Kiggavik Project

Environmental Impact Statement

Tier 3 Technical Appendix 2I

Water Management Plan

December 2011

TABLE OF CONTENTS

SECTION **PAGE**

1 INTRODUCTION 1-1

1.1 OVERVIEW 1-1
1.2 PURPOSE AND SCOPE 1-1
1.3 RELATED DOCUMENTS 1-1

2 WATER MANAGEMENT CONCEPT 2-1

3 GENERAL MANAGEMENT PRACTICES 3-1

3.1 FRESHWATER WITHDRAWAL 3-1
3.1 SEWAGE MANAGEMENT 3-1
3.2 DRAINAGE FROM HAZARDOUS MATERIAL STORAGE AND HANDLING AREAS 3-2

4 KIGGAVIK SITE WATER MANAGEMENT 4-1

4.1 FACILITIES AND INFRASTRUCTURE 4-1
4.2 KIGGAVIK SITE WATER BALANCE 4-1
4.2.1 Overview 4-1
4.2.2 Site Drainage 4-2
4.2.3 Type 2 Mine Rock Drainage 4-3
4.2.4 Mine Water 4-3
4.2.5 Water Storage Pit 4-5
4.3 WATER TREATMENT AND DISCHARGE 4-5
4.4 CONTINGENCY MEASURES 4-5

5 SISSONS SITE WATER MANAGEMENT 5-1

5.1 FACILITIES AND INFRASTRUCTURE 5-1
5.2 SISSONS SITE WATER BALANCE 5-1
5.2.1 Mine Water 5-2
5.2.2 Site Drainage 5-3
5.2.3 Industrial Water 5-4
5.3 WATER TREATMENT AND DISCHARGE 5-4
5.4 CONTINGENCY MEASURES 5-6

6 SITE ACCESS WATER MANAGEMENT 6-1

6.1 BAKER LAKE DOCK FACILITY AND STORAGE AREA 6-1
6.2 QUARRY SITES 6-1
6.3 BAKER LAKE – KIGGAVIK ACCESS ROADS 6-2
6.3.1 Winter Access Road 6-2
6.3.2 All-Season Access Road 6-2

7 CLIMATE CHANGE CONSIDERATIONS 7-1

8 REFERENCES 8-1

1 INTRODUCTION

1.1 OVERVIEW

The AREVA Resources Canada Inc. (AREVA) Water Management Plan (Plan) will be in effect for the duration of the Kiggavik Project. The Plan is intended to apply to the Kiggavik Project located approximately 80 km west of Baker Lake and all points located between the site and Baker Lake.

The enclosed document forms part of the Kiggavik Project Environmental Impact Statement (EIS) submission. The submission has been prepared for the Nunavut Impact Review Board by AREVA Resources Canada Inc to fulfill the requirements of the “Guidelines for the Preparation of an Environmental Impact Statement for AREVA Resources Canada Inc’s Kiggavik Project (NIRB File No. 09MN003)”.

1.2 PURPOSE AND SCOPE

The purpose of the Plan is to provide consolidated information on water management strategies for intercepting, collecting, containing, and monitoring potentially contaminated water from the Project sites. The Plan has been written to address Section 9.4.3 of the Nunavut Impact Review Board’s “*Guidelines for the Preparation of an Environmental Impact Statement For AREVA Resources Canada Inc’s Kiggavik Project”, May 2011.*.

1.3 RELATED DOCUMENTS

This document presents the management and treatment of water under normal operating conditions. Although contingency measures to prevent the unanticipated release of waters from the Project are presented herein, mitigation measures to address spills and other water management malfunctions are addressed in Volume 10 and related technical appendices.

2 WATER MANAGEMENT CONCEPT

The overall objectives of the water management strategy are to minimize the intake of fresh water from lakes, to minimize the release of treated effluents to surface water receptors, and to ensure containment of potentially contaminated waters. Project design, water recycling, and management practices will be the key factors used to achieve this objective. Conservative assumptions have been used at this stage of design; continuous improvement will be used during operation to further reduce water consumption and discharge.

For the purpose of the water management, contact water is defined as any water that may have been physically or chemically affected by site activities. Contact water includes:

- surface runoff from the mill terrace and mining areas,
- surface runoff from lined ore stockpiles,
- surface runoff from lined special waste stockpiles,
- surface runoff and shallow drainage from unlined clean rock piles,
- water expulsed during tailings consolidation; and
- water inflows into mines

All contact water will be intercepted, contained, analyzed and treated when required. All water released to the environment will meet the discharge quality criteria, which have been selected to ensure no significant environmental effects associated with the release of water.

Non-contact water includes runoff originating from areas unaffected by site activities and will not come into contact with mining and milling areas. Non-contact water will be diverted from the site activities to the surrounding surface water system.

The water management strategy is based on the following concepts:

- Minimize contact water by diverting local drainage prior to contact with the site and use snow fences to minimize on-site drifts
- Contain all contact drainage and provide contingency storage

- Contain all mine water

- Maximize recycling of on-site contact water

At Kiggavik the milling process is the primary consumer of fresh water and determines the type of effluent treatment required. The other key components of the water balance are surface runoff and water expulsed as a result of tailings consolidation in the Tailings Management Facilities (TMFs).

3 GENERAL MANAGEMENT PRACTICES

3.1 FRESHWATER WITHDRAWAL

Freshwater will be required at both the Kiggavik and Sissons sites. Siamese Lake will be used for Kiggavik site fresh water while Mushroom Lake will be used for Sissons site freshwater. Water will be drawn from a depth of at least 3 m below surface and pumped to the site through a heat-traced line.

Recycling strategies will be used to minimize the volume of fresh water required at both sites. Site drainage and mine water will be used for industrial purposes wherever possible. The inclusion of substantial water storage capacity at both sites will facilitate recycling efforts.

3.1 SEWAGE MANAGEMENT

Sewage at the Kiggavik and Sissons sites will be treated in vendor packaged plants. The sewage treatment plants will be housed in either modular units or standard 20ft or 40ft containers. It is estimated that at peak manpower levels the volume of sewage requiring treatment at the Kiggavik site will be 150 m^3/d, while at the Sissons site the volume of sewage requiring treatment will be 60 m^3/d. A biological treatment plant is envisioned. The exact type of biological treatment plant will be selected at the detailed design stage. The biological processes commonly employed in sewage treatment include oxidation of carbonaceous BOD and conversion of ammonia to nitrates. Membranes or other separation technologies may be applied to separate the sewage solids from the treated sewage liquids. The sewage treatment plant will be designed to meet the criteria outlined in Table 3.1-1.

Table 3.1-1 Sewage Discharge Criteria

Parameter	Quality
BOD_5	≤ 15 mg/L
TSS	≤ 15 mg/L
NH3-N	≤ 15 mg/L
Phosphorus	≤ 1 mg/L
Faecal Coliform	≤ 100counts / 100mL

Sewage effluents will meet the Nunavut Public Health Regulations and any requirements stipulated by the Nunavut Water Board and the CCME Municipal Effluent Guidelines. Treated sewage effluent will be combined with the water treatment plant discharge (after monitoring) and discharged to Judge Sissons Lake. Sewage solids from Sissons will be transported periodically to the Kiggavik site and placed in a sludge pond on the side of a TMF along with the sewage solids from the Kiggavik site.

Sewage effluent that does not meet the discharge criteria will be recycled to the front-end of the sewage treatment plant.

The minimal amounts of sewage expected at the Baker Lake dock site will either be collected in a portable unit (port-a-potty) or a sewage tank. The sewage will be trucked to the Baker Lake community sewage lagoon.

3.2 DRAINAGE FROM HAZARDOUS MATERIAL STORAGE AND HANDLING AREAS

Drainage for fuel storage areas, fuel transfer stations, and hazardous materials storage areas will be contained within bermed areas. This drainage would be sampled prior to release through a passive organic removal filter. Any contaminated water would be recovered using a vacuum truck and delivered to the water treatment plant.

4 KIGGAVIK SITE WATER MANAGEMENT

4.1 FACILITIES AND INFRASTRUCTURE

The Kiggavik site will include the water management facilities and infrastructure listed in Table 4.1-1 and summarized in Figure 4.1-1.

Table 4.1-1 Summary of Kiggavik Site Infrastructure

Facility	Containment		Key Features
	Yes	No	
Fresh Water Pipe and Service Road		✓	• To Siamese Lake
Water Treatment Plant	✓		• 5,560 m3/day capacity
Monitoring Ponds	✓		
Treated Effluents Discharge Pipe and Service Road	✓		• Discharge to Judge Sissons Lake
Purpose Built Pit	✓		• Storage of site drainage
Site Drainage Ponds	✓		• Collection of ore pad, mine rock and general site drainage
Water Diversion Structures		✓	• Fresh water diversion
Snow Fences		✓	

4.2 KIGGAVIK SITE WATER BALANCE

4.2.1 Overview

Key site water inputs include:

- Fresh water for the mill process, general industrial use, and potable use
- Contaminated site drainage
    - Plant and mine site drainage
    - Ore pad drainage
    - Type III mine rock (special waste) drainage

- Type I & II mine rock stockpile drainage
- Pit inflows due to direct precipitation into Main Zone, Centre Zone, East Zone and the Purpose-built Pit
- Minor groundwater inflows to Main Zone during mine development

All of the water inputs shown above, with the exception of fresh water intake, are considered contact water

The water balance is summarized for an average operating year in Table 4.2-1 below.

Table 4.2-1 Summary of Kiggavik Site Water Inputs during Operation

Component	m3/year
Contaminated Site Runoff	296,594
Pit Water (Direct and Groundwater)	221,309
Type 2 Stockpile Runoff	456,805
Mill Water Requirements[2]	2,689,400
Net Input with No Recycle to Mill	3,664,108
Net Input with Drainage Recycle to Mill	1,714,692
Net Freshwater Input with Drainage & Permeate Recycle to Mill[3]	1,102,692

4.2.2 Site Drainage

Key components of Kiggavik site drainage management include:

- Containment of all drainage that has contacted the site
- Treatment of drainage as required
- Storage and recycling of drainage to mill processes where practicable
- Contingency storage through site design

Site drainage will include runoff that contacts the mill terrace, ore pad, and Type 3 mine rock pad. This water will be contained using lined pads and ditches and collected in lined sedimentation ponds. Where practicable, this water will be pumped to the water storage pit for storage and use in the mill. Any non-recyclable water will be pumped to the WTP for treatment prior to discharge.

Consistent with SERM (2000), the ore pad will be double-lined with HDPE or LLDPE. The special waste pad will be single-lined. All sedimentation ponds will be double-lined and sized to safely contain drainage during 24-hour PMP event. A leakage detection system will be included to monitor the ore pad and pond system. Final design and construction of the pads and ponds must take into account the potential for thaw induced differential settlement. Design of the pads and ponds is further detailed in Technical Appendix 2D.

4.2.3 Type 2 Mine Rock Drainage

Part of the runoff management strategy within the site boundary consists of the construction of drainage channels around the mine rock piles to collect runoff water for passive treatment in unlined sediment ponds to reduce potential suspended sediment loads prior to releasing flow to the natural receiving drainages. Runoff conveyance channels have been designed to manage the PMP, and lesser precipitation events, using the same methods as the freshwater diversion channels. In most cases the pile exterior will form one side of the channel while a berm will constrain the flow within the desired alignments. Where topography dictates, channels may need to be excavated over some sections. These channels will drain according to topographic controls and discharge to unlined sedimentation ponds. Outflow from the sedimentation ponds will be to natural channel flow pathways or existing channels, with the exception of the north pile at the Kiggavik site, which will drain to the east freshwater diversion channel. Where channels encounter roadways, culverts will be used to facilitate cross-drainage.

4.2.4 Mine Water

In general the mines proposed for the Kiggavik site will be excavated in competent low permeability bedrock and therefore significant issues relating to dewatering and groundwater quality and quantity management are not expected. Furthermore the mines will be excavated entirely (East Zone and Centre Zone) or partially (Main Zone) in permafrost, where the frozen ground conditions are expected to further reduce the permeability of the rock mass. For the open pits snowmelt in early summer months is expected to be the dominant source of water inflow.

At the Kiggavik site, mine water will consist of direct precipitation and some groundwater entering the East Zone, Centre Zone and Main Zone open pits. During mining and TMF preparation, this water will be collected in pit sumps and pumped either to the WTP for treatment or to the water storage pit for recycling to the mill. Once the pit has been transformed to a tailings management facility, this water will contribute to the total volume of tailings reclaim water, which is pumped to the WTP.

The groundwater flow model developed for the Kiggavik Project area (Technical Appendix 5D) was used to simulate the dewatering of the Kiggavik mines (Technical Appendix 5E). Transient simulations presented in the technical appendix 5E suggest that the groundwater inflow to the proposed open pits will be low due to the low hydraulic conductivity of the rock mass in which the pits will be excavated. In addition mining of the Main Zone pit is expected to take place over several years. During most of this time, the pits will be excavated in permafrost and groundwater inflows are expected to be negligible. In the final years of mining the pits are expected to extend below the bottom of permafrost; the results of the model simulations predict that groundwater inflow to Main Zone pit will be lower than 200 m^3/year for the ultimate pit depth.

Water balance estimates for the open pits suggest that the snowmelt in early summer months will be the dominant source of water inflow to the pits. A peak rate of 745 m^3/day is predicted for Main Zone. Inflow rates are much smaller for Centre Zone and East Zones pits. There is no groundwater inflow component for these open pits and the total inflows are predicted to be less than 500 m^3/day.

For design purposes a total inflow of 2,400 m^3/day was considered for Main Zone pit. This design flow is expected to include a snowmelt component of 1600 m^3/day and a groundwater flow component of 800 m^3/day through depressurization wells. The expected design flow for Centre Zone and East Zone is 500 m^3/day.

Given the development schedule of the Kiggavik and Andrew Lake pits it is proposed to use two pumps (each with a backup) to handle the dewatering of the open pits. One pump will be sized to pump the expected flow from the bottom of the fully developed Main Zone ultimate pit and the other, smaller pump will be used to pump water from the bottom of the fully developed East Zone and Centre Zone pits. The larger pump used to pump water from the Main Zone pit will eventually be moved over to the Andrew Lake pit, once the depth in Andrew Lake pit warrants having a larger pump. The smaller pump will be used to pump water from East Zone pit, then in Centre Zone pit, and then in the shallower Andrew Lake starter pit, while the development of Andrew Lake and Main Zone pits overlap.

The pumps are sized based on the expected frictional head losses and static head in each dewatering pipeline. In each case, calculations are based on using Standard Steel pipe from the bottom of each pit, running straight up the side of the pit and emptying to atmosphere at the diversion ditch on the catch-berm near the top of the pit.

The proposed pumps are submersible vertical turbine style pumps which discharge straight up from the pump column and can be lowered into a sump for operation.

Designing for PMP

The Probable Maximum Precipitation (PMP) represents what is meteorologically possible for the area where the pits are located. The likelihood of a PMP event occurring is extremely low. The PMP estimate for Kiggavik project is 185 mm in 24 hours, approximately. This would translate to an inflow ranging from 27,000 m^3 in 24 hr for East Zone pit to 142,000 m^3in 24 hr for Andrew Lake pit, approximately. It is not practical to design for such an event. However, to ensure the pumping system would remain running in the unlikely event of a PMP rainfall the electrical works for the pumping system should be located high enough off the pit floor to stay dry. This way the pumping system could remove excess water accumulated over a longer period of time.

4.2.5 Water Storage Pit

Construction and operation of a water storage pit is proposed as a means of managing spring freshet. This pit will be located to reduce pumping distances to the mill, to take advantage of gradients and to provide contingency containment in case of failure of the primary site containment structures. During normal operation, recyclable water will be diverted to this pit for storage prior to use in the mill. Contingency uses include storage of TMF reclaim solution.

Water from the north Type 2 mine rock pile may be diverted directly to this pit using diversion channels. All other sources will be pumped to the pit as needed. The design storage volume of the pit is 350,000 m3. Preparation of the pit includes placement of a pump and access. The level of the water will be maintained 5m below the pit crest.

4.3 WATER TREATMENT AND DISCHARGE

Water to be treated at Kiggavik includes:

- Open pit mine water
- Site drainage
- Reclaim water from the tailings management facilities
- Tailings thickener overflow

4.4 CONTINGENCY MEASURES

Preliminary contingency measures for discharge during upset conditions have been developed. Table 4.4-1shows the upset condition and the contingency measures to be taken.

Table 4.4-1 Contingency Measures for Discharge

Upset Condition	Contingency Measures
Liner break in monitoring pond	- Operate with 3 of 4 monitoring ponds - Reduce feed flow rate if required
Operator unable to monitor pipeline due to poor weather conditions	Temporarily suspend discharge of effluent Suspend operation of water treatment plant If mill running, temporarily pump tailings thickener O/F to TMF
Major leak in pipeline	Temporarily suspend discharge of effluent Temporarily divert treated effluent to TMF
Monitoring pond does not meet discharge criteria	Recycle pond contents to front-end of water treatment plant or empty pond contents to TMF
Sewage does not meet discharge criteria	Recycle to front-end of sewage treatment plant
Water treatment plant not operating and sewage requires discharging	Batch discharge of sewage

Figure 4.4-2 Kiggavik Site Water Recycling Strategy

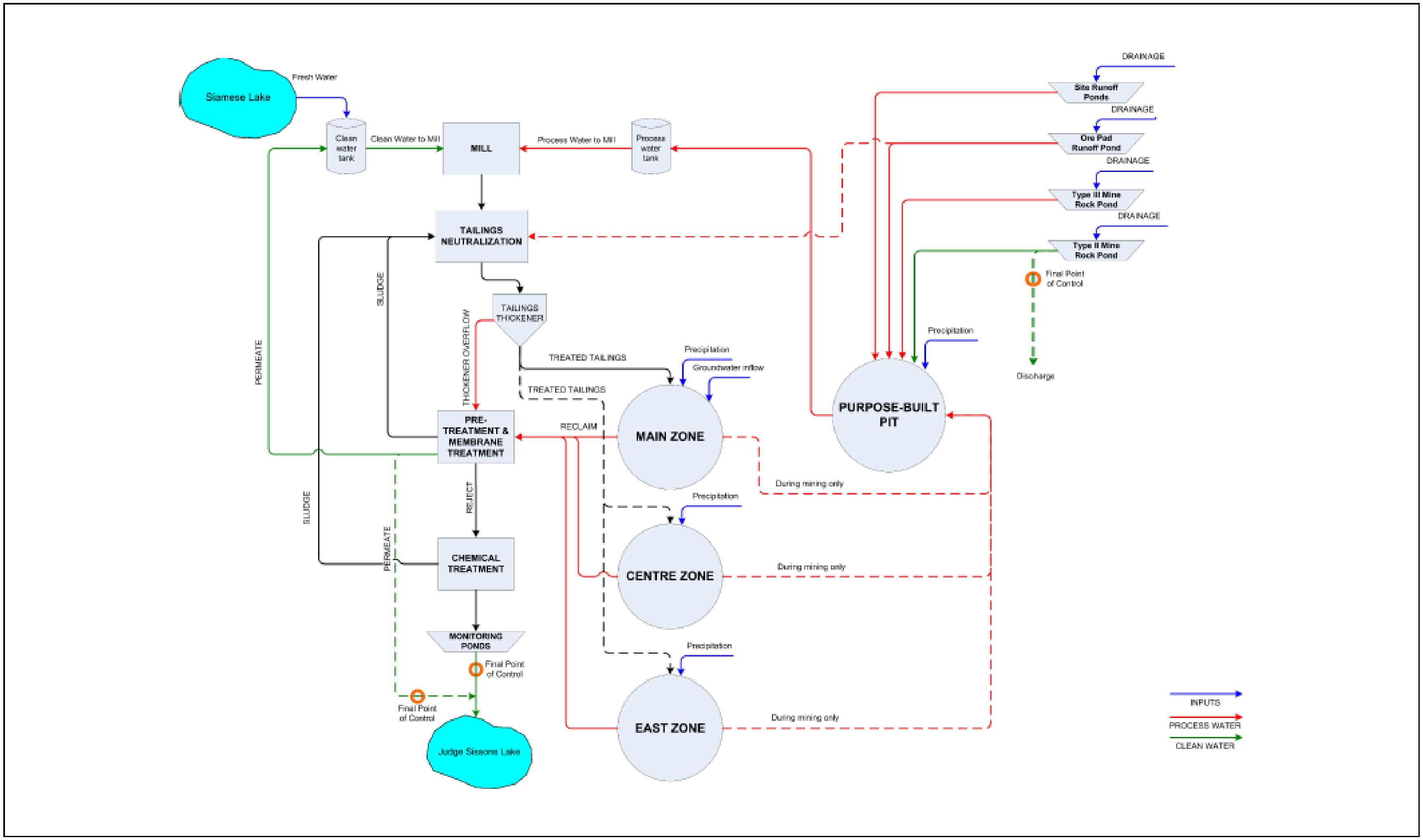
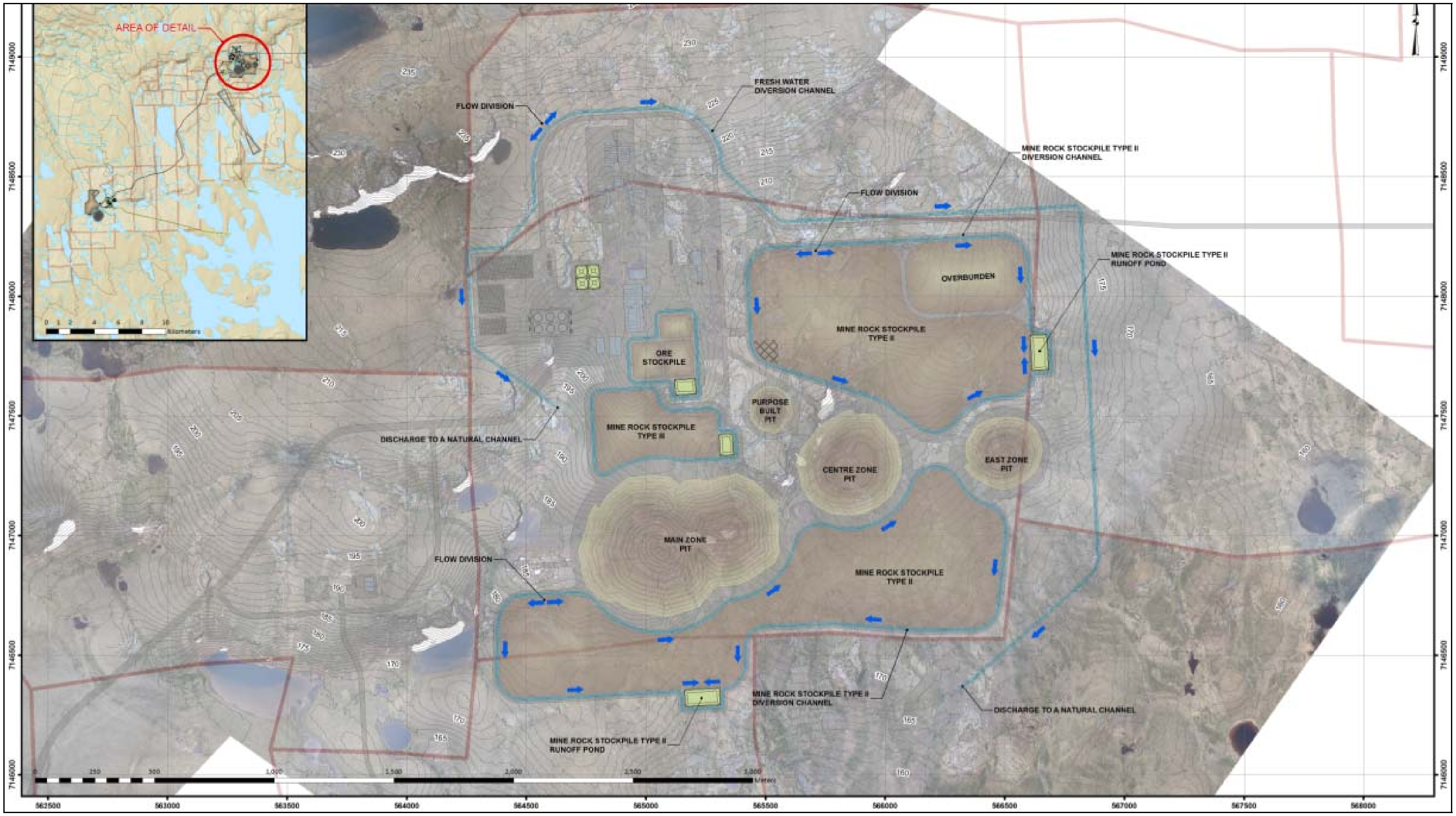


Figure 4.2-3 Kiggavik Water Diversion Channels



5 SISSONS SITE WATER MANAGEMENT

5.1 FACILITIES AND INFRASTRUCTURE

The Sissons site will include the water management facilities and infrastructure listed in Table 4.1-1 and summarized in Figure 5.1-1.

Table 5.1-1 Summary of Sissons Site Infrastructure

Facility	Containment		Key Features
	Yes	No	
Fresh Water Pipe		✓	• To Mushroom Lake
Water Treatment Plant	✓		• Chemical treatment • 1,475 m3/d nominal capacity
Monitoring Ponds	✓		
Water Diversion Structures		✓	• Fresh water diversion
Snow Fences		✓	
Treated Effluents Discharge Pipe	✓		• Discharge to Judge Sissons Lake
Sedimentation Ponds	✓		• Storage of mine water and site runoff for WTP flow equalization

5.2 SISSONS SITE WATER BALANCE

The water balance is summarized for an average operating year in Table 5.2-1 below.

Table 5.2-1 Sissons Site Water Balance (m3/day)

Andrew Lake Open pit	End Grid U/G mine	Ore pad, type 3 mine rock pad and site runoff	Site Total
245	760	530	1,535

To minimize the use of fresh water, mine process water will use recycled water as much as possible. For underground drilling, an inventory of water will be kept underground for use in drilling processes. Sand filters may be used to reduce the total suspended solids of the drilling water. The mine water inflow is insufficient to meet the technical water requirements. Site runoff water could be used for technical water. Sufficient inventory will need to be maintained in the site runoff sedimentation ponds to ensure adequate supply of technical water. In the event that sufficient site runoff is not available, treated effluent could be used to supplement the technical water needs.

At the Sissons site, fresh water is required primarily for potable use. Surface drainage and recycled water will be used for most other purposes. The other key components of the water balance are surface runoff and mine water.

5.2.1 Mine Water

At the Sissons site, mine water will consist of direct precipitation, groundwater entering the Andrew Lake open pit, and surface water inflows, groundwater inflows and technical water from the End Grid underground mine. During mining, this water will be collected in pit sumps and pumped to a sedimentation pond for temporary storage. The sedimentation pond will be sized to allow sufficient buffer capacity to store surface runoff collected during spring freshet. Water from the sedimentation pond will be pumped to the WTP for treatment.

The mines proposed for the Kiggavik Project will be excavated in competent low permeability bedrock and therefore significant issues relating to dewatering and groundwater quality and quantity management are not expected. Furthermore the mines will be excavated partially (Andrew Lake and End Grid) in permafrost, where the frozen ground conditions are expected to further reduce the permeability of the rock mass. For the open pits snowmelt in early summer months is expected to be the dominant source of water inflow.

Andrew Lake Open Pit

In the final years of mining the pit is expected to extend below the bottom of permafrost; the results of the model simulations predict that groundwater inflow to the Andrew Lake pit will be lower than 200 m^3/year for the ultimate pit depth.

Water balance estimates suggest that the snowmelt in early summer months will be the dominant source of water inflow to the pits. A peak rate of 1050 m^3/day in July is predicted for the Andrew Lake open pit. For design purposes a total inflow of 2,400 m^3/day was considered for Andrew Lake pit. This design flow is expected to include a snowmelt component of 1600 m^3/day and a groundwater flow component of 800 m^3/day through depressurization wells.

End Grid Underground Mine

For the underground mine End Grid mine water will include groundwater inflows to the mine, technical water (i.e., drilling, wall and mine equipment washing, dust suppression, backfill, combustion) and surface water entering the mine. The sum of these three components is not expected to exceed 1,000 m^3/day for the final mine configuration and during the peak production phases of the operation.

Although End Grid extends into the groundwater regime beneath the permafrost, groundwater inflows into the mine openings are expected to be small due to the low hydraulic conductivity of the rock mass. Model results (see Technical Appendix 5E) suggest that inflow to the End Grid underground mine may slightly increase as development progresses below the permafrost horizon. Predicted groundwater flow to the End Grid underground mine is approximately 160 m^3/day for the ultimate configuration of the mine. Most of this flow originates from the enhanced permeability zones assumed to be associated with the sub-vertical faults passing through the mine. If these faults are either not present or have a lower hydraulic conductivity than assumed then inflow to the mine would be lower than 100 m^3/day.

During the development of the decline in permafrost, pressure heads beneath the permafrost will not be reduced; therefore, if prior depressurization is not undertaken, pressure heads will initially be initially be 250 m or more when the mine first penetrates beneath the permafrost. If these pressures are determined to be high, based on stability concerns, or the inflow volumes are considered to be difficult to manage, then a depressurization program will need to be implemented. An effective depressurization system would likely consist of vertical or sub-vertical boreholes drilled from a development excavation. The boreholes could either be allowed to flow under artesian conditions, or pumps could be installed (if larger diameter holes are drilled) to provide additional lowering of water levels. The water would then be pumped to surface for treatment.

5.2.2 Site Drainage

Key components of Sissons site drainage management include:

- Containment of all drainage that has contacted the site
- Treatment of drainage as required
- Storage and recycling of drainage to underground mine processes where practicable
- Contingency storage through site design

Site drainage will include runoff that contacts the mine site infrastructure, ore pad, and special waste pad. This water will be contained using lined pads and ditches and collected in lined sedimentation pond. Where practicable, this water will be used for technical water in mining operations. Any water which is not recycled will be pumped to the WTP for treatment prior to discharge.

Consistent with SERM (2000), the ore pad will be double-lined with HDPE or LLDPE. The special waste pad will be single-lined. All sedimentation ponds will be double-lined and sized to safely contain drainage during 24-hour PMP event. A leakage detection system will be included to monitor the ore pad and pond system. Final design and construction of the pads and ponds must take into account the potential for thaw induced differential settlement. Design of the pads and ponds is further detailed in Technical Appendix 2D.

The Sissons site includes a fresh water diversion channel that intercepts flow from natural channels draining from the north. Drainage basins to the south and west drain away from the site. Figure 5.2-1 indicates the proposed freshwater diversion channel, and mine rock channel alignments and flow directions for the site.

The freshwater diversion channel has three main sections, one flowing eastward around the core facilities area and reporting to End Grid Lake, the second flowing initially south along the Mushroom Lake access road, and then west to discharge to the third section that flows southward through a series of small ponds. The east channel section carries outflow from Mushroom Lake to Grid Lake which is the natural receiving waterbody. The lower potion of the east channel will be deeply incised through bedrock at the same gradient as the existing channel. This was done to allow the same opportunity for fish movement as was available in the natural channel. Both diversion channels converge at a small waterbody which drains Shack Lake. Shack Lake received runoff from these same drainages prior to development.

The mine rock pile area is located at the west side of the site and will have a sedimentation pond on the south end. Outflow from the sedimentation pond will drain to Andrews Lake.

5.2.3 Industrial Water

The main consumer of industrial water is the backfill plant for the end grid underground mine. The industrial water requirements are estimated at approximately 30m^3/d. The industrial water requirements can be met by using site runoff water (preferred) or by using fresh water. Any waste water produced from industrial sources will be pumped to the runoff sedimentation pond for treatment in the water treatment plant.

5.3 WATER TREATMENT AND DISCHARGE

A water treatment plant will be constructed at Sissons to treat all contaminated waste water prior to discharge. Sedimentation ponds will be constructed for temporary storage of contaminated water prior to treatment. The ponds will be sized to contain spring freshet and allow for flow equalization for the WTP feed.

The proposed water treatment process for the Sissons site has been selected to meet MMER effluent criteria and, also, to maintain the annual contaminant mass load of discharges to Judge Sissons Lake below a potential threshold of concern based on aquatic life criteria. The water treatment plant will be a three stage chemical treatment plant with a capacity of 1,700m3/d and is designed to remove metals and radionuclides to environmentally acceptable levels. Each stage of water treatment consists of chemical addition in reaction tanks followed by multimedia filtration for removal of suspended solids. Each stage has two tanks, each with a 40 minute retention time. Reagents are added to the first tank, designed for rapid mixing to promote the precipitation reactions. Flocculant is added to the second tank, which is a slow mix tank, to promote flocculation. .

Table 5.3-1 below indicates the expected discharge concentrations from the Sissons WTP.

Table 5.3-1 Sissons WTP Discharge Concentrations

Contaminant	Concentration (mg/L)
Calcium	336.0
Chloride	846.6
Magnesium	84.3
Potassium	8.640
Sodium	84.2
Sulfate	166.9
Nitrate	0.083
Aluminum	0.003
Ammonia (as N)	3.126
Antimony	0.001
Arsenic	0.018
Barium	0.785
Beryllium	6.41E-05
Boron	0.109
Cadmium	1.18E-04
Chromium	3.20E-04
Cobalt	2.80E-04
Copper	0.001
Iron	0.106
Lead	4.77E-04
Manganese	1.467
Molybdenum	0.085
Nickel	1.20E-03
Selenium	0.004
Strontium	6.086
Uranium	0.034
Vanadium	0.001
Zinc	0.014
Fluoride	0.737
Radium-226	0.1 Bq/L

The water treatment plant effluent will be monitored using four lined monitoring ponds to ensure the effluent meets regulatory requirements. The water will be sampled as it is being discharged to the monitoring ponds and the assay results will be used to confirm that the sample is suitable for discharge. Water will be discharged to Judge Sissons Lake via a single-walled pipeline. The pipeline will be monitored on a regular basis to ensure that there are no leaks.

5.4 CONTINGENCY MEASURES

Preliminary contingency measures for discharge during upset conditions have been developed. Table 5.4-1 shows the upset condition and the contingency measures to be taken.

Table 5.4-1 Contingency Measures for Discharge

Upset Condition	Contingency Measures
Liner break in monitoring pond	Operate with 3 of 4 monitoring ponds Reduce feed flow rate if required
Operator unable to monitor pipeline due to poor weather conditions	Temporarily suspend discharge of effluent Suspend operation of water treatment plant
Major leak in pipeline	Temporarily suspend operation of WTP and discharge of effluent
Monitoring pond does not meet discharge criteria	Recycle pond contents to run-off sedimentation pond for re-treatment in WTP
Sewage does not meet discharge criteria	Recycle to front-end of sewage treatment plant
Water treatment plant not operating and sewage requires discharging	Batch discharge of sewage

Figure 5.4-1 Sissons Site Water Management

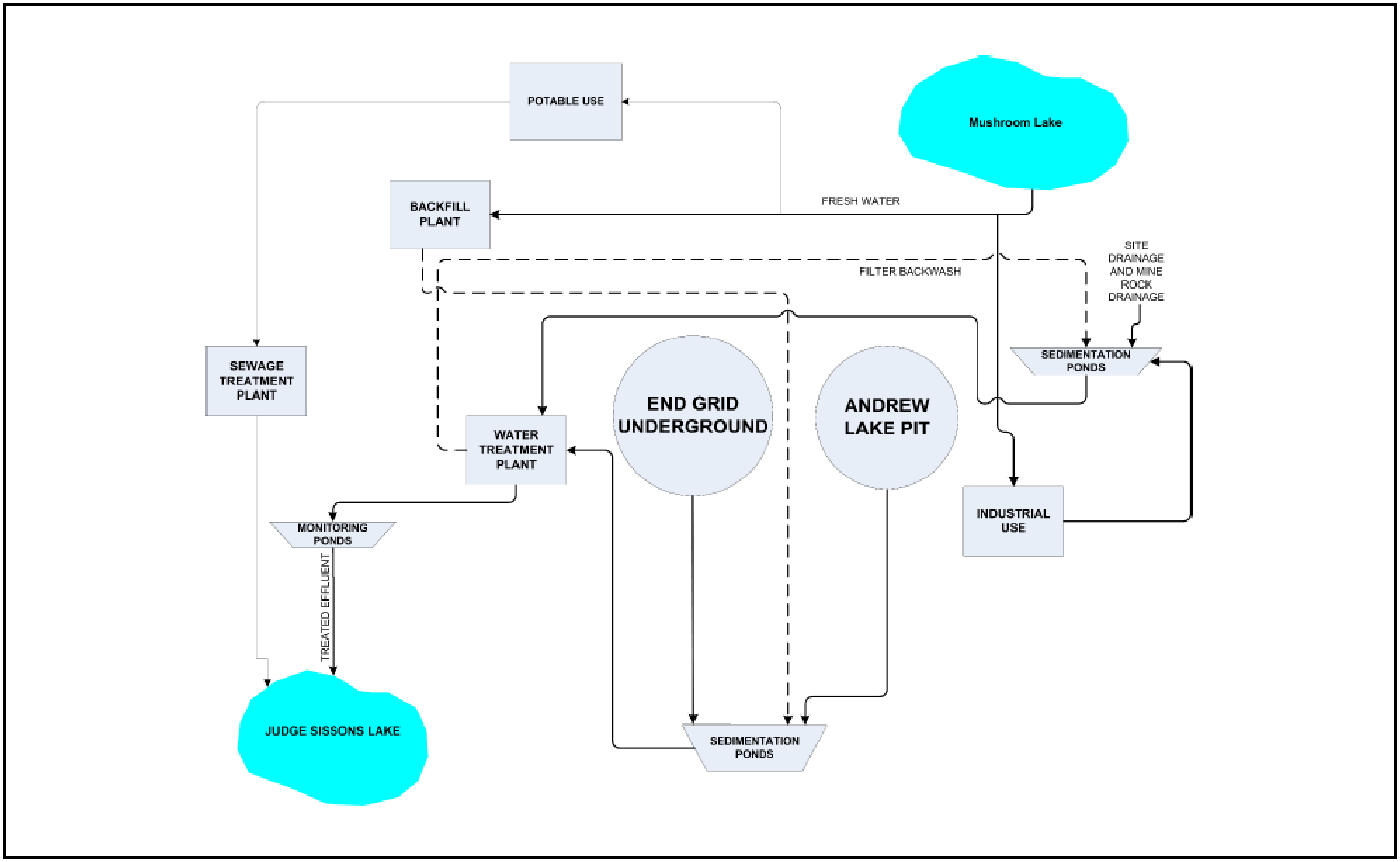
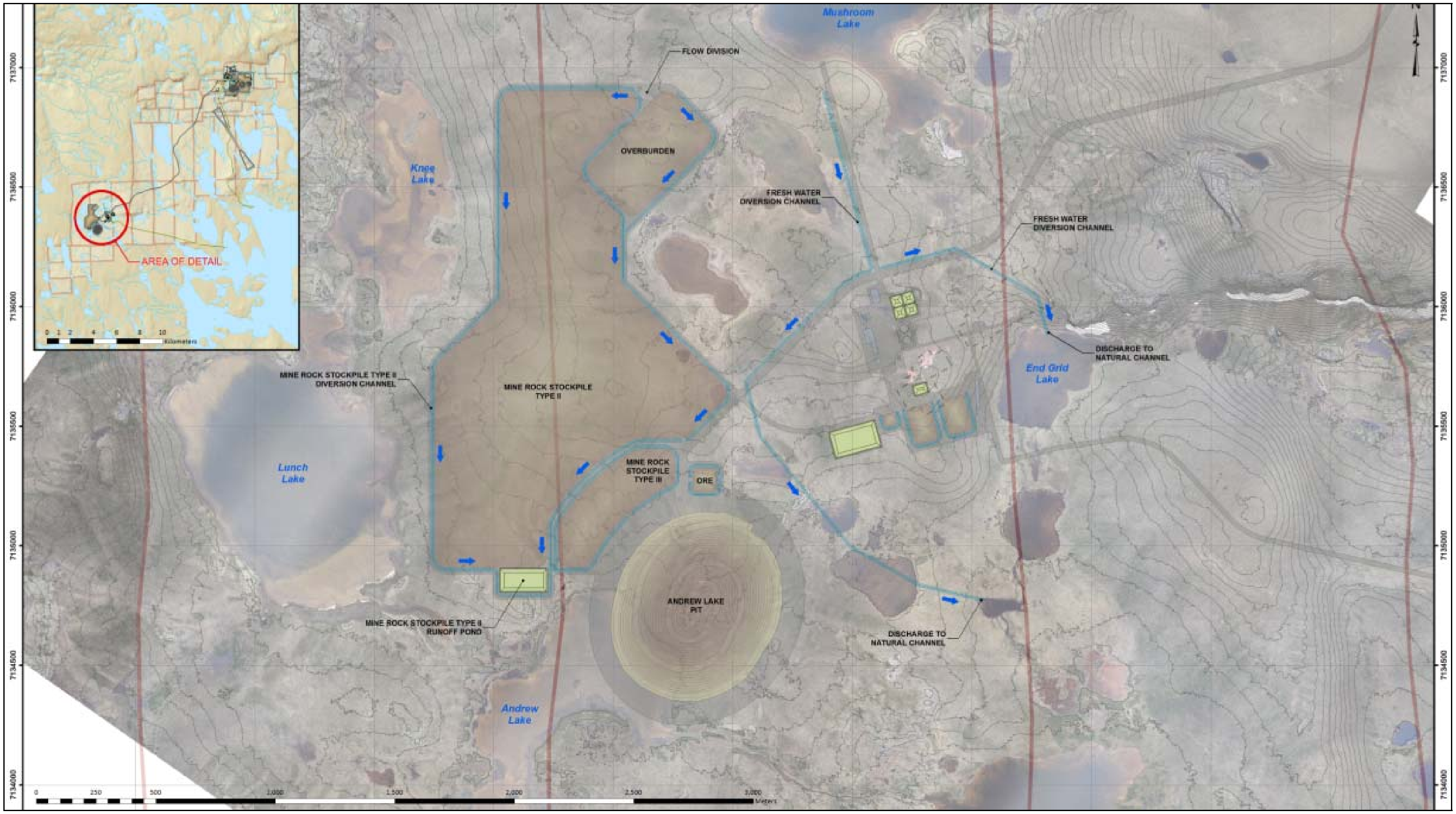


Figure 5.2-2 Sissons Water Diversion Channels



6 SITE ACCESS WATER MANAGEMENT

It is expected that any contact waters associated with the Baker Lake dock site, the access road(s), and quarries, will generally not require treatment. Where sediment transport is identified as a potential concern, sedimentation ponds or other means of removing total suspended solids (TSS) from runoff, such as silt fences, will be installed.

6.1 BAKER LAKE DOCK FACILITY AND STORAGE AREA

The Baker Lake storage area and associated infrastructure will be located on an upland area near to the temporary dock. General drainage will be diverted around the site.

General drainage from within the site footprint is not expected to require treatment. Berms or silt fences may be utilized to control any excess runoff and potential sediment transport from the site.

Fuel and hazardous materials will be stored within secondary containment berms. Runoff from within the berms may be passed through a passive filter prior to discharge to remove any organics or other contaminants.

6.2 QUARRY SITES

A number of potential aggregate source quarries have been identified along the access road routes. Water from within quarries will be managed to prevent effects on the aquatic environment. To reduce ponding and resulting permafrost degradation, drainage ditches or channels will be constructed, where required, to divert water from entering the quarry. Where water erosion may cause slope destabilization or sediment transport, side slopes will be maintained below 1H:1V to 2H:1V where possible, and erosion control measures will be available (e.g., geotextiles, rip-rap, straw blankets). Berms and silt fences may be utilized to control any excess runoff from the quarry.

Drainage from within the quarry will be collected in a sump, and if required, will undergo testing prior to release. Material characterization indicates that the majority of excavated rock would not have significant acid rock drainage (ARD) or metals leaching (ML) potential (Technical Appendix 5F). The aggregate rock materials are not likely to leach constituents of potential concern.

6.3 BAKER LAKE – KIGGAVIK ACCESS ROADS

The two access road options proposed for the Project are a winter access road and the north all-season access road.

6.3.1 Winter Access Road

Water for preparation of the winter access road will be withdrawn from lakes of substantial volume along the route. Withdrawal rates will follow all applicable Fisheries and Oceans Canada (DFO) guidelines for protection of fish habitat. Approaches along shorelines will be built up using ice ramps to reduce the potential for erosion or sediment transport.

As the winter access road will operate only during periods of ice cover, it is not anticipated that any collection or treatment of water will be necessary.

6.3.2 All-Season Access Road

The north all-season access road will cross the Thelon River and a number of other streams. The Thelon River crossing will consist of a cable ferry during the ice-free season and an ice-bridge during the ice-covered season. The reminder of the crossing will consist of either clear span bridges or culverts.

The road will be constructed from fill drawn from the quarries. Only clean fill that does not have potential for ARD or ML will be used for construction purposes. Therefore drainage from the road bed is not expected to require collection or treatment.

Construction best-practices will be used when constructing crossings to ensure that potential aquatics effects due to sediment transport or shoreline erosion are mitigated.

7 CLIMATE CHANGE CONSIDERATIONS

Considerations for climate change have been incorporated in the development of water management strategies and facilities primarily through conservatism in both design and in the environmental assessment basis. This is considered the best approach since changes in regional climate have the potential to either decrease or increase the volume of contact water.

Design measures to account for potential changes in water flows include sizing of channels and ponds for a 24-hour Probable Maximum Precipitation (PMP) event (Technical Appendix 4A), over-sizing the water treatment plant, and providing contingency containment with on-site pits and ponds.

The assessments of environmental effects have been based on conservative values (refer to Tier 2 Volume 2 Project Description and Assessment Basis) wherein freshwater withdrawal rates are assumed to be consistently at the high end of the range (in case of lower volumes of recyclable site drainage) and treated effluent discharge is assumed to be consistently at the maximum capacity of the water treatment plants.

During the construction and operational phase, additional data will be gathered on hydrological conditions in the site areas (see Technical Appendix 5A for existing baseline). This data, in addition to site-specific operating experience, are considered to provide opportunities for continuous improvement in water management and optimization of storage, such that the Project will adapt to future fluctuations in climate within the context of the current Environmental Impact Statement.

8 REFERENCES

AREVA Resources Canada (2011). Kiggavik Environmental Impact Statement – Tier 2 Volume 2 – Project Description and Assessment Basis, December 2011

AREVA Resources Canada (2011). Kiggavik Environmental Impact Statement – Tier 2 Volume 10 – Accidents and Malfunctions, December 2011

AREVA Resources Canada (2011). Kiggavik Environmental Impact Statement – Tier 3 Technical Appendix 2D- Conceptual Design for Ore and Special Waste Pads and Ponds, December 2011