*Descurainia Sophia*	Flixweed	10-99	several sporadically occurring individuals	4	65.019687	-96.071088

n/r – not recorded

APPENDIX B

Meadowbank Complex - 2019 Non-Native Plant Species Survey Representative Photographs

Photo 1. Flowering flixweed (*Descurainia Sophia*) at Meadowbank Mine (MB13).

Photo 2. Flowering flixweed at Meadowbank Mine (along MB23 transect).

Photo 3. Vegetative flixweed at Meadowbank Mine (MB15).

Photo 4. Post-seed flixweed at Meadowbank Mine (along MB23 transect).

Photo 5. Flowering scentless chamomile (*Tripleurospermum inodorum*) located at Meadowbank Mine (MB32).

Photo 6. Dead and flowering flixweed located at Meadowbank Mine (MB41).