ANNUAL REPORT MEMORANDUM

Agnico Eagle Mines Ltd Meadowbank Division
Environment Department

SUBJECT: 2020 Meadowbank and Whale Tail Blast Monitoring Report for the Protection of Nearby Fish Habitat

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1. Introduction and Objectives

In accordance with NIRB Project Certificate No.004 Condition 85 and Project Certificate No. 008 Condition 22, Agnico Eagle Meadowbank Division developed a blasting program which complies with *The Guidelines for the Use of Explosives In or Near Canadian Fisheries Water* (Wright and Hopky, 1998) as modified by the DFO for use in the North and adhere to guidance provided in *Monitoring Explosive-Based Winter Seismic Exploration in Waterbodies* (Cott and Hanna, 2005). As a result, Agnico Eagle conducts monitoring to evaluate blast related peak particle velocity and overpressure to protect nearby fish bearing waters.

The detonation of explosives in or near water produces compressive shock waves that can cause significant impacts to the swim bladders of fish, rupture other internal organs and/or damage or kill fish eggs and larvae. In addition, the effects of the shock waves can be intensified in the presence of ice. Consequently, the Guidelines for the Use of Explosives In or Near Canadian Fisheries Water guidelines have been developed by DFO to protect fish and fish habitat from works or undertakings that involve explosives in or near fisheries waters. Guidance provided in Monitoring Explosive-Based Winter Seismic Exploration in Waterbodies (Cott and Hanna, 2005) was also followed. It includes the following requirements:

1. No explosive is to be detonated in or near fish habitat that produces an instantaneous pressure change (IPC) greater than 100 kPa in the swim bladder of a fish; representatives from DFO requested that Agnico Eagle use a value of 50 kPa instead of 100 kPa; and

2. No explosive is to be detonated that produces a peak particle velocity greater than 13 mm/s in a spawning bed during the period of egg incubation (for lakes near the Meadowbank mine, it takes place between August 15 and June 30).

Peak particle velocity (PPV) and overpressure monitoring data was recorded throughout 2020 during blasting activities at Whale Tail and IVR Pits as well as during the construction of the Whale Tail South Channel. Additionally, blast monitoring also occurred at underground workings in the Whale Tail exploration ramp. However, this monitoring was not for the purposes of fish habitat protection.

The locations of the blast monitoring stations on surface in 2020 at Whale Tail are highlighted in Table 1 and Figure 1 and 2 below.

Table 1: 2020 Surface Blast Monitoring Stations – Whale Tail Property

Station	Easting	Northing
IVR Pit (Nemo Lake)	606,588	7,256,992
Whale Tail Pit (Mammoth Station)	605,945	7,255,169
SWTC-1 (Mammoth Lake)	604,435	7,253,636
SWTC-2 (Whale Tail South Lake)	604,675	7,252,837
IVR Pit (A48)	607,250	7,256,739

No blast monitoring was conducted at the Meadowbank property in 2020 as mining operations ceased in 2019.

Figure 1 – Whale Tail Blast Monitoring Stations

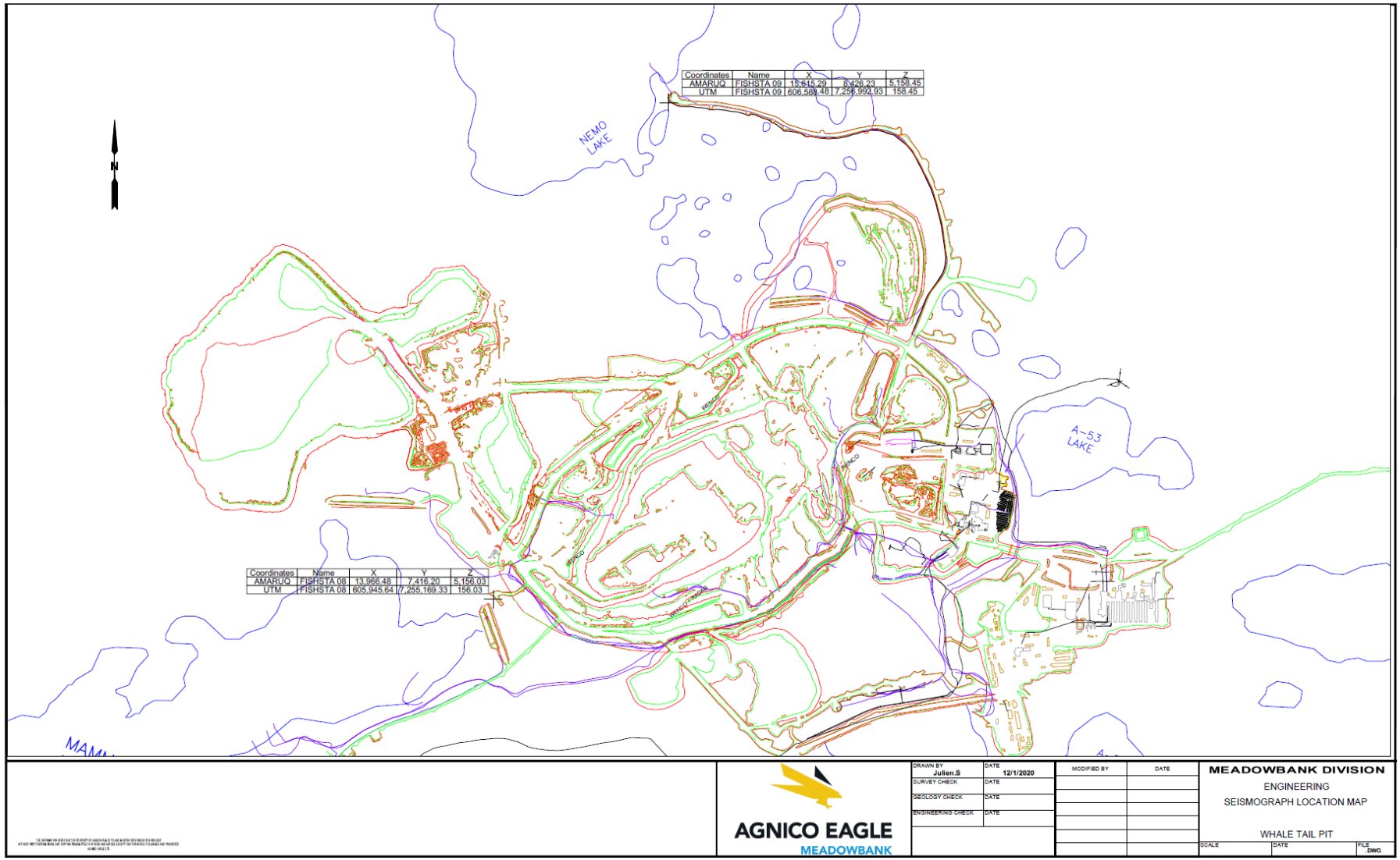
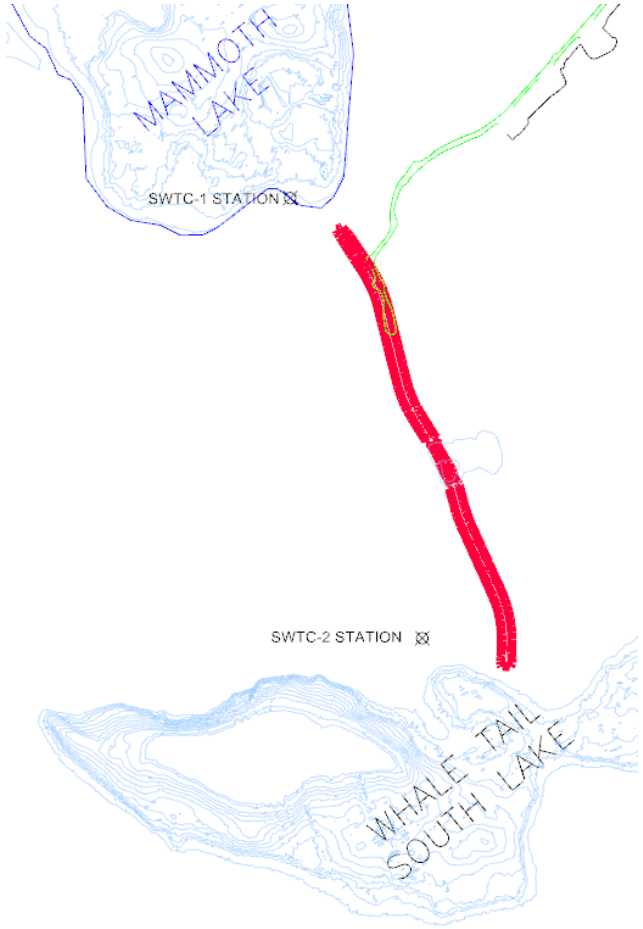


Figure 2 – South Whale Tail Channel Temporary Blast Monitoring Stations



2. Methods

2.1- Blast Monitoring

Blasts were monitored using an Instantel Minimate Blaster which is fully compliant with the international Society of Explosives and Engineers performance specifications for blasting seismographs (Instantel, 2005). The Minimate Blaster has three main parts: a monitor, a standard transducer (geophone) and a microphone. The monitor contains the battery and electronic components of the instrument. It also checks the two sensors to ensure they are functioning. The transducer measures ground vibration with a mechanism called a geophone.

This instrument measures transverse, vertical and longitudinal ground vibrations. Transverse ground vibrations agitate particles in a side to side motion. Vertical ground vibrations agitate particles in an up and down motion. Longitudinal ground vibrations agitate particles in a back and forth motion progressing outward from the event site (Instantel, 2005). The Minimate Blaster calculates the PPV for each geophone and calculates the vector sum of the three axes. The final result is the Peak Vector Sum (PVS) and is the resultant particle velocity magnitude of the event:

$$PVS = \sqrt{(T^2 + V^2 + L^2)}$$

Where:

T = particle velocity along the transverse plane
V = particle velocity along the vertical plane
L = particle velocity along the longitudinal plane

The transducer is installed as per the model specifications. All monitoring follows Agnico Eagle Blast Monitoring Program (2021).

2.2- Data Analysis

The blast monitoring data was screened to ensure blast PPV and IPC monitoring results corresponded to a single blast event. As previously discussed, in 2020 the engineering department thoroughly documented blast patterns, sequencing, and detonation results to track the material accurately, optimize blasts and review procedures. As a result, blast monitoring data is collected as a composite of blast patterns and may include multiple blast patterns that could have occurred during the same monitoring event (i.e. a single PPV and IPC value for 3 blast patterns). The data was screened to remove all redundant data points (such as replicate readings).

2.3- Results, Discussion and Conclusions

PPV and IPC blast monitoring results are presented in Table 4.

In 2020, 24 blasts were monitored at IVR. There were no PPV readings exceeding 13 mm/s and IPC measurements were all below the DFO limit of 50 kPa.

For Whale Tail, 356 blasts were monitored. One (1) blast exceeded the PPV concentration DFO limit of 13 mm/s and no blast exceeded the IPC measurement DFO limit of 50 kPa.

During the construction of Whale Tail South Channel, three (3) PPV exceedances were recorded at a temporary blast monitoring station by Whale Tail South.

A total of 4 PPV exceedances were recorded in 2020. All of them occurred during period of egg incubation (egg incubation period is from August 15 to June 30). One of these events were located at Whale Tail site and the other 3 were recorded during the construction of Whale Tail South Channel:

- The first exceedance was recorded at Mammoth Station for the 5116PSW60 with 14.6 mm/s in July 10th, 2020. For this blast, eight (8) preshear holes were detonated on the same delay. To mitigate the probability of another exceedance for preshear holes, mitigation technique number four from the Blast Monitoring Plan was used. This technique is to reduce the explosives quantity per delay.

- The other exceedances were recorded at the Whale Tail South Channel construction site on January 27, February 5 and February 10. Agnico Eagle advised DFO following each events, in a delay of 72h, to detail the cause and mitigation measures put in place. All the exceedances were observed at the SWTC-2 station. The completed explanation are provided in Appendix A, B and C.

Summary of PPV and IPC exceedance for Whale Tail Site since 2018 is presented in Table 2.

Table 2: Whale Tail PPV and IPC exceedance 2018-2020

Year	PPV exceedance	IPC exceedance
2018	2	0
2019	8	0
2020	4	0
Total	**14**	**0**

The blast monitoring results are reviewed after each blast and the blast mitigation plan was implemented immediately, if the vibrations or the overpressure exceeded the guidelines. This plan includes a retroactive analysis to determine what caused the higher than expected results.

In 2020, for Whale Tail Pit, the average PPV was 0.98 mm/s with a maximum of 14.6 mm/s. For IVR Pit, the average PPV was 0.67 mm/s with a maximum of 6.5 mm/s.

As previously mentioned, measures have been put in place to minimize the probability of having a PPV exceedance.

Table 3: Maximum and average PPV and IPC per year

Location	Parameters	2018	2019	2020
Whale Tail Pit	Max PPV (mm/s)	26.1	20.9	14.6
	Average PPV (mm/s)	4.5	2.16	0.98
	Max IPC (kPa)	30.54	24.46	17.09
	Average IPC (kPa)	5.01	2.23	1.19
IVR Pit	Max PPV (mm/s)	N/A	N/A	6.5
	Average PPV (mm/s)	N/A	N/A	0.67
	Max IPC (kPa)	N/A	N/A	7.59
	Average IPC (kPa)	N/A	N/A	0.81

As discussed in the 2011 monitoring report, Wright (1982)[1], determined that peak particle velocity greater than 13 mm/s is potentially damaging to incubating eggs, however Faulkner et al. (2006)[2], found no effects on lake trout eggs due to blasts at Diavik Mine, NWT with maximum PPVs of 28.5 mm/s. Faulkner et al. (2006) measured mean PPV at three exposure stations from September to July, 2003-2004 and found a mean range of 5.8 - 6.4 mm/s and reported 80 exceedances of 13 mm/s PPV at these stations with a maximum PPV being double the DFO guideline. They found there were no differences in mortality of lake trout eggs in incubators between exposure sites and reference sites that resulted from blasting at Diavik in 2003-2004. As a result, Agnico Eagle suggests that additional studies may not be necessary to confirm low PPV at spawning and incubation sites, since results of this study suggest impacts are likely not occurring even if no attenuation of PPV is occurring between blast monitoring sites and spawning habitat.

[1] Wright, D.G. 1982. A Discussion Paper on the Effects of Explosives on Fish and Marine Mammals in the Waters of the Northwest Territories. Canadian Technical Report of Fisheries and Aquatic Sciences 1052.

[2] Faulkner, Sean G., Tonn, William, Welz, Marek, Welz, and Schmitt, Douglas. 2006. Effects of Explosives on Incubating Lake Trout Eggs in the Canadian Arctic. North American Journal of Fisheries Management. 26:833-842.

APPENDIX A
16-HCAA-00370 2020-01-27 Whale Tail South Channel Blast Exceedance

APPENDIX B
16-HCAA-00370 2020-02-05 Whale Tail South Channel Blast Exceedance

APPENDIX C
16-HCAA-00370 2020-02-10 Whale Tail South Channel Blast Exceedance