Kiggavik Project
Final Environmental Impact Statement

Tier 3 Technical Appendix 2C:
Explosives Management Plan

September 2014

History of Revisions

Revision Number	Date	Details of Revisions
01	December 2011	First Issue with Draft Environmental Impact Statement
02	September 2014	Issued for Final Environmental Impact Statement

A management plan is a living document which is continually reviewed and revised throughout the life of the Project to ensure it meets health, safety, and environmental performance standards. This process of adaptive management and continual improvement (Tier 2, Volume 2, Section 17) is consistent with the Inuit Qaujimajatuqangit (IQ) principles of Qanuqtuurunnarniq *being resourceful and flexible to solve problems* and Pilimmaksarniq *maintaining and improving skills through experience and practice.*

Table of Contents

List of Tables

List of Figures

Attachments

Abbreviations

AN ..... Ammonium nitrate

ANFO ..... Ammonium nitrate fuel oil

AREVA ..... AREVA Resources Canada Inc.

CCME ..... Canadian Council of Ministers of the Environment

DFO ..... Fisheries and Oceans Canada

EHS ..... Environmental, Health, and Safety

EIS ..... Environmental Impact Statement

EPCM ..... engineering, procurement, construction, and management

EPP ..... Environment Protection Plan

HADD ..... Harmful Alteration, Disruption, or Destruction

INAC ..... Indian and Northern Affairs Canada

MMER ..... Metal Mining Effluent Regulations

the Project ..... Kiggavik Project

IOL ..... Inuit Owned Land

1 Introduction

The Kiggavik Project will require ammonium nitrate (AN) to manufacture ammonium nitrate-fuel oil (ANFO) and emulsion explosives for controlled blasting during the mining of the Kiggavik and Sissons area deposits. This plan discusses explosives management and in particular ammonium nitrate pursuant to directives from the Nunavut Impact Review Board and Nunavut Water Board. At this stage, the explosives management plan is conceptual since mine construction has not commenced. A detailed Explosives Management Plan will be developed at the licensing stage in conjunction with the selected explosives contractor to ensure that all possible hazards are identified, mitigation methods are detailed, and spill response strategies are developed in accordance with manufacturer's recommendations and applicable regulations.

1.1 Explosives Use

Explosives use management will have the primary goal of limiting loss of ammonia to mine rock and ore, which could subsequently leach into runoff. Explosives storage will be controlled and runoff from storage areas contained. Emulsions will be used for wet blasting; ANFO will be used for dry blasting to limit ammonia leaching. Consideration will be given to using 100% emulsion products to simplify the blasting procedure. Packaged explosives will be kept on site where required and for a backup for emulsion explosives and where required. All runoff into the pit and off of waste rock piles will be contained.

1.2 Explosives Regulations

The proposed explosives magazine for the Kiggavik Project will be designed in accordance with the Canadian Regulations for the Storage, Possession, Transportation, Destruction and Sale of Blasting Explosives and Initiation Systems (2008). The Regulations state that "*a magazine should be situated so that the accidental explosion of its contents is not likely to cause serious damage to other buildings or injury to persons*".

As well, the Kiggavik explosives magazine will conform to Nunavut Mine Health Safety Regulations (1994), Section 14.06 which state that:

- Overhead power lines supplying electricity to a magazine or area where explosives are prepared shall:
    - be protected against power surges and lightning; and

    - be terminated in a cable a minimum of 60 m horizontal distance from the magazine.
- And Section 14.08, subsection 2) which states:
    - The ground surrounding a magazine must be kept free of brush, timber or other combustible material for a distance of not less than 20 m from the magazine.

1.2.1 Impact on Fisheries

Fisheries and Oceans Canada (DFO) has established a set of guidelines for the use of explosives in or near Canadian fisheries waters (Wright and Hopky, 1998). These guidelines set out that "No explosive may be used that produces or is likely to produce, a peak particle velocity greater than 13 mm/s in a spawning bed during egg incubation". Under conditions where these guidelines cannot be met, the proponent is required to prepare a mitigation plan outlining additional procedures for protecting fish and their habitat. It is worth noting that this guideline limit only applies during spawning season and only at spawning beds. The DFO guidelines also set out an underwater overpressure limit of 50 kPa at fish habitats in northern environments.

1.2.2 Nitrogen Compounds in Mine Effluent

Mines are subject to regulations limiting ammonia, nitrate and nitrate levels in mine effluents release into the environment. Discharge limits are typically defined in consultation with the regulators based on legislated water quality guidelines (e.g. metal mining effluent regulations (MMER)).

The ammonia limits in mine effluent in Nunavut are set by the water board in consultation with AREVA. The effluent limits are intended to allow the proponent to meet Canadian Environmental Quality Guidelines (CCME) aquatic life guidelines in the receiving environment at a pre-determined location. The receiving guidelines are as follows:

- Total unionized ammonia 0.019 mg/L (dependent on water temperature); and
- Total NO_3-N = 13 mg/L.

The MMER does not have ammonia guidelines but states the undiluted effluent cannot be acutely toxic.

1.3 Mitigation and Monitoring

AREVA's approach incorporates integrated design and environmental assessment activities. Where a Project effect can be reduced through mitigation, this has been identified to the point possible and has been considered in the conceptual design, construction, operation, and decommissioning plan. Mitigation measures have been incorporated into the facility design. Plans have been developed to

actively manage mitigation measures where a design approach does not apply. Monitoring of the facilities, infrastructure, and operations will occur to ensure design and management mitigation measures are functioning as intended. Monitoring results will be compared to predicted performance. An adaptive management approach will be implemented to ensure that predicted performance is achieved.

A summary of mitigation and monitoring commitments regarding the use of explosives are discussed in the following sub sections. Mitigation and monitoring of explosives will adhere to AREVA's Environmental Protection Framework as detailed in the Environmental Management Plan, Technical Appendix 2T. This iterative process will ensure continual improvement of the Explosive Management Plan from the current conceptual stage to, and throughout, operations. Further details of mitigation measures can be found in the following sections of this Plan and in Tier 3, Technical Appendix 2B - Drilling and Blasting Design.

1.3.1 Mitigation by Design

Specific design features of facilities are intended to mitigate environmental, health, and safety effects. The main design mitigation measures regarding explosives outlined in this Plan include:

- For safety, the location of explosive storage compounds will be isolated from other facilities and from well-travelled roads.
- To prevent ammonium nitrate affecting the surrounding environment, runoff from explosive storage and preparation facilities and blasting areas will be captured and treated.

1.3.2 Mitigation by Management

Management of the Project will be conducted in a manner to mitigate environmental, health and safety impacts. This often includes the use, enforcement, and revision of proper procedures. The main mitigation measures by management regarding explosives outlined in this Plan include:

- For safety, individuals handling explosives will be provided with procedures and have adequate training.
- For safety, transportation of explosives will be conducted using specialized equipment and conducted in in such a manner as to safeguard human health and prevent impacts on the environment.
- Explosives handling procedures will be developed to ensure potential spills will be prevented. In the event of a spill, it will be cleaned up in a manner that is safe and limits the impact on the environment.
- To limit environmental effects to the aquatic environment, alternative blasting procedures will be used when blasting near waterbodies.

1.3.3 Monitoring

Results from the monitoring of facilities, infrastructure and operations will be compared to predicted performance. An adaptive management approach will ensure that environmental effects are minimized to the extent possible and at a minimum that performance predictions are met. The main monitoring commitments include regarding explosives include:

- Blast monitoring of ground vibrations will be conducted to ensure the protection of fish and fish habitat is maintained. Monitoring results will be interpreted following a blast event and mitigation measures will be implemented where necessary.

- All monitoring and reporting will be completed as per requirements of the *Explosives Act* and other Nunavut regulatory requirements as noted in this Plan.

2 Explosives Management

Mining involves drilling large diameter holes (blast holes) and loading these holes with an explosive to blast the material into sizes that can be handled. The depth of these blast holes is determined by the bench height. Blasted materials are then loaded into large trucks using a hydraulic shovel, loader, or backhoe, and hauled to an appropriate stockpile or disposal area.

There have been *some concerns raised regarding the storage and access of blasting materials* (EN BL NIRB 2010)[1]. This Explosives Management Plan has taken consideration of storage, access and transport of blasting materials to ensure blasting materials is carefully controlled, handled and used appropriately for its intended purpose.

2.1 Explosive Use and Type

At the beginning of mine operation, it is anticipated that the mined rock will be blasted using a bulk form of emulsion and ANFO mixture (70% emulsion to 30% ANFO). A bulk explosive truck will mix the appropriate blend of emulsion and AN prill and transfer this product to the pit for borehole loading of both dry and wet holes. A powder factor of 0.66 kg/bcm (0.25 kg/t) has been used for design purposes. Blasts are typically envisioned to be 200,000 to 300,000 tonnes each and will occur about two or three times per week.

For detailed information on the drilling and blasting design proposed for the Kiggavik Project, refer to Technical Appendix 2B “Drilling and Blasting Design and Related Regulatory Considerations”.

2.2 Product Description

Explosives will be required at the Kiggavik Project for blasting of rock and ore at the various mine locations. Transportation, storage, use, and handling of blasting materials are strictly regulated by the Federal *Explosives Act* and the *Transportation of Dangerous Goods Act*. Territorial regulations include the *Explosives Use Act* and Regulations and the *Mine Health and Safety Act* and Regulations. For further detail on the hazards associated with explosives material, refer to Tier 3, Technical Appendix 2U Hazardous Material Management Plan.

[1]EN – BL NIRB April 2010: *How will the blasting materials be stored? Will be have easy access to the blasting materials? Concerned over safety and storage of blasting materials and the possible misuse of the blasting materials by the people.*

Material hazard class, potential impacts, site handling and storage requirements, and recommended personal protective equipment are summarized in Tables 2.2-1 to 2.2-3.

Table 2.2-1 Explosives – Hazard Class and Potential Impacts

Material	Hazard Class	Potential Impact
Ammonium Nitrate	5.1	Water & Soil Contamination
High Explosive Detonators	1	Negligible

Table 2.2-2 Explosives – Safe Handling Procedures

Material	Safe Handling Procedures
Ammonium Nitrate	Keep away from heat and sources of ignition. Do not ingest or breathe dust. In case of insufficient ventilation, wear suitable respiratory equipment. Avoid contact with skin and eyes. Store in a cool, well-ventilated area separate from acids, alkalies, reducing agents and combustibles.
High Explosive Detonators	Store under dry conditions in a cool, well ventilated magazine in closed containers. Keep away from heat, sparks, and flames.

Table 2.2-3 Explosives – Personal Protective Equipment

Material	Personal Protective Equipment		
	Eyes	Skin	Respiration
Ammonium Nitrate	Safety goggles	Nitrile or rubber gloves; protective clothing	NIOSH/MSHA approved respirator
High Explosive Detonators	Safety goggles	Nitrile or rubber gloves; protective clothing made from cotton	None usually required

2.3 Explosives Quantities

The Kiggavik Project is estimated to require a maximum of approximately 10,000 tonnes per year of blasting materials during peak mining operations. The majority of this represents ammonium nitrate, which is not an explosive until mixed with fuel oil. For Kiggavik, to increase water resistance and the heave energy, a doped emulsion of 70/30 (70% Emulsion/ 30% AN) blend is recommended (see Technical Appendix 2B). Emulsions consist of an immiscible fuel mixed with a super saturated

aqueous solution of ammonium nitrate (AN). Prills of AN can be blended with the emulsion. Emulsion and AN will be mixed in an on-site plant by qualified personnel on an as-needed basis.

The explosives contractor will be responsible for maintaining inventory of all explosives onsite which will be reported to the mine manager weekly. A sample inventory control form is included as Attachment A. Table 2.3-1 provides a summary of the estimated annual explosives use for the Kiggavik Project.

Table 2.3-1 Summary of Estimated Explosive Use by Year

Year	All Open Pits 70/30 Blend (tonnes)	Underground Mine ANFO (tonnes)
1	231	0
2	7,693	0
3	7,331	40
4	7,645	237
5	6,823	372
6	6,808	426
7	6,771	770
8	1,998	819
9	1,677	814
10	1,529	841
11	1,540	793
12	731	556
13	311	125
Total	**51,090**	**5,793**

2.4 Explosives Storage

Explosives components will be shipped to the Kiggavik site and the emulsion/ANFO blend will be mixed at site. Bulk storage facilities for emulsion and ammonium nitrate products will be constructed at the Kiggavik main site. The 70/30 emulsion/ANFO non-detonator sensitive blend is only considered an explosive agent when loaded at the hole. The explosive supplier will be responsible for designing and constructing the on-site manufacturing facility. Detonators, primers, pre-split

explosives and miscellaneous blasting products will be shipped to site as explosives and be stored in site magazines. It is anticipated that four 4 m by 11 m magazines will be required for the following:

- Two magazines for pre-split and miscellaneous explosives;
- One for primers and detonating cords; and,
- One for detonators.

Figure 2.4-1 shows the proposed location of the ammonium nitrate storage area and emulsion plant. The powder magazine will be located in the same area 100 m beyond the detonator magazine. The roadway will be 5 wide, approximately, allowing only one-way traffic to and from the Main Zone pit area. It is estimated that the facility will contain a 40,000 kg capacity explosives magazine (pre-split powder and miscellaneous cartridge powder, primers and detonating cord), a magazine for blasting accessories (detonators, wire, etc.), bulk storage silos and a garage to house explosives delivery vehicles. The access road leading to this area will be located within the Kiggavik surface lease and access will be controlled.

The explosives magazines will be comprised of a 2 m thick pad with surface areas of approximately 430 m^2 and 630 m^2 for the detonator and powder magazines, respectively. The explosives magazines will be designed to Type 4 magazine standards. Storage of combustible materials will be strictly controlled. The grounds surrounding the magazines will be free from brush, timber and other combustible materials for a minimum distance of 20 m. There will be only one main magazine location for both the Kiggavik and Sissons sites. Explosives and accessories will be delivered to the pits by truck. Similarly, portal delivery to the underground mine will also be done by truck and temporary storage locations will be used as required.

A temporary storage area for explosive materials awaiting transport to the Project will be located at the Baker Lake port storage facility as indicated on Figure 2.4-2. This temporary storage area will be designed to conform to the same regulatory standards as the site magazine. Note that only explosives component materials will be stored at the port site and no explosives (emulsion/ANFO blend) will be produced or stored there.

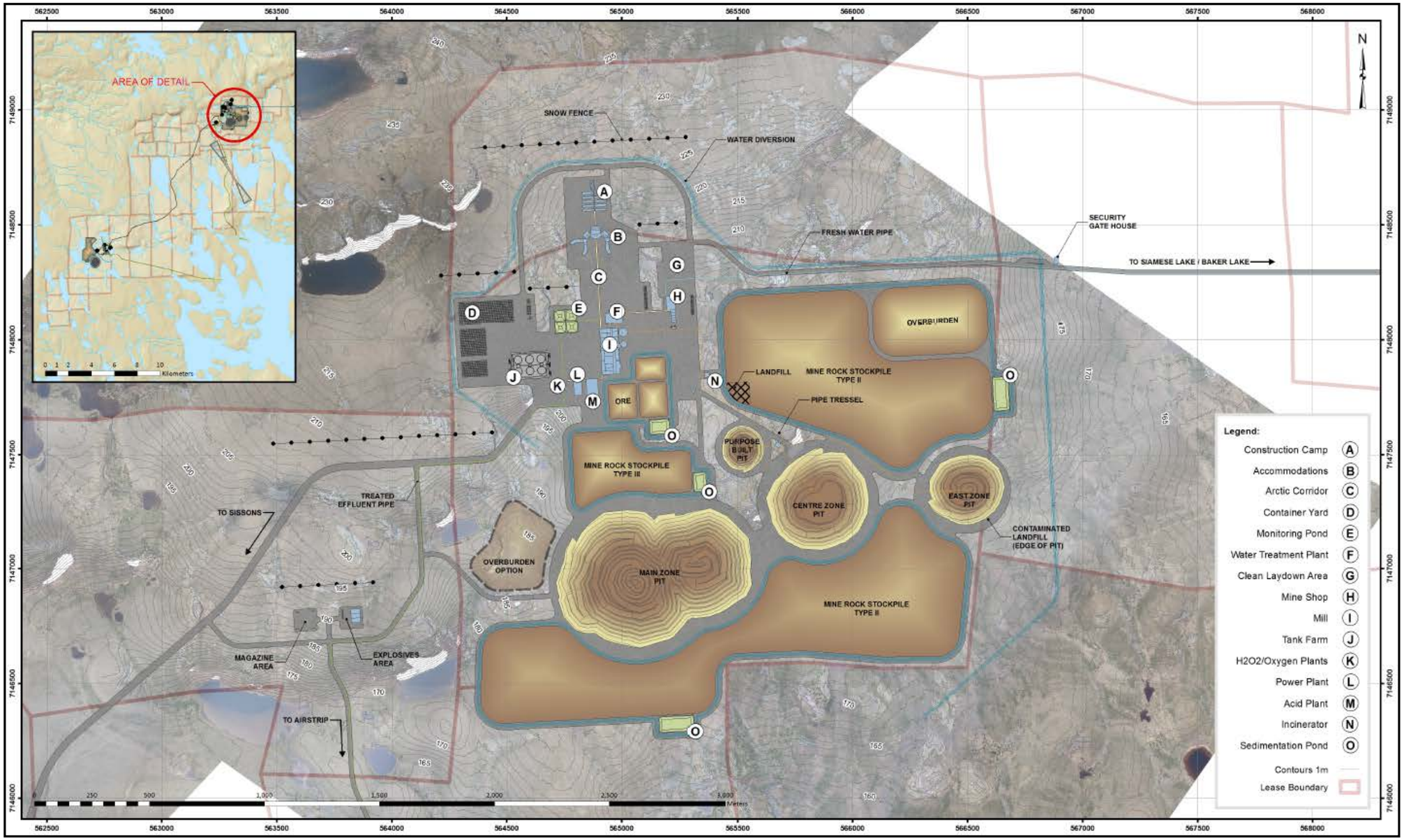

Figure 2.4-1 Kiggavik Site Layout

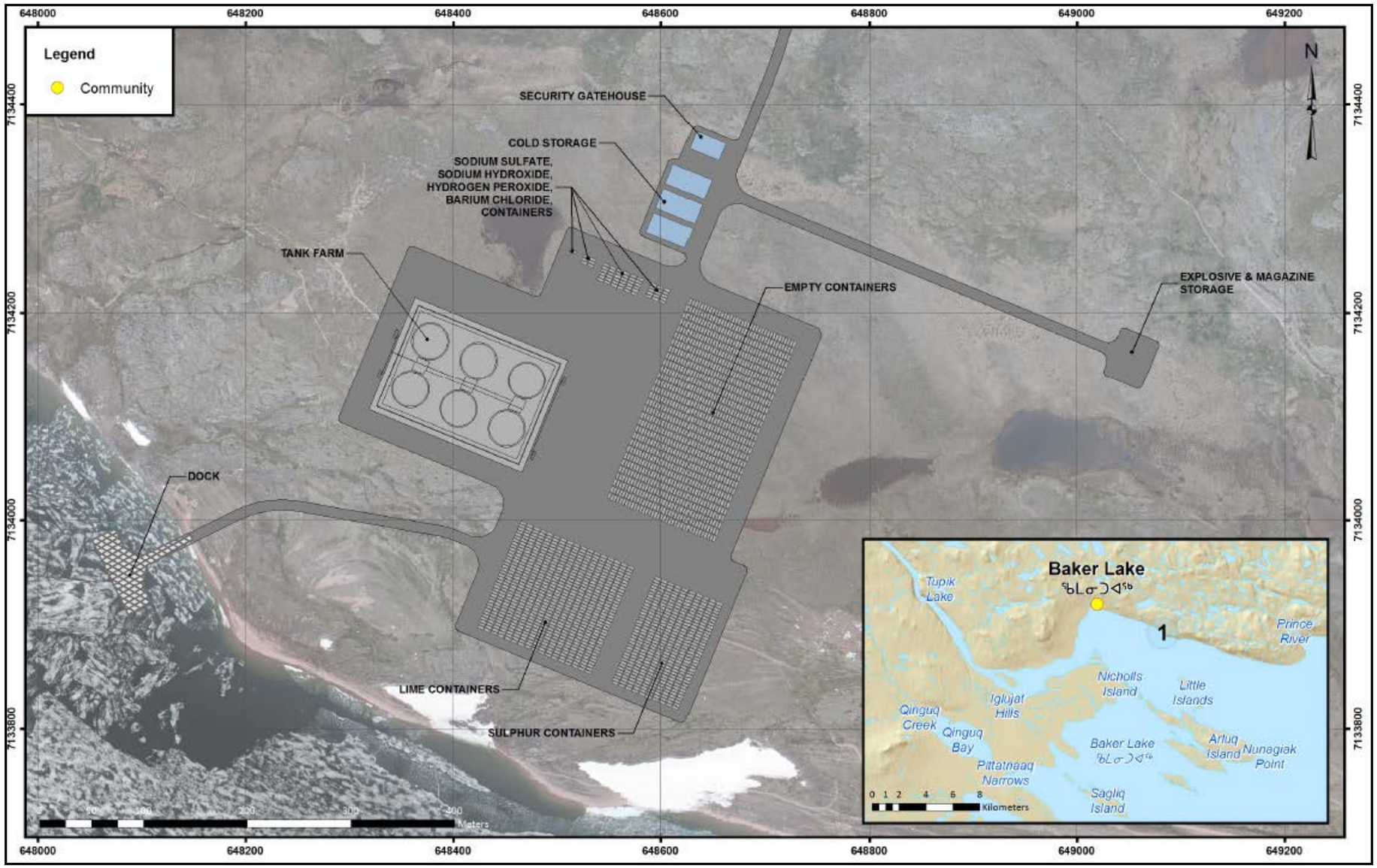

Figure 2.4-2 Baker Lake Dock and Storage Facility Layout

2.5 Transport of Explosives

Transportation of explosives from the Baker Lake port storage facility to the Kiggavik site and from the Kiggavik magazine to mining areas will be conducted in such a manner as to safeguard human health and prevent impacts on the environment. The transfer will be arranged so that:

- delays between the points of transfer are minimized,
- explosives are not left at any location other than designated locations , and
- explosives are not left unattended during transportation.

Transportation of explosives at the mine site will be undertaken according to the requirements of applicable regulations including the *Explosives Act* and Nunavut Regulations. The explosives contractor and personnel are responsible for ensuring compliance to these regulations.

Nunavut Mine Health Safety Regulations state that mobile equipment used for transporting explosives onsite will:

- be kept in sound mechanical working condition
- be provided with orange diamond-shaped placards and with clearly visible signs marked "EXPLOSIVES" in letters not less than 150 mm in height when carrying explosives
- not be used to transport other goods or materials at the same time as explosives are transported
- be equipped with a type 20-ABC fire extinguisher
- not be loaded with explosives in excess of 80% of its rated carrying capacity
- have explosives secured or fastened so as to prevent any part of the load from becoming dislodged
- only be operated by an authorized person who is in attendance at all times
- carry only those persons necessary for handling explosives
- not be refuelled if explosives or detonators are on board except where the mobile equipment is designed and used solely for transportation of bulk blasting agents
- have its engine shut off and its parking brake engaged while loading or unloading explosives, except where the vehicle uses an engine-powered device for loading and unloading

2.6 Blasthole Design

Production and blasthole designs for the proposed open pits at the Kiggavik Project have been designed based on standard design methods and are detailed in Tier 3, Technical Appendix 2B Drilling and Blasting Design.

3 Ammonium Nitrate Management

3.1 Nitrate Loss Mechanisms

Mines are subject to regulations limiting ammonia, nitrate, and nitrite levels in mine effluents released into the environment. The primary source of these nitrogen compounds is typically explosive used in blasting operations, as AN remains a significant component of most explosives used in the mining industry. The amount of AN entering a local water drainage system is related to site conditions, explosives used, explosive handling, and blast efficiency.

The key mechanism by which AN is lost to the water drainage system are as follows:

- Spillage during blasthole loading or transportation to the blast site;
- Dissolution by standing or flowing water through the blasthole;
- Erosion of explosive from high flowing water through the basthole; and,
- Leaching of undetonated explosive from the blasted puck, including both ore and mine rock.

Although the majority of explosives used will be from the surface open pits, the End Grid underground mine is also a potential source of AN loss.

3.1.1 Nitrogen Loss

The total annual nitrogen loss, as well as that for the three primary nitrogen compounds, has been estimated for the life of mine. The total annual estimated nitrogen loss ranges from 2,244 kg (Year 1) to 74,904 kg (Year 4). These estimates of annual nitrogen loss are from the total explosive use at the Kiggavik, Andrew Lake and End Grid operations. They are conservative estimates and employ factors for nitrogen loss which are based on field studies at mining operations, Pommen (1983) and Ferguson and Leask (1988). The factors used in the estimates do not consider the rate of ground water flow which may be low since the pits will be located within permafrost.

The 70/30 emulsion/ANFO blend, proposed for open pit blasting, is considered to have excellent water resistance. Where the geology is wet, the explosives may stand in loaded boreholes for approximately 2 weeks. No comparison of the predicted loss rates for bulk versus package explosives was done for this Project. It is industry practice to use bulk explosives for open pit operations and underground development blasting.

Best practices to minimize nitrogen loss suggest the following:

- Switching to an 80/20 blend provides better water resistance than the proposed 70/30 blend. This is particularly important in very wet areas, areas of high water flow and blast where explosives may stand in loaded boreholes for extended periods.
- Minimize the length of time which explosives may stand in loaded boreholes before detonation.
- Optimize and minimize the use of ANFO to reduce the emissions of NO_x

3.2 Mitigation Strategy

In order to minimize potential impacts, an explosives management system will be implemented as part of the mine production start-up. In addition to what is included in this management plan, the explosives management strategy will include the following:

- An education program for all production employees that outlines the potential problem and appropriate mitigation techniques;
- A spill handling procedure;
- A monitoring program that is integrated with baseline water quality information; and,
- A review of blasting operations early in production to determine efficiency levels.

3.3 AN Storage Area

AN dissociates readily in water to ammonia which, in its unionized form, is toxic to fish and other aquatic organisms. Storage on land away from water largely eliminates the risk of ammonia loss to water bodies. All AN for the Project will be stored in an enclosed warehouse in one tonne tote bags at the Kiggavik explosives storage area and within enclosed shipping containers at the Baker Lake temporary storage area. The AN prills will be delivered to the manufacturing facility by truck as they are needed.

In addition to training for the proper handling of explosives and the enforcement of good housekeeping practices, regular, periodic inspections of the facilities will be conducted to ensure that protocols are followed. Periodic maintenance will be carried out which is necessary to ensure that bins, tanks, storage trailers and loading equipment, including at the Baker Lake storage facility, remain in a condition necessary to prevent releases.

There is the potential for spills to occur at the ANFO mixing facility. Detailed work instructions will be provided in the revised Plan that will be developed by the explosives contractor at the licensing stage. In general, the following procedures will be implemented to prevent incidents involving spills:

- Used ANFO bags should be emptied completely and stored outside the facility at a safe distance from explosives to reduce the fire hazard risk.
- Any spill of ANFO will be immediately reported and promptly responded to, regardless of location. Investigation of the spill site by the Emergency Response Team (ERT) in coordination with the explosives contractor and the Kiggavik Environment Group will determine the most appropriate method of clean-up, disposal, and reclamation strategy to minimize effects on the environment.
- Transportation of explosives from the Baker Lake port storage facility to the Kiggavik site, and from the Kiggavik magazine to mining areas, will be conducted in such a manner as to safeguard human health and prevent impacts on the environment. The transfer will be arranged so that:
- delays between the points of transfer are minimized;
- explosives are not left at any location other than designated locations; and,
- explosives are not left unattended during transportation.

Any water runoff from the AN storage facility, mining activities (surface pits and underground operations), the main waste rock storage area, the ore processing plant, and mining support infrastructure will be collected and conveyed to the containment facility via a series of retention ponds, sumps, pipelines and pumps.

3.4 Emulsion Materials

Emulsion materials are acutely toxic to aquatic life. Release of these compounds directly to receiving water bodies would likely have negative effects on aquatic life. All emulsion materials will be stored at the emulsion plant where spills would be contained within the building.

3.5 Explosives Truck Wash

Water from the truck wash will have elevated ammonia concentrations from residual ammonium nitrate during transportation and handling. The explosives truck wash will be located at the emulsion plant. Water from the truck wash will be collected in a sump, pumped out as required and trucked to the water treatment facility.

3.6 AN Use

Explosive management systems and procedures will be implemented to minimize the impact of ammonia and nitrate levels in mine effluents. ANFO has no water resistance and will dissolve readily in water so spillage and blowback during loading operations will be controlled. Also, any wet holes will not be loaded with ANFO but a packaged emulsion product will be used in these instances.

4 Blasting Operations

4.1 Blasting

Blasting will be carried out by a certified blasting contractor following blasting regulations and safety protocols and under the supervision of mine supervisors. A revised detailed Explosives Management Plan will be developed by the blasting contractor and reviewed by the mine manager.

Blasting practices at the Kiggavik site will change as the mine ramps up and test blasting will be required to optimize loads, burdens, powder factors and delay sequencing of the holes. In addition, due to inherent variability in site conditions, vibrations incurred by blasting will be monitored during blasting operations.

Blasting operations at the Kiggavik Project will involve a qualified and licensed explosives contractor responsible for all blasting operations. The explosives contractor will be responsible for the inspection of all explosives facilities and the safe operation of all explosives equipment. Weekly reports to the mine manager detailing total explosives consumption, inventory of ammonium nitrate onsite, other explosives, and safety concerns or incidents will be required.

Since the proposed open pits and underground deposits are some distance away from the explosives magazine, it will be necessary to transport prepared ANFO and blasting materials to the mine locations. Transport of ANFO and detonators will only be done by trained personnel on controlled roads under rigorous supervision. All explosives transport must comply with the *Canadian Explosives Act & Regulations* (1985).

The drilling of blast holes will be completed by mine personnel under the supervision of the mine supervisor and blasting contractor. Appropriate precautions will be taken to secure the area prior to blasting to ensure the safety of personnel. As well, precautions will be taken to minimize damage from flyrock and a blast clearance zone of 500 m from the pit crest has been set for all open pits at the Kiggavik Project. It is anticipated that no more than one blast would occur per day.

During open pit mining, blasting patterns will be used to control the dispersion of materials as well as dust. Where possible, blasting may be avoided on days where dust dispersion outside of the Project footprint is anticipated to be excessive due to prevailing wind speeds.

4.1.1 Blasting in or Near Water

A blasting plan for blasting near water will be developed by the blasting contractor and included in the site-specific blasting management plans to address this issue prior to Project licensing. In circumstances where DFO guidelines cannot be met, AREVA will work proactively with DFO representatives to implement mitigation measures to avoid, minimize, or offset harm to fish.

Blasting near Andrew Lake will be planned during the frozen water period when Andrew Lake and the inflow and outflow streams do not support fish populations or during times of year when egg incubation is not occurring. Smaller explosives shall be used near fish habitats that do not produce, or is likely to produce, an instantaneous pressure charge (i.e. overpressure) greater than 50kPa in the swimbladder of a fish. This is less than the 100 kPa IPC threshold, however, DFO has requested a threshold of 50 kPA be used, see DFO letter Technical Appendix 2B Drilling and Blasting Design, Appendix C. The charge sizes to be used near Andrew Lake during the open water season are to reduce the blasting setback distance to less than 50 meters (the width of the dyke). In addition to these measures, an annual installation of fish exclusion barrier net in Andrew Lake to prevent fish from entering the area of Andrew Lake adjacent to Andrew Pit.

Proper blast design is essential in ensuring these limits are not exceeded. Proposed blast designs outlined in Technical Appendix 2B indicate that Project blasting is unlikely to induce overpressure levels that are harmful to fish in adjacent water bodies. Blast monitoring will be conducted to ensure ground vibrations generated are maintained at less than 13 mm/s and an overpressure at less than 50 kPa. Vibration monitoring equipment will be installed at mining areas to monitor ground vibrations resulting from blast events. Monitoring results will be interpreted following each blast event and if ground vibration limits have been exceeded, the cause will be investigated and mitigation measures implemented where necessary. Mitigation measures may include alternative blast designs or the use of a bubble curtain.

4.2 Blasting Safety

General blasting safety procedures on breaking rock and frozen material are described below:

- Established blast clearance zones of 500 m will be communicated.
- No unauthorized person is allowed inside a posted blast area whether the holes have been loaded or not.
- The blast supervisor and the blaster are responsible for the safe handling, loading and connection of a blast.
- The blast supervisor is responsible for the evacuation of all personnel and equipment from the blast area and the guarding of the blast.

- The mine manager is responsible for notifying the appropriate personnel, and other departments and personnel that are outside of the 500 m clearance zone but who may be affected by a particular blast.
- Guards will be posted prior to blast time, and must remain guarding until they are told verbally by the blast supervisor that they can leave their position.
- Once guards are posted, the blast area must be inspected by the blast supervisor to ensure that no personnel or equipment remain inside the blast area.
- A blast-warning siren will be sounded for 1 minute. Three minutes after this the blast will be fired.
- The blaster will only fire the blast when given a direct verbal order to do so by the blast supervisor.
- Before firing a shot the blaster must ensure the immediate area is clear - i.e. aircraft etc.
- The blast supervisor and blaster will inspect the fired shot for indications of any problems such as misfires or cut-offs.
- Areas in which charged holes are awaiting firing shall be guarded or posted against unauthorized entry.
- Vehicles containing explosives shall not be taken to the repair shop or any other building for any purpose. No open flames or welding are to be used for field repairs unless explosives are first removed.
- Downhole initiation lines must be attached to a stake planted in the cuttings on all holes.
- All loaded patterns in addition to being marked with blasting signs shall be clearly delineated to outline the pattern.
- Redrills shall be marked with a plastic cone and be designated by a member of the blasting crew. The plastic drill cone shall be firmly implanted in the cuttings of the hole to be redrilled. The cone should be removed by the driller before drilling and inverted in the hole after drilling for pickup by the blasting crew.
- Where redrills are required on loaded patterns the drill must be guided by the blasting supervisor or blaster or a responsible person designated by them.
- Service vehicles and fuel trucks are not allowed on a loaded pattern. The drill must pull well clear of the loaded holes before work shall be done on it. Where the drill cannot be moved and service is required, it may be done only under the direct supervision of the blast supervisor or designate and all loaded holes must be covered.
- Only authorized personnel will be permitted to enter the explosives storage areas.

4.3 Spill Prevention

There are potential for spills to occur at the ANFO mixing facility. Other incidents such as fire or explosion are also a risk. Detailed work instructions will be provided in the revised Explosives Management Plan that will be developed by the explosives contractor. In general, the following procedures will be implemented to prevent incidents involving spills, fire, or explosion:

- Ensure that fire extinguishers are provided both inside and outside the facility so that if extinguishers inside could not be used in an incident, outside ones are available. Fire extinguishers must be compatible with flammable materials (water-based where ammonium nitrate is involved).
- Used ANFO bags should be emptied completely and stored outside the facility at a safe distance from explosives to reduce the fire hazard risk.
- Any spills will be cleaned up and removed immediately to appropriate disposal facility. The spill will be reported and investigation of cause may be required.
- A “NO SMOKING” sign will be posted on visible walls of the facility.
- Ensure that lighters, matches, mobile phones, or radio transmitters or any item that might conduct electricity is not used at the explosives storage area.
- Follow all transportation, storage, use, and handling procedures outlined in this Plan.
- Report incidents of “near-miss” and actual accidents to appropriate personnel. Incidents will be investigated to help identify trends and reduce future reoccurrence.

For underground loading operations, the spillage of ANFO can occur as a result of blowback during the pneumatic loading of blastholes and moving the hose from hole-to-hole. The operator will measure and ensure that the loading of ANFO is terminated at the designed depth. The loader shall remain shut-off during the transition to another hole and the end of the hose shall be elevated so that the product remains in the hose. The loading hose should be marked for the proper collar length so the loading operator knows when to shut off the ANFO supply. Any spillage shall be cleaned up immediately as per spill cleanup procedures that will be developed as part of this revised Plan at licensing.

Training will be provided to the designated individuals and detailed work instructions will be written up. Attention to proper loading practices and good housekeeping limits the impact of spillage during loading at the blast site. Supervision and education of the explosive handling personnel will be implemented in order to reduce the potential for spillage and limit the impact if spillage occurs. The bulk explosive will be loaded according to the manufacturer’s specifications.

Any spill of ANFO will be immediately reported and promptly responded to, regardless of location. Investigation of the spill site by the Emergency Response Team (ERT) in coordination with the explosives contractor and the Kiggavik Environment Group will determine the most appropriate method of cleanup, disposal, and reclamation strategy to minimize effects on the environment.

4.4 Disposal of Explosives

Explosives and explosive materials can be disposed of by burning, detonation, dissolution in water or solvent, or by chemical destruction. The selected disposal method will depend on the type of explosive, quantity, condition, and specifications from the manufacturer. All destruction of explosives will be carried out by licensed blasting personnel.

Destruction of large quantities of explosives will be carried out at a designated location at least 500 m from any building that could be damaged by the detonation. Personnel and other property damage will be avoided by sheltering the detonation area. Small quantities of explosives may be added to production charges in blast-holes for destruction.

Blasting personnel will adhere to the following procedures:

- Only a licensed person, or a person under the supervision of a licensed person, is allowed to dispose of or destroy explosives.
- Use a method of disposal that provides the greatest degree of safety to humans and protection of property and the environment. Take adequate precautions to protect against injury or damage to property.
- Ensure that the method of disposal is appropriate to the type and condition of explosives.
- Follow recommended disposal method indicated by manufacturer or responsible authorities.
- Unused explosives and explosive waste must be removed and disposed of under the supervision of or by the blasting contractor.

5 Monitoring and Reporting Requirements

Blast monitoring will be conducted to ensure ground vibrations generated are maintained at less than 13 mm/s and an overpressure at less than 50 kPa. Vibration monitoring equipment will be installed at mining areas to monitor ground vibrations resulting from blast events. Monitoring results will be interpreted following a blast event and mitigation measures implemented where necessary.

Explosives regulations and guidelines provide extensive detail regarding all aspects of the management and use of explosives. AREVA and its contractors will adhere to the applicable regulations and guidelines and will develop and maintain detailed management plans, operating procedures, and associated work instructions to include potential scenarios that could occur during the life of the Project. All monitoring and reporting will be completed as per requirements of the Explosives Act and other Nunavut regulatory requirements.

6 References

AREVA Resources Canada (2014). Kiggavik Project Environmental Impact Statement. Tier 3 Technical Appendix 2B – Drilling and Blasting Design and Related Regulatory Considerations. September 2014

AREVA Resources Canada (2014). Kiggavik Project Environmental Impact Statement. Tier 3 Technical Appendix 2U – Hazardous Materials Management Plan. September 2014

AREVA Resources Canada (2014). Kiggavik Environmental Impact Statement – Tier 3 Technical Appendix 10B - Spill Contingency and Landfarm Management Plant, September 2014

BL NIRB (Baker Lake - Nunavut Impact Review Board). April 2010. From "Public Scoping Meetings Summary Report, April 25-May 10, 2010, for the NIRB's Review of AREVA Resources Canada Inc's Kiggavik Project (NIRB File No. 09MN003)"; in Technical Appendix 3A: Public Engagement Documentation, Part 11.

Canadian Explosives Act & Regulations - Explosives Act (R.S., 1985, c. E-17)

Canadian Transportation of Dangerous Goods Act & Regulations - Transportation of Dangerous Goods Act, 1992 (1992, c. 34)

Furguson, K.D., and Leask, S.M., 1988. "The Export of Nutrients from Surface Coal Mines", Regional Program

Report 87-12, Environment Canada.

Government of Nunavut. 1990. *Explosive Use Act. Explosive Use Regulations. Iqaluit, NU.*

Government of Nunavut. 1994. *Mine Health and Safety Act. Mine Health and Safety Regulations*. Iqaluit, NU.

NRCan, 2008. *Blasting Explosives and Initiation Systems – Storage, Possession, Transportation, Destruction, and Sale.* March 2008.

NRCan, 2008. *Guideline for Bulk Explosives Facilities – Minimum Requirements*. Rev. 5. September 2008.

Pommen, L.W., 1983. “The Effect on Water Quality of Explosives Use in Surface Mining”, British Columbia MOE

Technical Report 4, Volume 1.

Transportation of Dangerous Goods Act, 1992 (1992, c. 34) as amended

Wright, D.G. and Hopky, G.E., 1998. *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters.* Canadian Technical Report of Fisheries and Aquatic Sciences 2107: iv+34 pp, Fisheries and Oceans Canada

Attachment A Sample Form of Inventory Control Sheet

EXPLOSIVES INVENTORY

MAGAZINE TAG NO.:

PRODUCT DESCRIPTION*:

DATE	Shipped To/ Received From	STOCK			SIGNATURE
		IN	OUT	BALANCE	

*** Product description, such as brand name, strength, size of cartridge, detonator type, length and period, etc.**