

Appendix 41

Meadowbank and Whale Tail 2020 Blast Monitoring Report

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

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

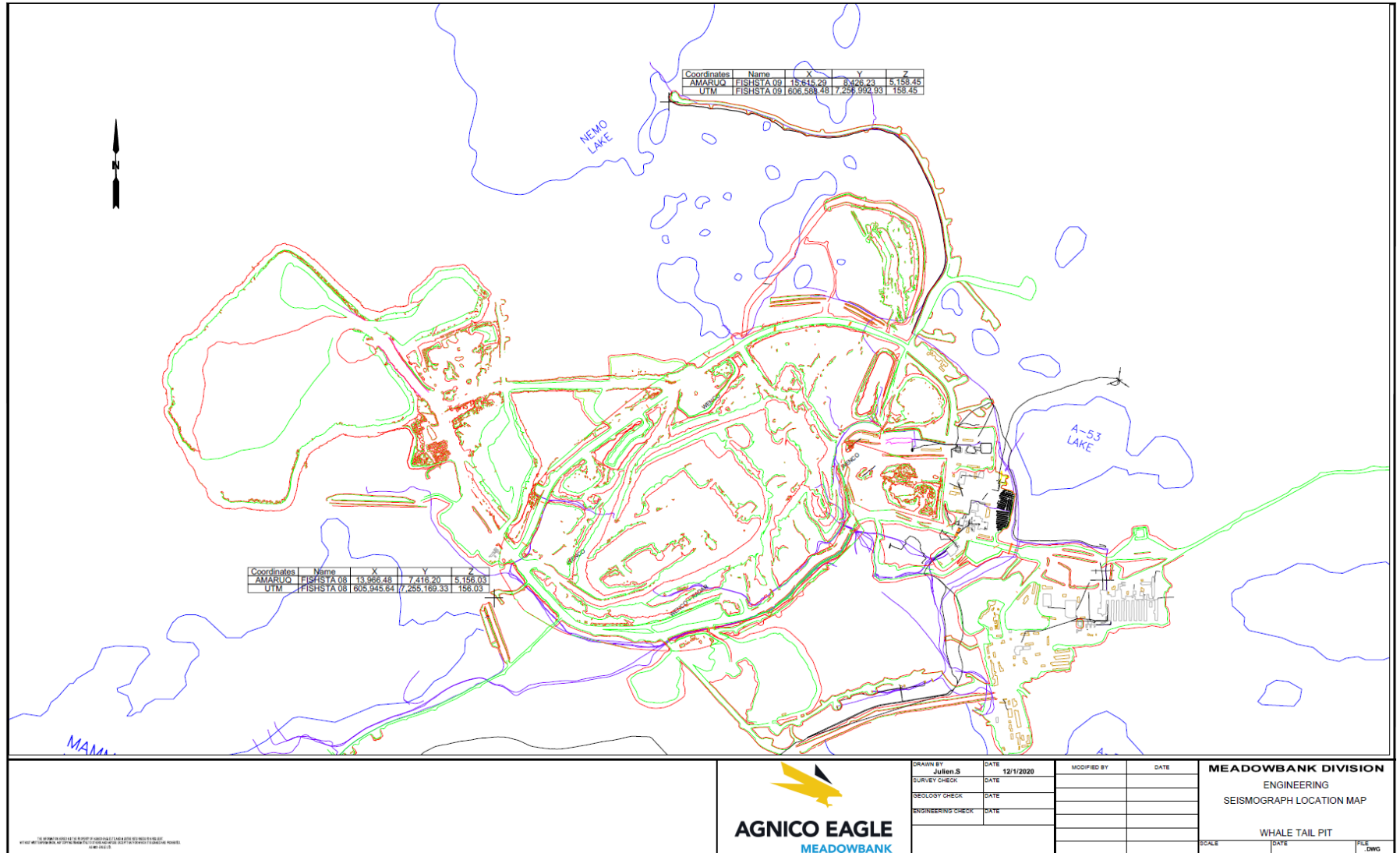
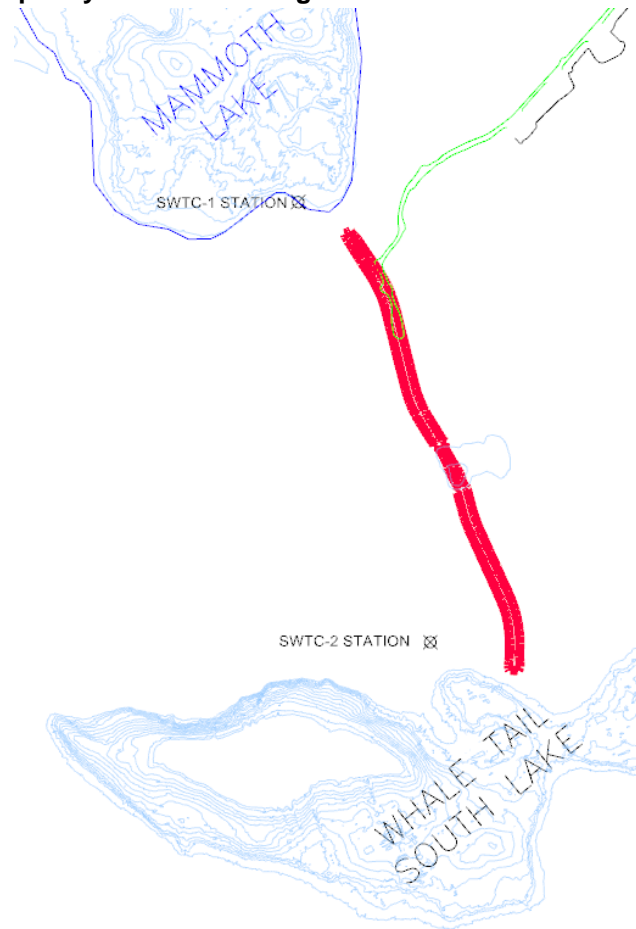


Figure 2 – South Whale Tail Channel Temporary Blast Monitoring Stations



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.



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



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January 31st, 2020

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Re: 16-HCAA-00370 – 2020-01-27 Agnico Eagle Whale Tail South Channel Blast Exceedance

Dear Boyan Tracz,

Agnico Eagle would like to notify you that on January 27, 2020, an exceedance in the peak particle velocity (PPV) occurred during the blasting activities related to the Whale Tail South Channel (SWTC) construction. As such, please find below information in relation to this event.

As detailed in the Memo Blasting Activities – South Whale Tail Channel Construction (September 2019), Agnico aims to comply with the DFO's Guidelines for Use of Explosives in or Near Canadian Fisheries Waters and shall adhere to the guidance provided in the Monitoring Explosive-Based Winter Seismic Exploration in Waterbodies, NWT 2000-2002. Those guidelines stipulated that:

- no explosive is to be detonated in or near fish habitat that produces an instantaneous pressure change (IPC) greater than 50 KPa; and
- no explosive is to be detonated that produces a peak particle velocity (PPV) 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).

On January 27, a first blast occurred at the south portion of the SWTC at monitoring station SWTC ST-2 (Figure 1 below). Analyse of the blast monitoring showed that the PPV was 22 mm/s and IPC was 25.75 KPa.



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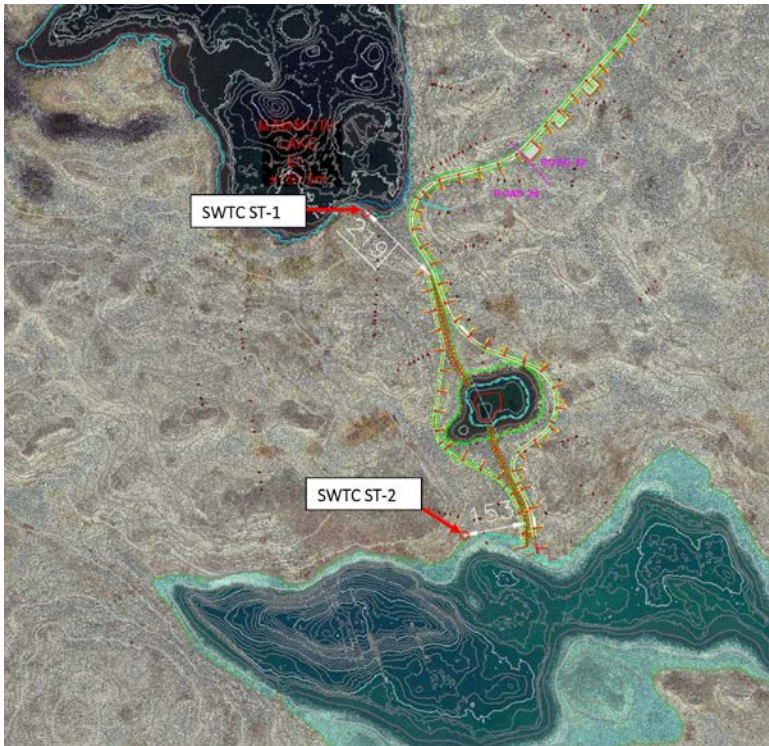


Figure 1 – Blast Monitoring Stations Location

Blast was performed following the blasting setback distance calculation as detailed in Appendix C of the Memo Blasting Activities – South Whale Tail Channel Construction (September 2019). From this initial analysis (before blast) and as per fish habitat type presented in Figure 2 below, it has been determine that the SWTC likely blasting area is in a low risk zone and more than 150m away from the worst case potential blasting area (highest charge combined with closest blast proximity). That worst case distance is either equal or greater than any of the setback distances computed.



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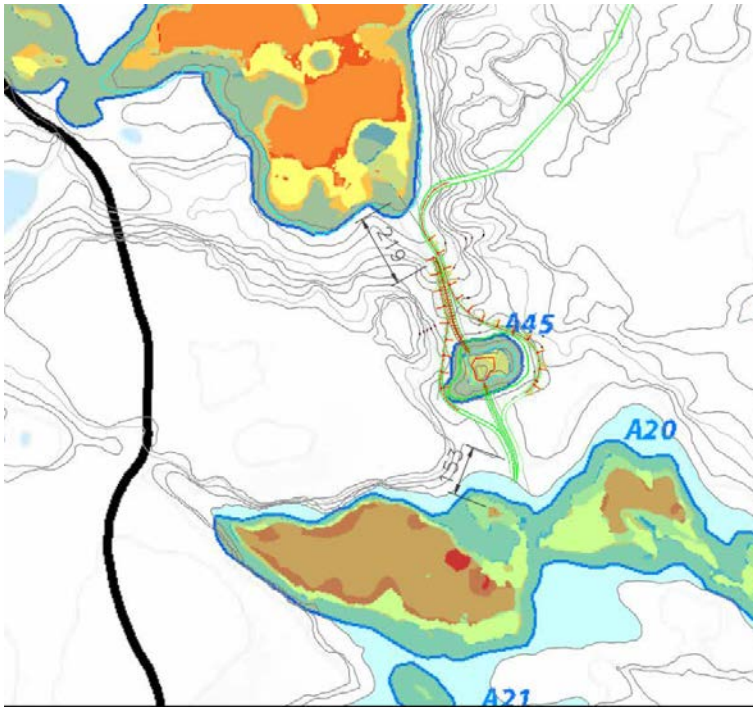


Figure 2 - Fish Habitat Type

During the blast on January 27, the blast monitor was put at the exact coordinates outlined in the Memo.

Following the investigation, it has been determine that the exceedance of vibrations might have been caused by:

- blast had no opened face, the blast was choked since the rock had nowhere to move;
- material in that area seems to be harder than the other blasts that were performed according to the drillers, this allows the waves to travel more freely in the ground.

Corrective measures to be put in place for following blast will consist of:

- collar (portion of a hole with stemming) for holes longer than 5m will be increased from 1 to 1.5m in order to reduce the powder factor;
- slow down the timing between the rows which creates a better freeface for the material to move during the blast and thus having less waves traveling towards the lake ;
- ensure no holes are on the same delay;
- have an open face; and
- blasts will be shot in shorter sequences of around 100 holes rather than over 200 holes, which would allow for further adjustments.



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Four previous blast have occurred at the north portion of the SWTC construction and blast monitoring at station SWTC ST-1 did not showed any exceedance in KPa and PPV. From the results of previous blast in this area, Agnico did not suspect that an exceedance may occurred. Agnico is confident the corrective measures, which will be put in place for the following blast, will aims to comply with the guidelines.

Finally, Faulkner et al (2006)¹ 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 is confident that the current exceedance of 22 mm/s were unlikely to cause impact to potential incubation sites in Whale Tail South.

Should you have any questions or require further information, Agnico remains available at your convenience.

Regards,

Agnico Eagle Mines Limited – Meadowbank Division

Robin Allard

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Environment General Supervisor

¹ 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.



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



AGNICO EAGLE

February 8th, 2020

Boyan Tracz
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Re: 16-HCAA-00370 – 2020-02-05 Agnico Eagle Whale Tail South Channel Blast Exceedance

Dear Boyan Tracz,

Agnico Eagle Mines would like to notify Fisheries and Oceans Canada that on February 5, 2020, an exceedance in the peak particle velocity (PPV) occurred during the blasting activities related to the Whale Tail South Channel (SWTC) construction at the Meadowbank Complex. As such, please find below information in relation to this event.

As detailed in the Memo Blasting Activities – South Whale Tail Channel Construction (September 2019), Agnico aims to comply with the DFO's Guidelines for Use of Explosives in or Near Canadian Fisheries Waters and shall adhere to the guidance provided in the Monitoring Explosive-Based Winter Seismic Exploration in Waterbodies, NWT 2000-2002. Those guidelines stipulated that:

- no explosive is to be detonated in or near fish habitat that produces an instantaneous pressure change (IPC) greater than 50 KPa; and
- no explosive is to be detonated that produces a peak particle velocity (PPV) greater than 13 mm/s in a spawning bed during the period of egg incubation (for lakes near the Meadowbank Complex, it takes place between August 15 and June 30).

Description of Event

On January 27, 2020, a first blast occurred at the south portion of the SWTC. Analyse of the blast monitoring station data SWTC-ST-2 (Figure 1) showed that the PPV was 22 mm/s and IPC was 25.75 KPa. Following this incident of vibration exceedance, additional measures were implemented as described in communication *16-HCAA-00370 - 2020-01-27 Agnico Eagle Whale Tail South Channel Blast Exceedance* sent on January 31, 2020.



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On February 5, 2020, the second blast occurred at the south portion of the SWTC with additional mitigation measures. Analyse of the blast monitoring station data at SWTC-ST-2 showed that the PPV was 15.7 mm/s and the IPC was 18.4 kPa.

The blast was performed following the blasting setback distance calculation as detailed in Appendix C of the Memo Blasting Activities – South Whale Tail Channel Construction (September 2019).

The blast was also performed using the following additional mitigation measures which helped reduce the blast vibration measured:

- Collar (portion of a hole with stemming) for holes longer than 5m was increased from 1 to 1.5m in order to reduce the powder factor;
- The timing between the rows was modified to a better freeface for the material to move during the blast and thus having less waves traveling towards the lake;
- It was ensured that no holes were on the same delay;
- It was ensure that the blast had an open face; and
- The blast was shot in shorter sequences of around 100 holes rather than over 200 holes.



Figure 1 – Blast Monitoring Stations Location



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Investigation of Exceedance

Following this second exceedance investigation, the following was found:

- The blast monitor station at SWTC-ST-2 was not installed properly and its installation had several features which would artificially increase the results obtained (i.e. uneven contact with natural soil, loose material in contact with the station)

This would explain why the four previous blasts at the north portion of the SWTC construction, which were monitored by station SWTC ST-1, did not show any exceedance in IPC and PPV.

Nevertheless, the additional mitigation measures were still able to decrease the PPV and Agnico will maintain them while adding additional mitigation measures until blast data results confirm this assumption.

Corrective Measure

Corrective measures to be put in place for following blast will consist of:

- A second blast monitor will be installed at SWTC-ST-2 and its installation will be validated by additional Quality Control. The initial blast monitor installation will also be maintained. This will allow comparison of the data for the next blast to determine whether the two exceedances reported were real;
- The timing delay for the blast will be increased further;
- Collar (portion of a hole with stemming) for holes longer than 5m will be maintained at 1.5 m;
- The measure of having no holes on the same delay will be maintained; and
- Quality control will be increased to ensure that no overloading occurs in such a way that the maximum charge per hole respects the design input.

While the measured values decreased in recorded PPV over the January 27 event, it still represents a reportable exceedance. However, as mentioned in previous communication, Faulkner et al (2006) found no effects on lake trout eggs due to blasts at Diavik Mine, NWT with maximum PPVs of 28.5 mm/s. No differences were noted in mortality of lake trout eggs in incubators between exposure sites and reference sites that resulted from blasting at Diavik in 2003-2004.

Assuming the current recording values were accurate, Agnico is confident that the PPV exceedance of 15.7 mm/s were unlikely to cause impact to potential incubation sites in Whale Tail South.



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Should you have any questions or require further information, Agnico remains available at your convenience.

Regards,

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



AGNICO EAGLE

February 13th, 2020

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Re: 16-HCAA-00370 – 2020-02-10 Agnico Eagle Whale Tail South Channel Blast Exceedance

Dear Boyan Tracz,

Agnico Eagle Mines would like to notify Fisheries and Oceans Canada that on February 10, 2020, an exceedance in the peak particle velocity (PPV) occurred during the blasting activities related to the Whale Tail South Channel (SWTC) construction at the Meadowbank Complex. As such, please find below information in relation to this event.

As detailed in the Memo Blasting Activities – South Whale Tail Channel Construction (September 2019), AEM aims to comply with the DFO's Guidelines for Use of Explosives in or Near Canadian Fisheries Waters and shall adhere to the guidance provided in the Monitoring Explosive-Based Winter Seismic Exploration in Waterbodies, NWT 2000-2002. Those guidelines stipulated that:

- no explosive is to be detonated in or near fish habitat that produces an instantaneous pressure change (IPC) greater than 50 KPa; and
- no explosive is to be detonated that produces a peak particle velocity (PPV) greater than 13 mm/s in a spawning bed during the period of egg incubation (for lakes near the Meadowbank Complex, it takes place between August 15 and June 30).

Description of Event

On January 27, a first blast occurred at the south portion of the SWTC at monitoring station SWTC ST-2 (Figure 1 below). Analyse of the blast monitoring showed that the PPV was 22 mm/s and IPC was 25.75 KPa. Following this incident of vibration exceedance, additional measures were implemented as described in communication 16-HCAA-00370 2020-01-27 sent on January 31 2020.

On February 5, 2020, the second blast occurred at the south portion of the SWTC with mitigation measures. Analyse of the blast monitoring station data at SWTC-ST-2 showed that the PPV was



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15.7 mm/s and the IPC was 18.4 kPa. Following this incident of vibration exceedance, additional measures were implemented as described in communication 16-HCAA-00370 2020-02-05 sent on February 8, 2020. These additional measures were as follows:

- A second blast monitor will be installed at SWTC-ST-2 and its installation will be validated by additional Quality Control. The initial blast monitor installation will also be maintained. This will allow comparison of the data for the next blast to determine whether the two exceedance reported were real;
- The timing delay for the blast will be increased further;
- Collar (portion of a hole with stemming) for holes longer than 5m will be maintained at 1.5 m;
- The measure of having no holes on the same delay will be maintained; and
- Quality control will be increased to ensure that no overloading occurs in such a way that the maximum charge per hole respect the design input.

On February 10, 2020, a third blast occurred at the south portion of the SWTC with additional mitigation measures. Analyse of the blast monitoring station data SWTC-ST-2 showed that the PPV was 17.7 mm/s and IPC was 20.72 KPa.

The blast was performed following the blasting setback distance calculation as detailed in Appendix C of the Memo Blasting Activities – South Whale Tail Channel Construction (September 2019).

The blast was also performed using the following additional mitigation measures which helped limit the blast vibration measured:

- A second blast monitor was installed at SWTC-ST-2 and anchored to a boulder for better contact with the ground (Figure 2). The initial blast monitor installation was also maintained (Figure 3) to allow comparison of the data between the two setup conditions and determine whether the two exceedances previously reported were real;
- Collar (portion of a hole with stemming) for holes longer than 5m was maintained at 1.5m to limit the powder factor;
- The measure of having no holes were on the same delay was maintained;
- It was ensured that the blast had an open face;
- Quality control was increased to ensure that no overloading occurred in such a way that the maximum charge per hole respect the design input and loading plan.

The measure consisting in increasing the timing delay was not implemented for this blast (refer to Section “Investigation of Exceedance” on Page 5).



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While this represents a significant decrease in recorded PPV over the January 27 event, after which the mitigation measures were implemented, it still represents an exceedance and is slightly above the PPV recorded during the February 5 event. However, as mentioned in previous communications, Faulkner et al (2006)¹ found no effects on lake trout eggs due to blasts at Diavik Mine, NWT with maximum PPVs of 28.5 mm/s. No differences were noted in mortality of lake trout eggs in incubators between exposure sites and reference sites that resulted from blasting at Diavik in 2003-2004.

Assuming the current recording values were accurate, Agnico is confident that the PPV exceedance of 17.7 mm/s was unlikely to cause impact to potential incubation sites in Whale Tail South.



Figure 1 – Blast Monitoring Stations Location

¹ 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.



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Figure 2 – Blast Monitoring Station installed with a rock anchor.



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Figure 3 – Blast Monitoring Station installed directly on the ground

Investigation of Exceedance

Following this third exceedance investigation, the following was found:

- The second blast monitor station installed on a bedrock outcrop at SWTC-ST-2 malfunctioned and failed to record the vibration during the event.
- The blast monitor station at SWTC-ST-2 that was not installed properly was the one recording the 17.7 mm/s PPV. As mentioned in the previous communication, its installation had several features which would artificially increase the results obtained (i.e. uneven contact with natural soil, loose material in contact with the station), which were maintained for comparison purposes.
- Although no hole was on the same delay, the time delay was not increased as initially planned after the previous exceedance, due to internal miscommunication. The time delay was kept at 109 ms between rows.
- The increased QC during the hole loading was able to confirm that the holes were not overloaded, and that sufficient collar was maintained as per design.



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- The theoretical vibration that the place design should induce was calculated and was found to be around 2.5 mm/s.

The poor installation of the SWTC-ST-2 blast monitor would explain why the four previous blasts at the north portion of the SWTC construction which were monitored by station SWTC ST-1, installed on rock, did not show any exceedance in KPa and PPV. This assumption is also supported by the theoretical blast design calculation. Unfortunately, no sufficient blast data is yet available to confirm this assumption.

Nevertheless, the additional mitigation measures still allowed to keep the PPV below the initial level of 22 mm/s and Agnico will maintain them while adding additional mitigation measures until blast data results confirm this assumption.

Corrective Measures

Corrective measures to be put in place for following blast will consist of:

- The second blast monitor will be reinstalled at SWTC-ST-2 and its installation and operation will be validated by additional Quality Control. All potentially defective devices have been sent back for maintenance and recalibration. A third blast monitor will be installed on a rock anchor at some distance to gather information on blast vibration propagation. The initial blast monitor installation will also be maintained. This will allow comparison of the data for the next blast to determine whether the exceedances previously reported were real.
- The timing delay for the blast will be increased further to 151 ms between rows.
- Collar (portion of a hole with stemming) for holes longer than 5m will be maintained at 1.5 m.
- The measure of having no holes on the same delay will be maintained.
- Quality control will continue to ensure that no overloading occurs in such a way that the maximum charge per hole respect the design input.

Should you have any questions or require further information, Agnico remains available at your convenience.

Regards,

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