AGNICO EAGLE

MEADOWBANK DIVISION

AMMONIA MANAGEMENT PLAN

WHALE TAIL PIT EXPANSION PROJECT

VERSION 2_NWB

April 2019

EXECUTIVE SUMMARY

In accordance with the Type A Water License, Agnico Eagle is completing Ammonia Management for the Whale Tail Pit Expansion Project, which includes monitoring for ammonia in all mine pit sumps, storage ponds, tailings storage facility (TSF), seeps, etc. Furthermore, Agnico Eagle has implemented a comprehensive, regular inspection program related to explosives management within the mine pits, conduct regular inspections at the explosives manufacturing facility (Dyno Nobel) to ensure all explosive products are stored in locked, sealed containers prior to use and will continue to perform continuous review of analysis results such that mitigation measures can be implemented when increasing trends of ammonia are determined.

As an extension of the Meadowbank Mine operations, ammonia management at Whale Tail Pit will follow the same practices as outlined in the approved plan. This Ammonia Management plan is a companion document to the Spill Contingency Plan, the Water Management Plan and the Water Quality and Flow Monitoring Plan and has been updated to provide guidance for monitoring ammonia levels at the Meadowbank mine site (including the extension of the mine through the Approved Whale Tail Pit Project and the Expansion Project), as part of the conditions applying to waste disposal and management listed in the water license.

This plan has been updated for the Expansion Project in support of the Nunavut Water Board (NWB) Type A Water License Amendment Process.

DOCUMENT CONTROL

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01	March 2016	13	Table 1 update
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WT	June 2016	All	Included Whale Tail Pit operations in the updated plan
2_NIRB	December 2018	All	Ammonia Management Plan as Supporting Document submitted to the Nunavut Impact Review Board for review and approval as part of Whale Tail Pit – Expansion Project
2_NWB	April 2019	All	Ammonia Management Plan as Supporting Document submitted to the Nunavut Water Board (NWB) Type A Water License Amendment Process

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ACCRONYMS

Agnico Eagle	Agnico Eagle Mines Limited
AMP	Ammonia Management Plan
AN	Ammonium Nitrate
ANFO	Ammonium nitrate – fuel oil
AWAR	All-weather Access Road
CCME	Canadian Council of Ministers of the Environment
CNO^-	Cyanate
NWB	Nunavut Water Board
TSF	Tailings Storage Facility
WRSF	Waste Rock Storage Facility

1. INTRODUCTION

The Ammonia Management Plan (AMP) was updated in March 2016 in response to concerns raised during the Meadowbank Water License 2AM-MEA1526 renewal process (January, 2015 - NWB Technical Meetings – Baker Lake) and was re-issued as part of the management plans update process. The concerns from interveners centered on ammonia loading resulting from mine infrastructure, in particular from cyanidation in the Tailings Storage Facility (TSF), the use and management of explosives, and management of treated sewage. In addition, there was a request for loading calculations of ammonia to the receiving environment.

This plan was also updated in support of the Nunavut Impact Review Board (NIRB) review process and the Nunavut Water Board (NWB) for the Whale Tail Pit Approved Project.

As an extension of the Meadowbank Mine operations, ammonia management for the Whale Tail Pit Expansion Project will follow the same practices as outlined in the approved plan and will similarly conduct routine monitoring in the receiving environment at the Whale Tail Pit site under the CREMP. This Ammonia Management Plan is a companion document to the Water Management Plan and the Water Quality and Flow Monitoring Plan and has been updated to provide guidance for monitoring ammonia levels at the Meadowbank and Whale Tail sites (including the Whale Tail Pit Expansion Project). This includes monitoring for ammonia in all mine pit sumps, attenuation ponds (Whale Tail and IVR), TSF, seeps, etc. in accordance with the Water Licenses 2AM-MEA1526 and 2AM-WTP1826. Furthermore Agnico Eagle will implement a comprehensive, regular inspection program related to explosives management within the mine open pits, conduct regular inspections at the explosives manufacturing facility (Dyno Nobel) to ensure all explosive products are stored in locked, sealed containers prior to use, and continue to perform continuous review of analytical results such that mitigation measures can be implemented when increasing trends of ammonia are noted.

Ammonia is a naturally occurring nitrogen compound found in the environment. However, there are two sources at the mine sites that can contribute to the mobilization of ammonia in the groundwater or surface runoff:

1. Blasting of ammonium-nitrate (AN) explosives is typically the primary source of ammonia in areas of mining operations at Meadowbank and Whale Tail Project sites. AN readily absorbs water and dissolves easily, thereby mobilizing ammonia in either groundwater or surface runoff; and
2. In gold mine operations using a cyanidation process to extract the gold from the ore, the cyanide in solution is oxidized to cyanate (CNO^-) using a sulfur dioxide (SO_2) air process before discharge to the TSF. The cyanate can then hydrolyze to ammonia in the TSF reclaim pond.

Ammonia dissolved in water exists in equilibrium of interchanging un-ionized (NH_3) and ionized (NH_4^+) forms. The equilibrium is influenced by pH, temperature, and ionic strength (salinity) where the amount of un-ionized ammonia increases as the pH becomes more basic or as the water temperature or salinity increases. Un-ionized ammonia can readily pass across the gill surface and enter into the bloodstream of

fish, while ionized ammonia passes with greater difficulty. Once inside the fish, both forms of ammonia can cause toxic effects (CCME, 2010). Furthermore, it should be noted that ammonia oxidizes to nitrite (NO_2) and nitrate (NO_3), the former being particularly toxic to fish and humans. Both nitrite and nitrate have CCME guidelines to ensure the Protection of Aquatic Life.

In addition to ammonia, monitoring of nitrate and nitrite is also considered in the AMP, as both water quality parameters are signature compounds of AN explosives. NO_3 has a discharge criteria threshold specified in the conditions applying to waste disposal and management in water licenses 2AM–MEA1525 and 2AM-WTP1826. This AMP proposes monitoring of blasting practices for the assessment of quantity of explosives used, blast performance, and monitoring of water quality to determine ammonia levels in waters within Meadowbank and Whale Tail Pit sites. The monitoring results can be used to review and adjust blasting practices or water management if ammonia levels need to be reduced.

2. EXPLOSIVE MANAGEMENT AND BLASTING PRACTICES

2.1 SITE DESCRIPTION

Explosive Storage

The primary storage area of explosive products will be located at the Meadowbank and Whale Tail mine site emulsion plant areas. The Meadowbank plant is located approximately 4 kms from the main site. The explosive products arrive by barge at the Baker Lake marshalling area. They are then transported by ground to the Meadowbank and Whale Tail emulsion plants and storage facilities.

Explosive products are packaged in the suppliers' containers and packed into sea containers, which limits the possibility of spillage into the environment. The products are only removed from these containers prior to use at the emulsion plant areas. Surface areas are graded to collect water runoff within the storage facilities.

The emulsion plant areas (one at Meadowbank and a new one at Whale Tail for the Expansion Project) consist of a plant for the preparation of bulk emulsion explosives, two buildings for the storage of AN, and four explosive magazines along the access road to the plant. The use of explosives at the Meadowbank mine for operations at Vault Pit, Goose Pit, Portage Pit and Phaser Pits will cease when mining is completed in 2019. For the Approved Project, the existing emulsion plant at Meadowbank will supply explosives to the Whale Tail open pit once development begins. For the Expansion Project, an emulsion plant at Whale Tail will supply explosives.

As for the Whale Tail Expansion Project, an Emulsion Plant will be built in a remote area southwest of the Pits and camp site. It will consist of an emulsion plant for the preparation of bulk emulsion explosives, two buildings for the storage of AN, and four explosive magazines along the access road to the plant. Please refer to Appendix 1 for the Whale Tail Pit site layout, and location of the remote emulsion plant.

Roads

The 105 km AWAR between the Meadowbank mine site and Baker Lake will continue to be used to transport explosive products from the Baker Lake site facilities to the emulsion plant area located 4 km north of the Meadowbank mine site. Agnico Eagle will continue to enforce restricted access from km 85 north to the Meadowbank Mine and will enforce the same restrictions along the Whale Tail Pit Haul Road (refer to the Whale Tail Pit Haul Road Management Plan). In preparation for blasting operations, explosive products are transported from the emulsion plant areas to the appropriate blasting locations.

Spillage control protocols, procedures and handling of spilled material, and explosive management for both storage and transport have been established by Dyno Nobel Inc. (Dyno) and are provided in Appendix 4. Explosive products and spills are referenced in the Spill Contingency Plan.

Pits and Underground Operations

The development sequence of the mine site is provided in the Whale Tail Pit Waste Rock Management Plan and the Meadowbank Mine Waste Rock and Tailings Management Plan.

Explosives are used for the excavation of waste rock and mining of the ore at the Portage, Vault and Whale Tail pits, and in the future at the proposed IVR pit and underground mines.

2.2 AMMONIA PATHWAYS

Emulsion not fully detonated in pit blasting operations provides several pathways for ammonia mobilization. Water from drainage runoff is the primary mechanism of mobilization for ammonia residuals remaining within open pits. Drainage within the open pits collects in pit sumps and then is pumped to the Portage Attenuation Pond, which became the South Cell TSF Reclaim Pond on November 2014. As for Whale Tail, the mechanisms are expected to be similar with the sump water pumped to the Whale Tail and IVR Attenuation Ponds.

Blasting residuals are also expected to be attached to waste rock and ore, which are transported from the open pits to their respective storage and processing facilities. Residuals from waste rock may be washed off by precipitation and be ultimately conveyed to the attenuation pond. Residuals from the ore may be carried in the tailings to the TSF. All of these pathways (mine sumps, attenuation ponds, TSF) are monitored in accordance with the Water License.

At Whale Tail, if blasting residues on waste rock are mobilized, they will collect in the Waste Rock Storage Facility (WRSF) pond, which is downslope of the WRSF, or the IVR WRSF contact water collection system. For ore stored within the dewatered portion of Whale Lake, drainage would flow to the attenuation pond. The locations of the WSRFs, the storage ponds, and the contact water collection systems are shown in the figure for Whale Tail site in Appendix 1.

To avoid any case of poor or incomplete detonation, Agnico Eagle employs the following measures:

- inspection of drilling depth to ensure it is in accordance with blast design;
- inspection of quantity of explosives in each drillhole to ensure it is in accordance with blast design;
- inspection of blast tie-in execution; and
- reporting of any anomalies during loading and priming of explosives to correct situations prior to initiation.

These measures will be reviewed should ongoing cases of poor or incomplete detonation be encountered. This will be included in the next revision of the Ammonia Management Plan.

2.3 EXPLOSIVES AND BLASTING

Based on experience at Meadowbank and at other open pit mines in the Canadian Arctic, the largest potential source of ammonia in mine water will be from explosive residue from blasting. Depending on the wetness of the site, water may leach explosives from blastholes prior to the blast.

Other forms of ammonia released from AN are explosives flowing into cracks and fissures in the rock and not detonating or leading to an incomplete detonation of the explosive column and misfired blastholes. An AN based emulsion is used as a blasting agent at the Meadowbank site and will be used at Whale Tail open pit for the Approved Project. For the expansion, AN based emulsion will come from the Whale Tail emulsion plan. This material is designed to repel water thus minimizing the potential for ammonia to impact mine water.

Blasting operations on site include monitoring the quantities of explosives used, and blast design procedures and practices. Combined with water monitoring, the compilation of this data is used to assess blasting performance. The results of this assessment are used to adjust blasting practices as needed to:

a) Optimize the use of explosives; and

b) Increase the completion and efficiency of explosive detonations.

Any modifications to blast design are intended to decrease the amount of ammonia that may become available for mobilization in mine water.

Explosive Products

Explosive products used at the mine site include bulk explosives (bulk emulsion), packaged explosives, cast boosters, detonating cords, non-electric delay detonators and non-electric lead lines. The material safety data sheets (MSDS) for these products are provided in Appendix 4. Of these products, the greatest potential for water contamination comes from the bulk explosives. Presently, Meadowbank uses emulsion as the primary bulk explosive for its blasting operations. Emulsion will continue to be the primary explosive used at Whale Tail Pit (both Approved and Expansion Project).

Bulk emulsions typically contain some or all of the following components:

- Ammonium, sodium and/or calcium nitrate;
- Fuel and/or mineral oil;
- Methylamine nitrate;
- Emulsifiers; and
- Ethylene glycol.

Although bulk emulsions are water resistant, contaminants can be leached from the product if it is left in contact with standing or flowing water for extended periods of time. The performance of the explosive, and hence the potential for post-blast contaminations, deteriorates with the length of time that the emulsion remains in the blasthole after it has been loaded (i.e., sleep time). Blast procedures currently in use are designed to minimize sleep time so that standing or flowing water is not in contact with the bulk emulsion for extended periods of time.

Procedures and Practices

Quality control procedures are in place to verify AN content in bulk explosives. Quality control procedures

for the emulsion occur at the plant and density tests are done at the blast site (on the trucks). Loading procedures specify that blastholes be loaded with emulsion from the bottom of the blastholes to provide a continuous explosive column. Details on the explosive quality control and loading procedures have been established by Dyno and are provided in Appendix 2.

The primary factors that may reduce the amount of ammonia available for mobilization in mine water are:

- Explosives handling; and
- Completeness of detonation.

Bulk emulsion spillage during blasthole loading could (as bulk emulsion is resistant to water) be a source of ammonia that could be carried by water collected in the pits. Spillage control protocols, procedures and handling of spilled material, and explosive management for storage and transport, as well as the emergency response plan, have been established by Dyno and are provided in Appendix 2 and 4.

Incomplete detonation results in higher ammonia residue on the blasted rock. Evidence of incomplete detonation is often observed as an orange fume after a blast and sometimes an orange pigment on the blasted rock. Explosives that have failed to detonate may be observed in the muckpile. Muckpiles are routinely inspected by Meadowbank staff for signs of incomplete detonation.

The same procedures and practices will be used at the Whale Tail site operations.

3. MONITORING

Monitoring of explosive handling and blasting is as follows:

a) Explosive quantities: Records of explosive quantities used for in-pit blasting are kept for each blasting event and will be conserved throughout the mine life. Furthermore, a record of blast location (i.e., pit and elevation), blast date, and bulk explosive type and name used (emulsion, with the corresponding ratio of AN over emulsion) is kept for all events.

b) Design parameters: Blast design parameters, as well as changes in the blast design parameters from the standard are recorded and dated.

c) Loading instructions: Loading instruction forms are completed for each blast event and provide a record of the as-loaded parameters for all blastholes in the blast pattern including:
   - Hole depth
   - Collar height
   - Priming (single or double)
   - Other observations made by the blast crew (e.g., wetness of holes, use of liners, collapsing holes or difficulty loading)

d) Video footage: Videos are taken of each blast. This practice provides a visual, qualitative record of the results of each blast and provides insight into potential problems such as incomplete detonation (e.g. orange fumes) and misfires, as well as areas of poor muckpile heave and forward movement.

e) Blast audits: Blast audits are conducted on a monthly basis to ensure that best practices are being followed in the field (audits may be adjusted to a lesser frequency if low ammonia levels are consistently observed, or conversely may be adjusted to a higher frequency if high ammonia levels are consistently observed).

An additional monitoring technique commonly used is the measurement of the Velocity of Detonation (VOD), which has been shown to be directly related to the volumetric fraction of the explosive that has been consumed. This technique will be implemented if poor or incomplete detonation is consistently suspected.

4. MILL EFFLUENT

4.1 SITE DESCRIPTION

The mill effluent consists of tailings produced at the mill that is pumped as slurry and deposited in the TSF where the tailings particles are allowed to settle and consolidate. The reclaim water is pumped back to the mill for re-use. Prior to discharge of the mill effluent to the TSF, the effluent is sent to the cyanide destruction process. The cyanide destruction process at Meadowbank uses the sulfur dioxide (SO_2) and air process to oxidize weak acid dissociable cyanide (CN-WAD) to a less toxic form: cyanate (CNO^-) based on the following reactions:

$$SO_2 + O_2 + H_2O + \text{CN-WAD} \rightarrow CNO^- + H_2SO_4$$

The process can also use sodium metabisulfite ($Na_2S_2O_5$) instead of sulfur dioxide in case there are operating issues with the dosing of sulfur dioxide gas in the process. This ensures that chemicals required for the cyanide destruction process (either SO_2 or $Na_2S_2O_5$) are always available.

4.2 AMMONIA PATHWAY

Cyanate produced from the oxidation of CN-WAD can readily hydrolyze to ammonia (NH_3) and carbon dioxide (CO_2) based on the following reaction:

$$CNO^- + H^+ + H_2O \rightarrow NH_3 + CO_2$$

Thus, the mill effluent provides an ammonia loading to the TSF reclaim water.

During the operation of the TSF, the reclaim water will be pumped to the mill for re-use in a closed loop system. Consequently, there will be no discharge of reclaim water to the environment during this period. Furthermore, it is expected that the ammonia concentration will gradually increase in the TSF reclaim pond over time, even though (1) there may be some slight attenuation of ammonia due to microbial/algae activity in the summer and (2) ammonia may oxidize to nitrite and nitrate, particularly near the top of the pond where oxygen is most present.

4.3 MONITORING

Concentrations of ammonia, nitrate and nitrite are parameters that are monitored on a monthly basis as part of this sampling campaign of the TSF reclaim water at station ST-21.

In the Water Quality Forecasting, a maximum ammonia concentration in the TSF reclaim water is evaluated in order to meet the 2AM-MEA1526 Water Licence criteria which for benchmarking are compared to CCME guidelines for the Protection of Aquatic Life in the Portage and Goose Island Pits once flooding activities are completed. If this concentration is exceeded before the end of the flooding operation, measures could be undertaken to lower the ammonia concentration, as well as nitrate and nitrite if required, in the TSF reclaim pond prior to the transfer of TSF reclaim water to the pits.

Ammonia treatment technologies that could be further investigated, if the need arises, include:

i) Biological nitrification / denitrification during the summer months;

ii) In-situ volatilization of ammonia during the summer months; and

iii) Ammonia removal by snow making.

5. WATER MANAGEMENT

For details on the site wide water management, please refer to the Meadowbank Mine Water Management Report and Plan and the Whale Tail Pit Expansion Project Water Management Plan.

In addition to controlling contact water through design, the Meadowbank and Whale Tail Water Quality and Flow Monitoring plans and Water Licenses 2AM-MEA1526 and 2AM-WTP1826 requires monitoring stations that are used for the monitoring of ammonia loadings around the mine site and waste rock storage areas from explosive residuals, as well as ammonia concentration found in the TSF reclaim pond. These monitoring requirements ensure contact water that may contain elevated ammonia, nitrates or nitrites are managed, treated if necessary and do not impact the receiving environment. Future monitoring at the Whale Tail Pit Expansion Project site presented in the Water Quality and Flow Monitoring Plan parallels the existing monitoring and will form part of the amendment to the Water Licence.

In addition to the monitoring listed in the Water Quality and Flow Monitoring Plan, the following actions will be undertaken at the Whale Tail Pit Expansion Project or continue at the Meadowbank and Whale Tail Sites as part of the AMP:

- If runoff or seepage is detected at the rock storage facilities, water samples collected at the Portage, Vault, Whale Tail, or IVR WRSFs during late operations, will also be analyzed for nitrate and nitrite to complete the suite of signature compounds found in explosive residuals.
- Tailings slurry volumes and density from the mill pumping facility to the TSF are recorded on a monthly basis.
- The records of water volumes pumped from the Whale Tail Pit sumps or WRSF pond to the Whale Tail Attenuation Pond, or the IVR sumps to the IVR Attenuation Pond will be recorded on a monthly basis.
- The records of water volumes pumped from the attenuation or storage ponds to the receiving environment will be recorded on a monthly basis.

Sampling frequency at the pit sump will also be increased if high variability is identified in observed constituent concentrations as a result of the blasting schedule.

Any drainage from the ore storage areas will collect in the Attenuation Ponds. The open pits, water storage ponds and the Attenuation Ponds at the Whale Tail Pit Approved and Expansion Projects are shown in Appendix 1.

6. REPORTING

Reporting of ammonia concentrations at the Type A sampling stations will be included as part of the reporting requirement of Water Licences 2AM-MEA1526 and 2AM-WTP1826. The reporting frequency is prescribed by the NIRB, KIA and NWB and includes, but may not be limited to:

- Brief monthly reports of the compiled water quality monitoring results, sent to the NWB, the CIRNAC Water License Inspector and to the Kivalliq Inuit Association (KIA); and
- An annual report submitted to the NWB, KIA, CIRNAC, Nunavut Impact Review Board, Government of Nunavut, and other interested parties. This report summarizes monitoring results for each sampling station, annual seep water chemistry results, annual groundwater monitoring results, receiving water monitoring results, spills and any accidental releases, measured flow volumes, effluent volumes and loadings, and results of QA/QC analytical data.

Mine operation personnel reviews on a monthly basis the data gathered from the sampling stations in the Type A Water license and from the monitoring action proposed under the AMP. If the data indicates that further studies and/or significant changes to the water management infrastructure are required to assess or control ammonia concentrations, Agnico Eagle will notify the NWB and KIA, as early as practical. Results of these further studies and/or changes to the AMP monitoring actions will be transmitted to the NWB for review.

7. INSPECTION

On a weekly basis, the environment department will conduct inspection in the blasting area to ensure that the Dyno Nobel loading procedures are being implemented (this will minimize blasting residues). In addition, inspections will be undertaken at explosive product storage facilities (Dyno Nobel) to ensure that explosives products are stored in sealed containers and there is no spillage. If any non-conformities are observed follow up action will be undertaken and corrective measure will be put in place. See Appendix 5 for copy of the AMP inspection form.

8. REVIEW OF AMMONIA MANAGEMENT PLAN

Review of the results of the site water quality and AMP monitoring during the year may provide new information, and/or indications that changes to the AMP are necessary. When revisions are warranted, an updated AMP will be submitted to the NWB for review.

9. REFERENCES

Agnico Eagle (2018a), Whale Tail Pit Expansion Project Water Quality and Flow Monitoring plan. November 2018.

Agnico Eagle (2018b), Whale Tail Pit Expansion Project FEIS. Volume 8 – Monitoring and Mitigation and Management Plans. November 2018.

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SLI (2012). Water Management Plan 2012. Agnico-Eagle Mines. Document No. 610756- 0000-40ER-0001, Rev. 02. March 2013.

SLI (2012). Water Quality Forecasting for the Portage Area 2012-2025. Agnico-Eagle Mines. Document No. 610756-0000-40ER-0002, Rev. 01. March 2013.

APPENDIX 1

Whale Tail Pit Expansion Project Site layout and the location of the Remote Emulsion Plant