Lupin Mines Incorporated

A wholly owned indirect subsidary of Mandalay Resources Corporation

Lupin Mine Site

Nunavut, Canada

Interim Abandonment and Restoration Plan

March 2016

Lupin Mines Incorporated
Mandalay Resources Corporation.
76 Richmond Street East, Suite 330
Toronto, Ontario M5C 1P1

Document Control

Revision No	Date	Details	Author	Approver
1.0	20/03/12	Reformatted to Lupin Mines standard Revised and updated to reflect new ownership and contact information Updated figures to reflect current site conditions Updated discussion to reflect Cycle 3 and Investigation of Cause EEM studies Updated discussion of fuel facilitates to reflect results of fuel containment system inventory Removed references to SNP; updated with references to Monitoring Program Station Numbers as per current water licence Address comments from Environment Canada (2010), AANDC (2010)	S. Hamm	P. Downey
2.0	15/04/13	Updated contact and general information Updated environmental policy Updated lease expiry dates A description of site access added Updated climatic data Updated description of the explosive magazine to reflect current site conditions Updated to reflect progressive remediation activities undertaken since 2005 that were not incorporated in previous versions Description of Tailings Containment Area moved from Section 6.5 to Section 3.3 and updated to reflect current site conditions Address comments from Environment Canada (2010) and Indian and Northern Affairs Canada (2010)	D. Vokey	W. Osborne
3.0	25/03/16	Updated to reflect new water licence Updated contact and general information Delinked this Plan from the Care and Maintenance Plan Added a timeline siting facility owners and major milestones Updated climatic data Rearranged text so that facilities are first described in Section 3 and closure activities are described in Section 6 Updated tailings water management to reflect current conditions	SRK	K. Lewis

Revision No	Date	Details	Author	Approver
		Added information about the landfarm operation and closure Updated tailings impoundment stability to reflect current guidelines Added concordance table to commitments made to update this Plan during the water licence renewal to Appendix F		

Executive Summary

Lupin Mines Incorporated (LMI), a wholly owned indirect subsidiary of Mandalay Resources Corporation, has prepared this Interim Abandonment and Restoration Plan (the Plan).

A review of the Plan takes place and revisions are submitted as necessary with the annual report. The current Type A water licence 2AM-LUP1520 (Water Licence) for the Lupin Gold Mine (Lupin or the Lupin Mine or the Site) is valid until August 18, 2020 and has been kept in good standing.

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1 Introduction

Lupin Mines Incorporated (LMI), a wholly owned indirect subsidiary of Mandalay Resources Corporation (Mandalay), has prepared this Interim Abandonment and Restoration Plan (the Plan).

An annual review of the Plan takes place and revisions are submitted as necessary with the annual report. The current Type A water licence 2AM-LUP1520 (Water Licence) for the Lupin Gold Mine (Lupin or the Lupin Mine or the Site) is valid until August 18, 2020.

1.1 Project and Company Information

Mandalay is a Canadian based company focused on producing assets in Australia, Chile and Sweden, a development project in Chile and the exploration and development of the past-producing Lupin Gold Mine and the Ulu gold project, both located in Nunavut, Canada.

Mandalay purchased Elgin Mining Inc., which owns the Lupin Mine, in September 2014. Lupin was in operation from 1982 to 2005 with temporary suspensions of activities between January 1998 and April 2000, and again between August 2003 and March 2004. The mine resumed production in March 2004 until February 2005. Since 2005, the Site has remained in Care and Maintenance.

General site maintenance and facilities upgrades are underway at the Lupin Mine to assess operational requirements. The activities underway were screened by the Nunavut Impact Review Board under file 99WR053 and approved by the Nunavut Water Board under Water Licence 2AM-LUP1520. Surface exploration is conducted under Water Licence 2BE-LEP1217. All camp infrastructure required for the surface exploration program currently exists at the Lupin Mine.

Company:	LMI
Project:	Lupin Mine, Nunavut
Company Address:	Suite 330, 76 Richmond Street East, Toronto, ON M5C 1P1
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Attention:	Karyn Lewis, General Administration
Effective date:	25 March 2016

Distribution List:

Karyn Lewis	General Administration
Discovery Mining Services	Site Contractor
Golder Associates	Site Consultant
SRK Consulting	Site Consultant

Additional copies of this Plan are available from General Administration. This Plan will be posted in key locations at the site and all employees and contractors will be made aware of its contents.

1.2 Site Location

The Lupin Mine is located in the Kitikmeot Region, Nunavut, 400 km north of Yellowknife, Northwest Territories and 285 km southeast of Kugluktuk, Nunavut. The airport serving this Site is at 65° 46'00" N and 111° 14'41" W. The Site is on the western shore of Contwoyto Lake, approximately 60 km south of the Arctic Circle (Figure 1).

1.3 Environmental and Sustainable Development Policy

Lupin Mines Incorporated (LMI) is committed to maintaining a safe, clean, compliant and respectful work environment. LMI looks to our employees, contractors and managers to adopt and grow a culture of social responsibility and environmental excellence. Together we achieve this by:

- Promoting environmental stewardship in all tasks. Nothing is too important that it cannot be done in a clean and responsible manner. We strive towards maintaining a zero-incident work place.
- Recognizing that we have a shared responsibility as stewards of the environment in which we operate. We will not walk away from a non-compliant act.
- Identifying, managing and mitigating environmental, business and social risks in an open, honest and transparent manner.
- Planning our work so it is done in the cleanest possible manner and executing work according to plan.
- Continually improving environmental and operational performance by setting and reviewing achievable targets.
- Providing appropriate and necessary resources in the form of training, personnel and capital, including that required for closure planning and reclamation.
- Managing our materials and waste streams, maintaining a high degree of emergency response preparedness and minimizing our operational footprint to maintain environmental protection at all stages of project development.
- Procuring goods and services locally, where available, and favouring suppliers with environmentally and socially responsible business practices.
- Seeking to understand, learn from and mitigate the root causes of environmental incidents and near misses when they do occur.
- Employing systems and technology to achieve compliance, increase efficiency and promote industry best practices in development, operations and environmental stewardship.
- Working with stakeholders to identify and pursue opportunities for sustainable social and economic development and capacity building.

- Conducting early and ongoing stakeholder engagement relevant to the stage of project and mine development and operation.
- Recognizing diversity in the workplace and building meaningful relationships with all stakeholders in a timely, collaborative and transparent manner.

Through implementation of this policy, LMI seeks to earn the public's trust and be recognized as a respectful and conscientious employer, neighbor and environmental steward.

1.4 Purpose and Scope

This Plan is designed to address the requirement for an interim abandonment and restoration plan within water licence Number 2AM-LUP1520 (Water Licence), Part I, Item 1. This Plan is derived from the 2005 Abandonment and Restoration Plan, Lupin Tailings Containment Area, responses to technical review comments prepared by Kinross Gold Corporation in 2005 and 2006 and in response to technical review comments received during the recent renewal of the Water Licence. Further history of the development of the Plan is described in Section 4.

The objectives of the Plan are to:

- Outline site history,
- Describe planned reclamation and closure activities for the mine site and the tailings containment area (TCA),
- Describe reclamation activities that have been carried out to date, and
- Describe progressive reclamation activities that are planned.

2 Site Information

2.1 Lupin Mine Operation Background

The Lupin Mine was discovered in 1960 as a result of reconnaissance sampling and mapping programs conducted by the Canadian Nickel Company Ltd, a subsidiary of Inco Limited. Between 1961 and 1964 the Canadian Nickel Company Ltd. conducted exploration in the Lupin area, which included geological mapping, geophysical surveying, trenching, stripping and channel sampling.

In February 1979, Echo Bay obtained an option on the Lupin property from Inco and proceeded with an underground exploration program. The geological information indicated enough ore reserves to provide six years of production, based on the potential to develop in excess of two million tons of ore with a mill designed to process an average of 950 tonnes per day.

In August 1980, the decision was made to proceed with development and construction of the Lupin Mine. Waste rock generated from the development of the underground workings was used to build the pad surrounding the mill and as roadbed material. Construction was completed on schedule in March 1982 and preproduction commissioning began.

From 1983 through to 1993, the mine and mill operations were expanded to increase capacity to a nominal 2,300 tonnes per day. In December, 1994, the paste backfill plant was completed, which provided critical ground support in production areas while reducing the amount of tailings reporting to the TCA. Operations were temporarily suspended at Lupin between January 1998 and April 2000, and again from August 2003 to March 2004. Mill throughput in the last year of operation, March 2004 to February 2005, averaged approximately 1200 tonnes per day, significantly less than in previous years. Production ceased in 2005; at this time, the Site was put under care and maintenance. No active mining has since occurred. In 2012 and 2013 significant site maintenance work and upgrades were completed to the mill, fuel tank system and residential complex.

The frequency of water discharge from TCA into the receiving environment has been variable over the life of the mine. Discharge occurred annually between 1985 and 1997, and then every two to four years until 2015. Since the Site entered care and maintenance in 2005, there have been four water treatment campaigns to reduce the volume of water within the facility. These campaigns have occurred in 2005, 2009, 2012, and 2015. Figure A illustrates the annual volume of water discharged to the environment.

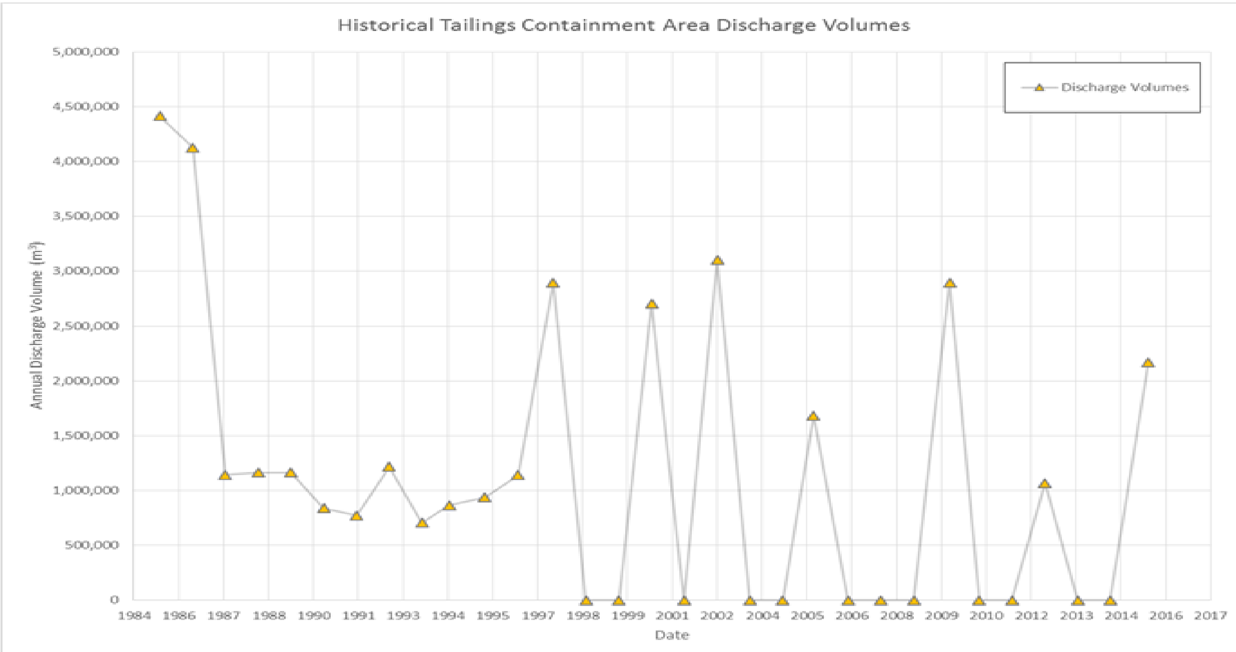

Figure A: Historical Tailings Containment Area Discharge Volumes

During the current period of care and maintenance, the Site has had seven changes in ownership (four of the changes in ownership were the result of the acquisitions rather than sale of the property). A timeline siting facility owners, and major milestones associated with the construction of the mine and tailings facility are illustrated on Figure B: .

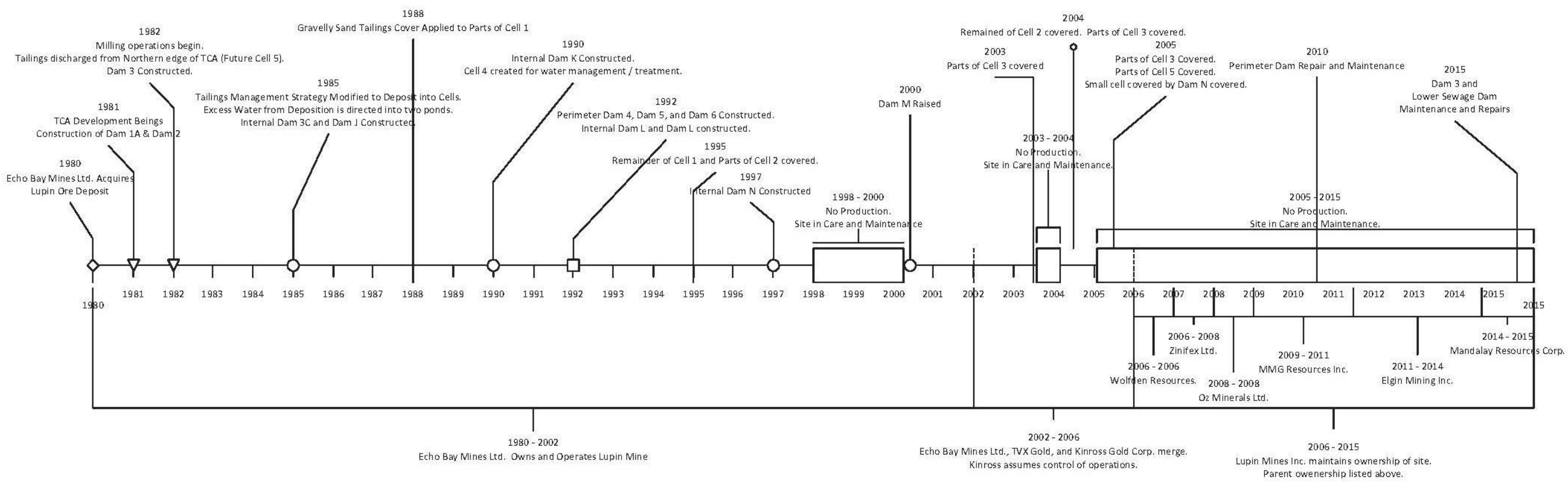

Figure B: Summarized Project History

2.2 Licences

The Lupin Mine is presently permitted by Water Licence 2AM-LUP1520 for water use and waste disposal in a mining and milling undertaking. The Water Licence was reissued the by the Nunavut Water Board (NWB) on August 19, 2015. It was approved by the Minister of Indigenous and Northern Affairs Canada (INAC) on October 5, 2015 and expires on August 18, 2020.

A list of the land leases pertaining to the Lupin Mine is presented in Table 1

Table 1 Mineral and surface leases, Lupin.

Name	Type	Description	Expiry	Area (ha)
2428	Mineral Lease	Lot 1 Group 1216 Quad 76E/14	12-Jul-2013(1)	2,831.59
3275	Mineral Lease	Lot 1003 Quad 76E\11	27-Sep-2030	927.13
3276	Mineral Lease	Lot 1002 Quad 76E\11	27-Sep-2030	891.92
3277	Mineral Lease	Lot 1004 Quad 76E\11	27-Sep-2030	959.10
3278	Mineral Lease	Lot 1001 Quad 76E\11	27-Sep-2030	1,148.09
76E/14-1-9	Surface Lease	Minesite, TCA	31-Mar-2012(2)	1,035.79
76E/14-2-10	Surface Lease	Airstrip	31-Mar-2012(2)	53.16
76E/11-2-3	Surface Lease	Fingers Lake Quarry, access road	31-Mar-2012(2)	137.80
76E/11-3-4	Surface Lease	Fingers Lake Waterlot - dock	31-Mar-2012(2)	0.43
76E/14-10-3	Surface Lease	VOR Navigation aid site	31-Mar-2012(2)	0.09

(1) Renewal has been applied for the lease expiring in July 2013.

(2) Renewal has been applied and fees paid for the leases that expired March 2012.

2.3 Site Access

The Lupin Mine property is accessible by fixed wing or rotary aircraft from Yellowknife. A 1,950 m long gravel airstrip suitable for Boeing 727 and C-130 Hercules sized aircraft is located on the property. A facility to handle float-equipped aircraft is located on the shore of Contwoyto Lake.

The Site is also accessible via the Tibbitt to Contwoyto winter road, which currently operates between February and April. By winter road, it is approximately 570 km from the end of the Ingraham Trail, located near Yellowknife, NWT to the Site. Following the closure of the Jericho Mine (km 600) in 2008, construction of the winter road beyond the Ekati Diamond Mine (km 405) has occurred periodically, not annually. The Lupin spur has been inactive for several years, but can be reactivated to allow for the delivery of bulk items.

2.4 Geology

2.4.1 Bedrock Geology

The Lupin gold deposit is situated in an Archean metaturbidite sequence of the Contwoyto Formation, part of the Yellowknife Supergroup of supracrustal metasedimentary and metavolcanic rocks of the Slave Geologic Province. The rocks have been subjected to both regional and contact metamorphism and to several phases of deformation and intrusion. The bedrock at the Site consists of a mixture of low grade metamorphosed argillite, siltstone, slate, greywacke, and quartzite, generally phyllite (Geocon 1980).

The Lupin ore unit is composed of the Centre Zone, East Zone, West Zone and L19 Zone, all of which are contained within a continuous, isoclinally folded, steeply dipping unit of amphibolitic iron formation within the Contwoyto Formation. This unit has been followed for a strike length of 3000 m and a dip length of 1500 m. Several phases of deformation have resulted in steeply plunging fold noses and steeply dipping fold limbs. The resulting pattern is 'M' shaped, consisting of a northerly-plunging syncline and adjacent anticlines to the west and east. The West Zone forms the west limb of the west anticline, the Centre Zone the west limb of the syncline and the East Zone the east limb of the syncline. Most of the gold occurred in the West Zone and Centre Zone. A lesser amount was found in the East Zone. The L-19 Zone did not contain economic concentrations of gold and was not mined.

The iron formation is a well laminated unit and consists of both silicate facies and sulphide facies metamorphosed to an amphibolite + quartz rich rock. The gold is found primarily within the sulphide rich iron formation. The ore at Lupin consists of amphibole, quartz, garnet, pyrrhotite, arsenopyrite, minor pyrite and traces of chalcopyrite. The gold is fine grained (generally less than 100 microns in diameter) and is associated mainly with the pyrrhotite and arsenopyrite. Although not common, visible gold is sometimes found and is usually in close proximity to quartz veining. Also found in trace amounts are scheelite, apatite, epidote, calcite, tourmaline, and some arsenides (notably loellingite). Arsenopyrite occurs as metacrysts, up to 2 cm in diameter, which often have loellingite cores. Much of the gold associated with these arsenides occurs at the arsenopyrite - loellingite boundaries within these metacrysts. Gold is also finely disseminated within pyrrhotite and silicates, and is rarely visible to the naked eye.

The McPherson Zones (M1 and M2) are in iron formation lenses separate from the main Lupin ore unit, contain economic quantities of gold, and were mined. They trend parallel to the West Zone at approximately 60 m and 80 m east of it near the latitude of the shaft. The M1 and M2 Zones contain a higher proportion of pelitic beds than the main Lupin ore unit. Gold is locally present in the pelitic beds, and visible gold is more common in the M1 and M2 Zones than in mineralized zones of the main ore body.

2.4.2 Surficial Geology

Where bedrock is not present at surface, the ground surface typically consists of glacial till which is occasionally overlain by glacio-fluvial and glacio-lacustrine sand and gravel deposits (in the form of eskers and lake shore deposits). The till is a silty sand with gravel and boulder content and is underlain by weathered and competent low grade clastic metamorphosed bedrock of the Yellowknife Supergroup. The esker material used for progressive reclamation is described further in Section 3.4.

2.4.3 Tailings

Tailings are primarily composed of the gangue minerals amphibole and quartz, which account for over 80% of the volume. Pyrrhotite and arsenopyrite make up an additional 17% (Klohn 1995). The tailings have been shown through various studies to be capable of generating acid upon oxidation. The tailings are a fine grained material with 80 to 87% less than 75 µm (SRK 2015). Arsenic concentrations range from 6750 to 8410 mg/kg (SRK 2015).

Tailings cover approximately 1,521,000 m^2 of the TCA. An esker sand cover with a minimum thickness of 1 m has been placed over approximately 1,280,000 m^2 of the tailings. The cover has been in place since 2005. The esker cover serves to eliminate wind dispersal of dry tailings, protect against contact with exposed tails by fauna, and the embedded moisture layer prevents oxidation of the underlying tails. A study conducted to assess the presence of recent windblown tailings adjacent to the TCA detected no deposition of tailings material on surface (SRK 2015).

2.4.4 Waste Rock

The waste rock is composed mostly of quartzite, phyllite, and minor amounts of carbonate, and has very low sulphide content. Column leach studies had shown the waste rock to have little potential for development of acid rock drainage (ARD) (Klohn 1992a). The results of a 2004 program determined that some acid generation could be expected from 'hot spots' within the waste rock, where concentrations of potentially acid generating (PAG) rock had accumulated (URS 2005). An assessment to evaluate the water quality of seepage from waste rock was conducted in 2005. The environmental site assessment detected groundwater and seepage with depressed pH and elevated metal concentrations in isolated locations (Morrow 2006).

An evaluation of options for dealing with the PAG waste rock is required to support the development of the final reclamation and closure plan. Should the preferred option require segregation of the PAG rock further work will be required to assess methods for identifying this material during excavation.

2.5 Climate

Table 2 shows the monthly precipitation from snow and rain, as measured at the Lupin Mine weather station, between 1982 and 2006. Precipitation readings were taken manually until 2006 when an automated system was installed by Environment Canada. The automated system does not separate measured precipitation into snowfall or rainfall, making it difficult to interpret. The automated system does measure temperature and wind speed. Table 3 shows the monthly rainfall, as measured at the Lupin Mine weather station, between 1982 and 2006.

Table 2 Monthly precipitation at Lupin.

	Total Monthly Precipitation (mm water equivalent; 1 cm snow = 1 mm water)												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
1982	0.8	3.0	M	13.2	12.8	44.9	36.0	62.4	36.6	21.3	14.1	15.0	260.1
1983	24.6	5.5	16.8	16.5	18.0	10.4	77.7	75.2	77.0	41.8	10.8	6.0	380.3
1984	6.8	19.4	16.2	19.3	17.8	60.0	69.6	53.7	19.8	25.4	13.2	9.2	330.4
1985	9.2	11.6	10.4	25.8	10.2	19.4	89.0	46.6	44.7	24.0	9.4	6.6	306.9
1986	20.0	9.2	5.2	19.7	29.2	17.5	18.0	100.8	30.0	28.0	13.6	12.8	304.0
1987	11.6	6.6	5.6	6.6	8.6	67.8	41.8	47.1	35.0	34.1	45.0	25.4	335.2
1988	1.8	3.6	4.2	6.0	10.8	50.3	32.4	18.7	43.4	32.2	22.2	8.2	233.8
1989	20.0	4.0	10.2	3.1	36.1	6.3	35.0	27.5	33.7	11.7	14.4	16.5	218.5
1990	11.8	6.0	12.0	8.3	2.4	23.4	23.3	54.0	48.5	20.1	9.2	14.7	233.7
1991	7.9	13.2	12.4	26.1	14.0	12.4	42.8	76.2	46.5	26.4	17.6	19.4	314.9
1992	17.6	8.6	9.8	20.4	21.4	21.2	14.8	47.0	31.2	43.8	15.4	4.2	255.4
1993	6.1	19.2	13.2	6.2	28.4	24.0	87.0	28.8	29.9	19.4	14.8	12.0	289.0
1994	3.4	2.2	22.0	8.2	15.4	39.2	13.8	47.2	43.4	29.2	11.0	14.8	249.8
1995	5.2	3.4	38.8	6.6	11.2	20.8	40.2	79.0	49.4	37.0	7.4	23.8	322.8
1996	5.6	18.4	4.4	8.0	24.8	53.2	57.7	156.0	68.8	12.4	13.6	6.6	429.5
1997	6.6	6.6	6.8	12.8	27.2	21.2	18.2	58.6	25.4	46.2	12.6	17.8	260.0
1998	5.2	7.2	5.6	17.8	19.2	38.4	32.2	57.4	61.8	51.7	17.0	21.6	335.1
1999	9.6	6.6	14.4	25.0	25.2	19.6	62.4	57.2	85.2	23.8	13.4	30.8	372.8
2000	3.8	5.4	7.0	12.4	18.6	5.0	27.2	49.2	58.6	43.4	14.0	7.8	252.4
2001	6.4	7.0	24.6	30.2	40.2	6.4	44.4	46.4	9.4	20.0	27.6	12.0	274.6
2002	7.6	2.2	6.4	15.8	4.4	35.6	67.0	92.8	52.2	14.2	20.2	11.2	329.6
2003	3.8	0.4	19.8	3.4	22.2	18.4	44.0	69.2	36.0	28.4	31.3	15.6	292.5
2004	10.8	12.4	9.2	18.4	6.0	21.2	12.2	111.0	61.2	29.2	30.2	3.4	325.2
2005	14.2	6.2	12.6	18.8	11.2	59.4	28.8	64.2	26.6	33.2	20.2	12.4	307.8
2006	14.6	6.8	16.8	16.8	9.2	63.7	21.6	35.4	11.2	20	M	M	M
Avg.	***9.4***	***7.8***	***12.2***	***14.6***	***17.8***	***30.4***	***41.5***	***62.5***	***42.6***	***28.7***	***17.4***	***13.7***	***300.6***

M – missing data; not used in average calculation.

Table 3 Monthly rainfall at Lupin.

	Total Monthly Rainfall (mm water)												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
1982	0	0	0	0	9.4	27.4	34.8	60.8	5.6	0.2	0	0	138.2
1983	0	0	0	0	0	9.2	77.7	75	36.9	0	0	0	198.8
1984	0	0	0	0	16.8	58.4	69.6	51.1	8.6	13.4	0	0	217.9
1985	0	0	0	0	3.2	16	85.2	25.2	35.8	0	0	0	165.4
1986	0	0	0	0	17	14.1	18	97.8	11.6	0	0	0	158.5
1987	0	0	0	0	4.2	66	41.8	42.3	29	0	0.2	0	183.5
1988	0	0	0	0	3.8	48.7	32.4	18.7	37.4	10.8	0	0	151.8
1989	0	0	0	0	0.6	6.3	35	27.5	22.4	0.4	0	0	92.2
1990	0	0	0	0	0.6	22.2	23.3	51.4	40.2	0	0	0	137.7
1991	0	0	0	0	1.2	12.4	41.4	75.8	15.7	0	0	0	146.5
1992	0	0	0	0	12.8	7	14.8	41.6	8.8	0.6	0	0	85.6
1993	0	0	0	0	9.2	20.2	87	25.8	16	0	0	0	158.2
1994	0	0	0	0	7.2	38.6	13.8	47.2	24	4.8	0	0	135.6
1995	0	0	0	0	1.2	20.8	40.2	77.6	21.2	1	0	0	162
1996	0	0	0	0	8.2	38.4	57.7	149.2	62.6	0	0	0	316.1
1997	0	0	0	0	6.2	18.4	18.2	56	20.6	0.8	0	0	120.2
1998	0	0	0	0	10.4	38.4	32.2	57.4	30	4.6	0	0	173
1999	0	0	0	2.2	5.6	19.2	60.2	54	67.4	0	0	0	208.6
2000	0	0	0	0.2	0	4.8	27.2	46.2	32.6	0	0	0	111
2001	0	0	0	0	4.8	0.4	44.4	46.2	7.2	1.2	0	0	104.2
2002	0	0	0	0	0	33.8	67	91.4	39.6	0.2	0	0	232
2003	0	0	0	0	5.4	9.6	44	69.2	14.6	1.4	0	0	144.2
2004	0	0	0	0	0.2	20.8	12.2	110.6	33.6	0.2	0	0	177.6
2005	0	0	0	6.4	0	57.6	28	62.4	6.2	0	0	0	160.6
2006	0	0	0	0	5	60.5	21.6	35.4	10.4	0.4	M	M	M
Avg. [1)]	***0.0***	***0.0***	***0.0***	***0.3***	***5.3***	***26.8***	***41.1***	***59.8***	***25.5***	***1.6***	***0.0***	***0.0***	***161.6***

1) Averaged precipitation values do not include missing or invalid data
M - missing data; not used in average calculation.

Climate in this region is classed as semi-arid subarctic, with an average annual precipitation of approximately 300 mm and a mean daily temperature of -10.9°C. Average temperature for the months of May through September is 4.8°C. Precipitation is heaviest in the months June through September.

Snowfall can occur during any month, although heaviest snowfalls generally occur in October. The prevailing winds in the Lupin Mine area are from the northwest.

Snowmelt is generally complete by the end of June. Break-up on Contwoyto Lake begins in mid-July, although in some years the lake is not ice-free until early August. Small lakes in the region are ice free by early July. Ice starts to reform on small lakes of the surrounded area in late August or early September. Complete freeze-over of Contwoyto Lake occurs in October. Table 4 shows the monthly temperature at the Lupin Mine, as measured at the weather stations.

The winter climate at this latitude is severe in intensity and duration and is followed by a short, warm summer. In winter, between 1 and 3 m of ice develop on the surface of the lakes and it is the rate of melting of this ice that greatly influences summer conditions. The interaction between climate and morphology of the individual lakes gives rise to great differences in the thermal regime of the lakes.

Table 4 Monthly temperature at Lupin.

	Mean Monthly Temperatures (°C)												
Date[1)]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
1982	-36.0	-28.5	-27.5	-19.8	-5.6	4.9	11.5	7.3	0.9	-7.2	-26.0	-29.8	-13.0
1983	-30.9	-33.4	-28.8	-17.2	-14.0	5.2	10.3	9.3	2.4	-9.4	-14.0	-27.1	-12.3
1984	-32.2	-25.8	-25.2	-12.0	-3.9	8.1	12.7	9.7	-0.1	-9.2	-21.8	-32.4	-11.0
1985	-27.7	-34.7	-26.5	-19.6	-1.6	6.5	7.8	6.3	0.8	-10.0	-23.5	-25.0	-12.3
1986	-31.8	-26.9	-27.6	-19.0	-5.7	3.0	10.5	7.0	1.5	-9.6	-24.1	-24.9	-12.3
1987	-24.7	-25.1	-26.0	-15.2	-6.9	5.4	10.1	5.4	4.1	-8.1	-21.2	-19.6	-10.2
1988	-31.6	-31.7	-22.7	-15.4	-10.1	7.1	11.5	10.4	3.7	-8.3	-25.5	-27.4	-11.7
1989	-33.4	-22.5	-29.7	-15.3	-8.2	7.9	12.3	12.7	1.6	-7.9	-26.0	-29.2	-11.5
1990	-32.8	-34.6	-21.3	-14.6	-7.4	4.3	10.9	6.1	1.0	-9.3	-24.9	-31.3	-12.8
1991	-31.5	-30.6	-28.1	-13.9	-1.8	7.5	11.4	10.1	0.0	-10.7	-22.7	-27.8	-11.5
1992	-29.2	-29.0	-23.0	-17.5	-5.8	4.3	11.0	8.2	-1.2	-8.4	-18.6	-26.0	-11.3
1993	-25.7	-28.3	-21.4	-17.1	-5.7	4.8	10.4	9.2	0.5	-8.9	-21.9	-29.0	-11.1
1994	-34.4	-33.6	-21.7	-17.5	-2.4	8.1	13.9	10.6	2.2	-5.0	-18.5	-23.5	-10.2
1995	-25.0	-28.3	-25.6	-15.2	-7.1	7.6	8.9	8.9	0.8	-9.3	-20.6	-29.9	-11.2
1996	-31.7	-26.7	-25.9	-16.3	-5.8	9.7	14.3	7.6	5.1	-9.5	-20.4	-26.9	-10.5
1997	-30.3	-27.5	-27.6	-16.0	-6.5	6.0	13.4	9.7	4.7	-10.6	-15.1	-23.0	-10.2
1998	-33.4	-25.6	-22.1	-10.7	-0.4	8.3	13.9	11.4	3.6	-4.1	-12.8	-22.2	-7.8
1999	-28.6	-23.3	-19.6	-13.3	-4.8	6.9	8.4	8.8	2.3	-8.9	-16.9	-24.8	-9.5
2000	-26.8	-24.9	-22.3	-16.1	-3.9	7.3	15.1	9.0	1.0	-8.7	-18.8	-29.5	-9.9

	Mean Monthly Temperatures (°C)												
Date[1)]	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Avg**
2001	-25.4	-27.7	-23.8	-15.8	-4.7	3.8	12.4	8.5	5.9	-9.6	-20.5	-23.2	-10.0
2002	-28.3	-30.1	-25.5	-19.9	-8.4	7.4	12.0	8.1	2.8	-9.0	-17.3	-20.2	-10.7
2003	-27.2	-32.0	-26.7	-13.5	-5.4	5.6	13.4	10.3	3.7	-4.3	-18.9	-25.1	-10.0
2004	-33.0	-29.1	-29.6	-19.3	-11.2	5.2	11.6	6.5	0.8	-10.6	-22.0	-29.7	-13.4
2005	-29.1	-29.5	-23.9	-11.4	-8.7	4.8	9.4	8.7	0.2	-7.0	-17.4	-20.6	-10.4
2006	-26.1	-23.3	-18.5	-13.4	-0.1	10.2	11.2	11.3	4.5	-6.0	-20.9	M	-7.7
2007	M	-28.3	-27.8	-14.3	-6.5	5.3	12.8	7.0	-0.8	-7.6	-22.1	-27.0	M
2008	-27.6	M	M	-15.8	-4.1	5.9	12.2	8.3	0.2	-6.0	-18.4	M	M
2009	M	M	M	M	M	M	M	M	4.3	-9.3	-17.0	-25.3	M
2010	-27.5	M	M	-8.8	-8.7	6.6	12.6	9.7	2.4	-5.6	-16.3	-24.4	M
2011	M	M	M	-19.7	-2.8	5.4	13.3	10.7	3.7	-5.4	-19.9	-24.6	M
2012	-28.6	M	M	-15.3	-1.1	9.4	13.5	10.3	6.4	-6.6	-21.3	-29.2	M
2013	-31.6	M	M	-17.9	-5.1	10.8	9.9	11.2	3.8	-3.6	M	-29.3	M
2014	M	M	M	-16.3	-3.0	9.4	13.5	7.9	0.6	-7.4	-20.5	-25.4	M
2015	-27.5	M	M	-17.5	-1.9	7.9	10.4	11.1	3.2	-10.0	M	-24.6	M
Avg.[2)]	**-29.7**	**-28.5**	**-24.9**	**-15.8**	**-5.4**	**6.7**	**11.7**	**9.0**	**2.3**	**-8.0**	**-20.2**	**-26.2**	**-10.9**

1) *Between 1982 and 2006 data was collected from station 23026HN and between 2007 to 2016 data collected from station 230N002*
2) *Averaged precipitation values do not include missing or invalid data*
M – Missing or invalid data from weather stations

The climate normals, climate averages and extremes for the Lupin site compiled by Environment Canada for the 1981 to 2010 period are listed in Table 5.

Table 5 Climate Normals 1981-2010 for Station 23026HN.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature												
Daily Avg. (°C)	-29.9	-28.5	-24.8	-15.8	-5.9	6.4	11.5	8.8	2.1	-8.4	-20.4	-26.2
Standard Deviation	3.2	3.5	3.1	2.6	3.3	1.9	1.9	1.8	1.9	1.9	3.7	3.6
Daily Max. (°C)	-26.3	-24.9	-20.9	-11.5	-2.1	10.8	16.3	12.6	4.8	-5.8	-16.9	-22.6
Daily Min. (°C)	-33.4	-32.1	-28.7	-20.1	-9.6	1.9	6.7	5	-0.6	-10.9	-23.9	-29.7
Extreme Max (°C)	-5	-5	0.5	6	17.5	27.5	31	27.5	21	13	0	-4.5
Date (yy/dd)	87/08	86/28	93/23	98/18	94/25	99/18	89/15	89/14	97/02	03/03	83/02	91/29
Extreme Min. (°C)	-49	-46	-44	-38	-29.5	-9	-1.5	-6.5	-13.5	-30.5	-40.5	-42
Date (yy/dd)	90/26	93/05	91/05	97/06	83/02	86/04	83/03	82/23	05/28	96/30	82/19	93/24
Precipitation												
Rainfall (mm)	0	0	0	0.4	5.3	26.8	41.1	59.8	25.5	1.6	0	0
Snowfall (cm)	9.4	7.8	12.2	14.3	12.5	3.6	0.4	2.6	17.1	27.1	17.4	13.7
Precipitation (mm)	9.4	7.8	12.2	14.6	17.8	30.4	41.5	62.5	42.6	28.7	17.4	13.7
Extreme Daily Rainfall (mm)	0	0	0	5.8	10.2	36.8	41.8	38.6	34.2	10.8	0.2	0
Date (yy/dd)	82/01	82/01	82/01	05/22	92/26	87/13	83/09	86/29	99/10	88/08	87/02	82/01
Extreme Daily Snowfall (cm)	11.6	14.2	10	13.8	14.3	13.4	3.4	8.8	17	31.8	14	10
Date (yy/dd)	92/02	93/01	03/14	91/08	89/11	92/15	85/18	85/19	83/27	98/28	87/09	87/08
Extreme Daily Precipitation (mm)	11.6	14.2	10	13.8	14.3	36.8	41.8	38.6	34.2	31.8	14	10
Date (yy/dd)	92/02	93/01	03/14	91/08	89/11	87/13	83/09	86/29	99/10	98/28	87/09	87/08

Source:
http://climate.weather.gc.ca/climate_normals/bulkdata_e.html?ffmt=csv&lang=e&prov=BC&yr=1981&stnID=1671&climateID=23026HN+++++++++++++&submit=Download+Data

2.6 Topography

The site is in the tundra zone of the Canadian Shield, an area of continuous permafrost. It was last glaciated during the Pleistocene ice age. Terrain in the vicinity of the site is generally low and undulating, ranging between 470 and 505 m elevation. Numerous shallow lakes and streams occur in depressions throughout the area.

While the Site area is predominantly bedrock at surface, it is typified by “tombstone” topography over some of its area. These “tombstone” features resemble grave markers and occur as a result of ice-jacking action in heavily jointed rocks where joints tend to be pseudo-vertical and near-horizontal. The frost heave blocks are of various sizes and are scattered in a chaotic fashion. Removal of a block raised by this action would reveal an underlying mass of permanent ice (Geocon 1980. Golder 1990).

2.6.1 Vegetation

The Lupin Mine is located within an area of sparse vegetation, in the barren land tundra of Nunavut. It is typified as having a generous amount of low lying vegetation extremely tolerant and well adapted to the climatic conditions. Some of the more prevalent types of habitat that can be found throughout the area include upland and lowland tundra, wet meadows and gentle slopes.

Throughout the site there is diverse amounts of vegetation consisting of grasses and sedges; ground cover such as mosses, labrador tea, cranberry, bilberry, bearberry, arctic white heather. In wet areas, predominant species include cotton grass, bog rush, and other aquatic grasses. Dwarf birch and willows populate trenches, and colourful flowering plant species include fireweed, lapland rosebay, azalea and saxifrage to list a few.

2.6.2 Hydrology

Contwoyto Lake is the major water body in the region, with a surface area of approximately 95,900 ha and a drainage area of 8,000 km^2. Contwoyto Lake has two outlets in the Burnside River, which flows from the northwest end of the lake towards Bathurst Inlet, and Back River at the southeast end of the lake, which flows into Pellatt Lake. The main body of Contwoyto Lake lies to the east and south of the mine site. To the north of the mine, a portion of the lake extends to the west and south, terminating in a narrow bay (Sun Bay) which lies directly west of the mine site.

Aquatic habitat in the receiving environment immediately downstream of the tailings area is comprised of three shallow lakes (colloquially referred to as Dam 2 Lake, Dam 1a Lake, and Unnamed Lake), two streams (Seep Creek and Concession Creek), two shallow ponds, and two embayment areas of Contwoyto Lake (Inner and Outer Sun Bay). Dam 2 Lake is a small lake (maximum depth of 7 m), bordered on the north by a gravel pit and the east by the TCA (AECOM 2011). With the exception of Dam 2 Lake, all of the small lakes and ponds freeze to the bottom in winter. Much of Inner Sun Bay also freezes to the bottom. Due to low winter flows, both Seep Creek and Concession Creek freeze to the bottom in winter. As a consequence, over wintering habitat for fish is limited primarily to Outer Sun Bay and the main body of Contwoyto Lake (Reid Crowther & Partners/RL&L Environmental 1985).

Concession Creek drains Concession Lake via Unnamed Lake to Inner Sun Bay. Seep Creek enters the Sun Bay drainage system along the east side of Unnamed Lake. Lower Concession Creek (i.e. that section between Unnamed Lake and Inner Sun Bay) varies in width between 25 and 75 m, depending on seasonal discharges. Side channels are active during spring freshet. Stream depth generally is less than 1 m, except during spring freshet when depths approach 1.5 m. The substrate is primarily large boulder with large and small cobble occupying the interstices.

Seep Creek is approximately 6.5 km in length, flowing from its source in Dam 2 Lake and Dam 1a Lake (via separate branches which join about 2 km downstream) to Unnamed Lake. The stream channel in upper Seep Creek generally is poorly defined, often flowing through marshy areas, or between large boulders or through bedrock fractures. This section of the creek generally is less than 0.5 m in depth and less than 2 m wide. The dominant substrate type is boulders, although localized areas of cobble and gravel are present. Lower Seep Creek (i.e. the 400 m section upstream of Unnamed Lake) is characterized by a well developed channel varying in width from 1 to 4 m, although during freshet, maximum wetted width was about 20 m. The dominant substrate type is boulder, with localized areas of cobble and gravel (RCPL/RL&L 1985).

Inner Sun Bay (approximate area of 150 ha) is primarily shallow (mean depth of 1.7 m), with a maximum depth of about 6.5 m. Over 91% of the surface area is shallower than 3 m, and much of the bay freezes to the bottom in winter. Outer Sun Bay is deeper (greater than 10 m).

3 Operation History

3.1 Construction

In the summer of 1980, prior to a production commitment, 1,960 m gravel landing strip capable of handling a C130 Hercules was prepared. Plant design was based on being able to air freight all the components to site. Mine site construction started in August 1980 and was completed on schedule in March 1982 when pre-production commissioning began. The transportation of personnel to the site was accomplished with a Convair 640, which also carried a total of 7 million pounds of supplies such as perishables and repair parts during construction.

During the twenty-month construction period, the Hercules aircraft made some 1,100 flights, carrying 25 tonnes of construction material per trip. This material included all the contained machinery and construction equipment, 2,200 tonnes of structural steel and the cement required to mix 9,500 yd^3 of concrete. The floor area of the main complex was 100,000 ft^2 (9,290 m^2). During peak periods, the construction crew numbered up to 400 people on site.

Engineering, procurement and construction management of the surface facilities was contracted to Bechtel Canada Limited, while the contract for mine development and underground construction was awarded to J.S. Redpath Limited. The Lupin Mine was constructed and commissioned for a total cost of $135 million dollars.

During 1983, a construction program was completed to expand the capacity of the mill from the original 1,000 tonnes per day, to a new nominal capacity of 1,200 tonnes per day. This construction phase included the installation of a rod mill in the grinding circuit, an additional 1,000-tonne fine ore storage bin, additional filters and an extension to the maintenance bay.

From 1983 to 1993, the Lupin Mine underwent a number of other expansions and operational changes to increase milling capacity to a nominal 2,300 tonnes per day. The main production shaft was deepened on two separate occasions to a final depth of 1,210 m below surface and the old sinking compartment was converted into a cage compartment. In April 2001, a production winze was commissioned between 1050 level and 1340 level. This infrastructure allowed mucking below the elevation of the crusher to be carried out more productively, thus extending the depth, and life, of the mine. The -15% decline drift, or ramp, which permits mobile equipment to access all the mine levels, extends from surface to the 1560 m level. The lowest developed level in the mine is at the 1550 m elevation.

3.1.1 Site Facilities

Other than the transportation requirement for materials and supplies necessary to sustain the workforce and industrial operations, the Lupin site is completely self-contained and relatively compact (Figure 2). There are two main areas of the camp: the residential complex consisting of accommodations, kitchen and recreation centre; the industrial complex comprised of milling and maintenance areas, head frame, hoist room, powerhouse, warehouse and office facilities. The freshwater pump house is situated approximately 1.6 km northwest of the camp, on the shore of Contwoyto Lake (Figure 4).

In association with the above, there are a number of support areas consisting of shops and yards (maintenance, surface, backfill, carpentry), storage/laydown areas (cold storage buildings, two fuel tank farms); camp sewage facilities (Figure 4), mill tailings line, and a weather/aircraft control office with exploration shack. Only the main tank farm is currently being used for the storage of bulk fuel. The Tailings Containment Area (TCA) is situated approximately 3 km south of the mine site (Figure 3). The only physical connections between the TCA and the mine site are a road and the 8 inch diameter insulated tailings line, used to transport the tailings slurry from the mill to the deposition point in the tailings cells (Figure 2). The explosives magazine is located approximately 2 km west of the TCA and is accessible by road from the TCA road network (Figure 2). There are currently no explosives on site.

3.1.2 Mining

Shaft sinking began in 1982 to an original depth of 370 m below the surface collar. The shaft has been deepened twice since then, first to the 780 m elevation during 1984-86 and the second time to its final depth of 1,210 m during 1988-90. The 2-drum ASEA production hoist, originally installed in 1987, was upgraded to 1,720 hp in 1992. This allowed 10-tonne capacity skips to be hoisted in the two skipping compartments. In 1992, the manway compartment above the 250 m level and the sinking compartment below the 250 m level were converted to a cage compartment. The hoistroom was modified to accommodate a fully automated cage hoist. There is currently not access to the underground by the shaft as the doors are welded shut.

The Lupin Mine is also serviced by an access ramp, which extends from surface to the bottom of the mine. For the most part, the ramp is a closed spiral and is located under the plunging south nose of the ore body. The 5 m wide x 3.5 m high ramp grades at -15% over its entire length. The termination of the ramp is at the 1,560 m level horizon. The ramp provided for movement of men and materials within the mine and allowed for efficient deployment of resources as required. The ramp has been sealed with a soil and rock plug and a lock fence installed to prevent access during the current phase of care and maintenance.

A 1,000 hp, 84 inch diameter Joy axivane fan mounted on surface, supplies fresh air to the mine via a 3 m diameter fresh-air raise. A similarly sized Joy fan is also mounted on surface, over a 3.4 x 3.4 m raise, and helps exhaust contaminated air from the mine.

Almost all of the lateral and ramp development at the Lupin Mine was accomplished with electric-hydraulic drills and diesel scooptrams. A number of sublevels were developed with pneumatic drills and slushers during the last few years.

Standard mechanised drift dimensions were as follows:

- Ramp: 5.0 m wide x 3.5 m high, -15%;

- Access Drifts: 4.6 m wide x 3.5 m high;
- CZ Ore Drifts: 4.0 m wide x 3.5 m high +2% grade; and
- WZ Ore Drifts: 2.0 m wide x 3.2 m high +2% grade.

Raises up to 20 m in length (stope slots, millholes, vent raise extensions) were driven by conventional open raising methods, longhole drop raises or longhole inverse raises. Longer raises were driven with an Alimak or raise boring machine.

Production at the Lupin Mine began with sublevel longhole open stoping in the Centre and East Zones. Stope heights were typically 80 m and were as long as the strike of the ore body. Every fourth sublevel was developed as an extraction horizon complete with a haulageway, drawpoints, ore pass and waste pass. All of the mining above 810 m in these two zones was done by this method. The West Zone is the narrowest zone at Lupin. It was first mined by shrinkage and later by a 'Raise Platform Mining' method, which involved driving closely spaced raises and then breasting between them from an Alimak raise climber. This method was in turn replaced with sublevel longhole stoping similar to the Centre Zone but utilizing much smaller equipment.

As mining progressed to greater depths and the accumulated volume of stope excavation increased, rock stress and ground control issues became an increasing concern. The stoping method was modified to integrate both waste and paste backfill into the mining cycle. Stope dimensions were decreased in both height and strike length as one technique used to control dilution. The method involved longitudinal retreat mining 20 m high panels over a relatively short strike length (20 m maximum in the Centre Zone and 15 m in the West Zone), remote mucking the stope empty, then filling with paste before mining the adjacent panel. This mining method has been used at the mine since 1995.

The paste backfill plant was commissioned in October 1994 and was one of the first such systems operating in Canada at that time. The process involves taking the filter cake from the second stage filters in the mill (tailings), conveying it to the paste plant where it is mixed in a pan mixer with cement and water to create the paste. The paste is pumped to the shaft utilizing one of two positive placement pumps. Once delivered to the shaft, the paste flowed by gravity through the 6 inch diameter fill line and was distributed throughout the mine. Design capacity of the paste system was 120 short tonnes per hour. Between January 1995 and December 2004, over 1.8 million tonnes of paste backfill, equating to more than 30% of all tailings produced by the mine in that time period, were placed in the underground stopes. The paste backfill plant was decommissioned and removed from site following 2004. There are no paste backfill holes to the underground workings.

During the last few years of mining, the crown pillars of the Lupin Mine orebody were recovered. The crown pillars were the portions of the East, Centre and West zones between surface and 27 m level, that were left behind when the initial mining was carried out. The East Zone crown pillar was recovered in 1997 and completely backfilled with waste rock and non-hazardous waste material in 1998. Mining of most of the Centre Zone crown was completed in 2003 and it was backfilled with pastefill that same year. A small portion of the Centre Zone crown pillar was mined during 2004 and remains open for the deposition of non-hazardous waste material. The West Zone crown pillar was mined between 1996 and 2004, and has been left open for the future disposal of demolition debris and soils. The crown pillar openings will be completely filled in, and the surface capping material contoured, during reclamation activities at the mine site.

The winze and underground mine equipment were removed from site when the mine entered care and maintenance in 2006. All hazardous materials were removed from the underground workings. Any equipment left (disposed of) in the underground workings was drained of fluids.

Mine water from the underground workings has been discharged either into the TCA or into the sewage lakes system in accordance with Part E(12) of the Water Licence. Mine water chemistry will be reported to the NWB prior to dewatering of the workings.

3.2 Metallurgical Processing

The Lupin Mine milling process remained basically consistent throughout the life of the mine. It utilized the Merrill-Crowe process for gold recovery, whereby a powdered zinc mixture is added to a gold bearing cyanide solution to precipitate out the gold. Lead nitrate is used in low doses to activate the zinc. The gold precipitate is then dried and melted in a furnace, and poured into dore bars. All metallurgical reagents, with the exception of lime, have been shipped off site during the current care and maintenance phase. The mill was given a complete wash down with the intent of gold recovery (visible gold that settles within the system) and removal of any residual contaminants (from chemical use) to the tailings impoundment prior to the current care and maintenance phase. The crushing, grinding, pre-aeration, leaching, filtration and recovery stages are described below.

3.2.1 Crushing

The ore from the mine was crushed underground to 5.5 inch by a primary jaw crusher. It was then skipped to a 600-tonne coarse-ore bin on surface. A vibrating feeder and conveyor belt transported the ore to a secondary cone crusher. After being reduced to -1.5 inch, the ore passed over a double-deck vibrating screen. Any material larger than 5/8 inch was fed into the tertiary cone crusher and re-circulated over the vibrating screen until it passed through the 5/8 inch openings. The ore passing this screen was conveyed to two 1,000-tonne fine ore bins, which fed the grinding circuit. The crushing circuit had the capacity to operate at a rate of 240 tonnes per hour.

3.2.2 Grinding

Liberation of the gold from the host rock was done by further reduction of the ore size. This was accomplished with a 9.5 foot diameter by 12 foot long rod mill feeding two 8 foot by 24 foot long ball mills in parallel. The ore was fed into the rod mill from the fine ore bins via belt feeders and conveyors. The ball mill discharge slurry was pumped to a common ball mill discharge or cyclone feed pump box, then to a cluster of cyclones which classifies the material. Cyclone underflow (+200 mesh material) was fed back into the ball mills. The cyclone overflow slurry (-200 mesh material) was pumped to the pre-aeration circuit at about 30% solids. The grinding circuit operated at a maximum rate of 2,300 tonnes per day, with the target-grind being 57% passing -400 mesh.

3.2.3 Pre-Aeration

The cyclone overflow was fed to the center well of the pre-aeration thickener, a 50 foot diameter shallow settling tank. The thickener overflow solution flowed by gravity to the recycle water tank and was recycled back to the grinding circuit. The thickener underflow slurry (60% solids) was pumped to the first of three 82,000 USG pre-aeration tanks. These tanks provided air to oxidize sulfide minerals, which would otherwise consume large amounts of cyanide and oxygen, thus hindering the leaching reaction. The circuit was tuned for efficient mechanical and chemical performance by operating under alkaline conditions (pH 10), adding lead nitrate reagent, and by using primary filtrate to dilute the thickener underflow density to 45% solids.

3.2.4 Leaching

The liberated gold particles were leached into solution through the reaction of cyanide, oxygen and water. Slurry from the pre-aeration circuit was leached in six consecutive agitated and aerated tanks. Lime was added to the circuit to maintain a constant pH of about 10. These six tanks in series gave the circuit 30 hours of retention time. The overflow from Leach Tank No. 6 feeds the cyanidation thickener. Thickener overflow solution is loaded with gold and flowed to the pregnant solution tank. The underflow, also containing some gold in solution, was pumped to the filtration circuit.

3.2.5 Filtration

A two-stage filtration system separated the dissolved gold from the waste solids of the cyanide thickener underflow. Each stage consists of four vacuum drum filters 8 ft in diameter and 14 ft long. In the first stage, the cyanidation thickener underflow slurry contacts the outside of the filter unit and the solution is drawn through the filter while the filter cake is washed with barren solution. The solution is returned to the cyanidation thickener or pumped to pre-aeration as dilution water. The filter cake passes through a repulper to a second stage. The second stage filter cake is washed with either barren or raw water and the solution is again returned to the cyanidation thickener. The filter cake is repulped with barren or raw water and flows by gravity to the tailings disposal pump box.

3.2.6 Recovery

The pregnant solution from the cyanidation thickener overflow was clarified and de-aerated, precipitated and refined to obtain dore bullion in a conventional Merrill-Crowe system. Three pressure clarifiers removed suspended solids from the solution, and then the oxygen was removed prior to precipitation in a de-aeration or Crowe tower. Zinc dust was added to the clarified de-aerated solution and the precipitated gold was collected in precipitation presses. The now barren solution was bled to tailings and recirculated throughout the plant. Once the filter press became loaded with precipitate, the feed was transferred to the other presses and the loaded press was emptied. After being mixed with suitable fluxes, the precipitate was smelted in the bullion furnace to produce dore bullion and slag. The slag was returned to the mill to be reprocessed. The bullion contained approximately 85% gold and 12% silver, the balance being base metals.

3.3 Tailings Containment Area

3.3.1 Description

The TCA is located approximately 6 km south of the Lupin Mine, and covers an area of about 361 ha within the 750 ha lease. The containment is divided into three main components: solids retention cells (cells 1 through 5), polishing ponds (Pond 1 and Pond 2) and the End Lake area (not used).

A detailed history of the design and operation of the TCA is contained in the attached Holubec (2005) report (Appendix B). The tailings facility consists of multiple frozen core perimeter dams. During active operation, the tailings management philosophy involved discharge of tailings into a closed system that allowed for solids accumulation and some supernatant water storage within five main cells, and treatment of water prior to discharge into the environment.The cells within the impoundment allow for separation of the liquid from the solid tailings as well as providing treatment through natural degradation (Figure 3). Currently, Cells 1 and 2 have been covered and retain only ponded precipitation in low lying areas of the cover. Contouring of the cover on Cell 1A directs run-off and precipitation on Cell 1A to a surface water conveyance ditch across Dam 3. Cell 3 has capacity for a small amount of run-off and precipitation and is directed into Cell 4. Cell 4 has acted as a water management pond, retaining water within the system prior to releasing it into Pond 1. Cell 5 retains run-off and precipitation, with water directed into Pond 1.Supernatant water and runoff storage occurs within one of two ponds – Pond 1 and Pond 2. Pond 1 acts as a buffering pond to manage the water chemistry. A water treatment plant (see section 3.3.2) is located between Ponds 1 and 2, and was used during operations to treat the water in Pond 1 prior to discharge into Pond 2. Pond 2 is the last point of control prior to discharge into the receiving environment. Water is managed in Cell 3 and Cell 5 and Pond 1 through pumping and the use of syphons, while Cell 4 maintains a gated culvert. Syphons are used to discharge water from Pond 1 into Pond 2, and from Pond 2 into the receiving environment. Pond 2 has no flood overflow structure, but is required to maintain a minimum 1.0 m of freeboard at all times.

The TCA is impounded through natural terrain relief and a series of engineered retaining structures. The main water retaining perimeter dams are Dam 1A and Dam 2, which contain Pond 2, and Dam 4 in Cell 4. Dams 5 and 6 within Cell 3 are low level dams. No tailings has been impounded against Dams 1B, 1C, or 5. The tailings impounded against Dam 3 (Cell 1A) and Dam 6 (Cell 3) was covered by 1 m of esker material. A design to raise Dam 6 was completed in 2003 (BGC, 2003) to increase the tailings capacity in Cell 3; however this raise was never constructed. The surface water conveyance ditch on Dam 3 was relocated in 2010 (TBT, 2010).

All perimeter dams have been designed with a geomembrane liner for initial control of seepage and to promote the establishment of permafrost within the dams. Temperature monitoring of the dams (based on installed thermistors) shows that the cores remain frozen year-round (Figure 3). K-Dam, which is an internal structure, was also designed with a synthetic liner for initial seepage control. A tailings beach, approximately 10 m in depth, has been placed on the upstream side of this dam and temperature monitoring indicates that the core remains frozen year-round.

Tailings Cells 1 and 2 are separated from Pond 1 by Dam 3D. The stability of this esker fill dam was enhanced in 1995 by the addition of a 10 m wide downstream berm, constructed of 75,000 m^3 of quarried waste rock, placed at a slope between 1.5H:1V to 2.0H:1V. The addition of this waste rock has also increased the erosion protection of the dam.

Ponds 1 and 2 are separated by J-Dam, which was constructed with esker material and mine development waste rock. Buried HDPE pipes in J-Dam currently act as an overflow structure from Pond 1 into Pond 2, reducing the risk of overtopping should the dam freeboard be encroached.

Table 6 provides a summary of perimeter and internal dams associated with the TCA. The geotechnical conditions and routine maintenance of the perimeter dams has been reported in the annual geotechnical inspection reports. Commencing with the 2012 annual geotechnical report, the geotechnical conditions of the internal dams has also been reported.

Table 6 Perimeter and Internal Dams.

Perimeter Dams	Internal Dams
Dam 1A	Dam 3D
Dam 1B	J Dam
Dam 1C	K Dam
Dam 2	L Dam
Dam 3	M Dam
Dam 4	N Dam
Dam 5	Divider dyke
Dam 6	

As part of ongoing restoration activities, and as described in the 1988, 1995, 2003, 2004 and 2005 Annual Reports to the Nunavut Water Board, Lupin has continued to cover the exposed tailings in completed cells with between 1.0 m to 2.0 m of esker material. To date, approximately 1,280,000 m^2 of exposed tails have been covered. It was planned to cover the remaining exposed areas, approximately 241,000 m^2, in 2006; however, due to the premature shutdown of the 2006 winter road, Lupin did not receive enough fuel to carry out the program in 2006. There remains approximately 155,000 m^2 in Cell 5 and 86,000 m^2 in Cell 3 of exposed tailings. The remnant areas of exposed tailings are saturated for most of the year and are available to be used upon mine restart. The Lupin property was then sold to a new operator and measures for final closure and reclamation of the TCA were halted.

The mine has remained on care and maintenance since 2005 and general site maintenance and facilities upgrades have been completed to assess operational requirements for resuming production that would involve resuming disposal of tailings in the TCA. There have been infrequent inspections and data collection to access the performance of the soil covers during this period. LMI has discussed the inclusion of monitoring cover performance with the engineers responsible for the annual geotechnical inspections, and is intending that this be included as part of the on-going annual inspections.

3.4 Support Infrastructure

Accommodation Facilities

The major component of the accommodations is the sleeping and eating quarters which consist of over 200 modular units and separately framed areas to form the complex. In 2012 and 2013, 150 rooms were refurbished. The other components consist of recreation and gymnasium facilities which are steel frame/metal clad construction.

Freshwater Supply

The freshwater for the site is obtained from Contwoyto Lake approximately 1.5 km from the complex. A causeway/breakwater extending out into the lake supports a pumphouse building and docking facilities.

The fresh water supply pumps were decommissioned in 2006 in preparation for the temporary closure of the mine. The pumps are currently stored at the mine site and were refurbished in 2013 in preparation for reinstallation. When the pumps are not in place, freshwater is trucked from the breakwater on Contwoyto Lake to a water storage tank at the accommodation buildings.

Arsenic Treatment Facility

This facility, a steel frame/metal clad building, is located at the TCA between Ponds 1 and 2, at the south end of J-Dam. It was used for mixing of reagents (ferric sulphate and lime) for water treatment operations during the early 1990's and has been inactive since 1996 and partially decommissioned. All remaining components were flushed after use.

Explosives Magazine

The explosives storage magazine is located 2 km west of the TCA and consists of 2 steel-frame/metal clad buildings for ANFO storage, and historically numerous Sea-Containers for the storage of stick powder and other blasting products. There are currently no explosives on site and no Sea-Containers at the explosives magazine.

Roads and Airstrips

A considerable amount of roadway exists at the TCA, with the largest portion being the access to the explosives magazine and the access to the Fingers Lake esker (Figure 5). The roadways are constructed in part with mine development waste rock.

The old airstrip used during construction had been used as a laydown area since the new airstrip was built. This area was slowly phased out as a storage location and in 1998 the gravel/esker fill strip was graded to conform to the natural landscape with cuts and backsloping applied where necessary to promote natural drainage and reduce erosion. The surface was scarified utilizing a grader with a ripping attachment.

The main airstrip is 6400 ft in length and is constructed of crushed waste rock produced from development underground. The drainage course in the area has been altered slightly in a lateral direction, however all runoff from both the east and west sides of the strip report in a northerly direction, eventually to Contwoyto Lake. The airstrip fueling facility has been removed and the area reclaimed.

Fingers Lake Esker

The sand and gravel used for road and dam construction, as well as the cover projects in the TCA, is obtained from the Fingers Lake esker located approximately 10 km south of the mine (4 km south of the tailings impoundment). The frozen nature of the material within the esker dictates that only shallow layers of material can be removed during excavation and hauling. In general this results in a larger area of the esker surface being disturbed but allows for easier restoration work upon cessation.

The esker material is well graded gravelly sand, composed of 59% sand, 38% gravel and 3% silt on average (Holubec 2005). The range of metal concentrations of potential chemicals of concern in the esker sand placed on Cell 3 are listed in Table 7 (SRK 2015).

Table 7 Range of metal concentrations of potential chemicals of concern in esker material.

Metal	Minimum mg/kg	Maximum m/kg
Arsenic	8	12.8
Cadmium	0.036	0.79
Cobalt	5.02	190
Copper	16.8	188
Lead	1.04	1.27
Molybdenum	0.17	0.33
Nickel	16.7	493
Selenium	<0.02	<0.02
Zinc	20.7	178

Sewage and Refuse Facilities

The sewage facilities consist of several lift stations within the camp and an 800 m long 6 inch diameter insulated steel pipeline to the first of two sewage lakes. Alternatively, when camp capacity requirements during care and maintenance do not warrants its use; sewage and grey water are collected in a sewage tank at the accommodation buildings. The tank is then hauled to the Upper Sewage Lake wherein waste is deposited. A sewage line to convey camp sewage directly to the Upper Sewage Lake may be utilized.

Grey water originating from log cabin (guesthouse or office cabin or manager's house) use may be deposited in an adjacent leach pit. All sewage is to be discharged to the Sewage Lakes Disposal Facilities.

A 'permeable' type dam with an emergency overflow and a syphon exist between the first and second lake. Discharge from the second lake is controlled by the use of syphons. Water accumulating in the Lower Sewage Lake is tested prior to discharge to the environment. Discharge procedures are described in the *Liquid Waste Management Plan*.

The refuse disposal area used at the site (the landfill) is located to the southeast of the mine and north of the second lower sewage lake. All non-burnable waste (scrap metal, plastics, residue from burning) historically were disposed of and buried with waste rock on a regular basis. A portion of this facility is utilized in accordance with the *Waste Management Plan (Solid and Hazardous)* and it's Appendix: *Landfill Management Plan* and the *Liquid Waste Management Plan*. The waste in the landfill is covered progressively during use.

On-going progressive reclamation at the Site is achieved with the operation of a landfarm. The landfarm is located on the foundation of the former paste backfill building. The facility is operated in accordance with the *Waste Management Plan (Solid and Hazardous)* and it's Appendix: *Landfarm Management Plan* and the *Liquid Waste Management Plan*. NWB approval of issued for-construction engineered drawings and is required before construction and operation of the facility can commence. Remediated soil will be re-used on site.

Tailings Lines

A steel tailings line exists between the mill complex and the Tailings Containment Area. The initial 6 inch line was removed in 2001. The newer 8 inch line extends the entire 6 km distance to the impoundment. The line extends further within the impoundment for an additional 2.5 km. Various small buildings along the line house valves for either dumping of the line to controlled sumps or switching flow direction. Development waste rock was used to construct part of the tailings line foundation.

Fuel Storage

The fuel storage facilities at Lupin include a main tank farm (including a system of 14 diesel tanks, 1 jet A tank and 9 individual tanks), a satellite tank farm (including a system of 10 diesel tanks and 2 gasoline tanks)and a waste oil tank farm (including 2 waste oil tanks). In addition there are five (5) glycol tanks on site and various individual tanks. Geomembrane liners were used for containment purposes.

In 2014 buried pipes were removed between the main tank farm and satellite tank farm. The fuel remaining in the satellite tank farm was used up in 2015.

Chemical Storage

During operations the mine has an inventory of chemicals which include; cyanide, lime, lead nitrate, zinc dust, flocculants and ferric sulphate in major quantities and miscellaneous refinery reagents in much lesser quantities. Of the chemicals listed, only lime is held on site during care and maintenance.

4 Requirement of an Abandonment, Reclamation and Closure Plan

On October 5, 2015, LMI was granted a new license, 2AM-LUP1520, which expires on August 18, 2020. The NWB approved the Interim Abandonment and Restoration Plan, dated March 2013; Part I(1) of the Water Licence. Part I(2) of the Water Licence requires an update to the plan referred to in Part I(1) to address relevant comments and recommendation provided by intervening parties and the NWB during the Water Licence renewal process.

4.1 Objectives of the Abandonment, Reclamation and Closure Plan

The objective of the Plan follows the *Mine Site Reclamation Guidelines for the Northwest Territories* (INAC, 2007) and the *Mine Site Reclamation Policy* (INAC, 2002) (Part I(2)). These guidelines will be adhered to; utilizing the objectives based approach outlined in the guide, ensuring that the global objectives (Physical Stability, Chemical Stability and Future Use and Aesthetics) are met. Furthermore, all regulations will be complied with to ensure that once abandonment and restoration has been completed:

- There is no danger to public health or safety;
- The requirement for long term maintenance and monitoring associated with the tailings area is minimal or nil;
- Contaminant loadings to the environment from the TCA are minimized or prevented;
- The cumulative degradation of abandoned areas affected by the mining activities is prevented, and natural recovery of disturbed lands is enhanced; and
- The affected areas will be returned to a condition that is compatible with the surrounding, original undisturbed area with respect to its future potential/productivity uses.

The Lupin operation has conducted progressive reclamation within the TCA since 1988. Kinross initiated a major tailings reclamation program in the summers of 2004 and 2005, in which the majority of the exposed tailings in the TCA were covered by a 1-m thickness of esker material. This project will recommence upon final mine closure.

5 Abandonment and Reclamation Plan History

The following provides background on the reclamation plan requirements for the Lupin Operation since construction/production began.

1983	Commercial production began and the first 'conceptual' Abandonment and Restoration Plan was submitted to DIAND to fulfill requirements of Water Licence N7L2-0925 and Land Lease No.'s 3593 and 3594. Revisions were requested clarifying certain areas of the plan.
1984	In December the Plan was re-submitted in two parts: 1. Part 'A' was prepared by consultants Reid Crowther and Partners Ltd. and contained a review of current technologies for reclamation applicable to the Lupin Mine as well as potential problems and conditions that may develop as a result of the operation. 2. Part 'B' was prepared by Echo Bay Mines Ltd. and outlined the plan of action with respect to the conditional requirements outlined in the Water Licence and the Federal Land Leases.
1985	The Plan was resubmitted to include revisions required under the amended Water Licence and was accepted with the exception of the plans for the TCA. Regulatory authorities indicated that it would be unwise to commit to a specific plan of action at that time due to advancing technology and the anticipated mine life.
1987 - 1995	Annual updates and revisions to the Plan were submitted for approval along with the results of various studies/reports undertaken during operations. A complete revision of the plan incorporating new information/changes in scope was not requested until the 1995 Water Licence renewal.
1995 - 2000	Licence renewal granted on June 01, 1995 by the NWT Water Board and a revised 'Interim' Abandonment and Restoration Plan was submitted in January 1996. Annual updates and revisions to the Plan were submitted to the Board for approval along with results of various studies completed to date. Transfer of authority to the Nunavut Water Board.
2000	Licence renewal granted on June 01, 2000 (NWB1LUP0008) by the Nunavut Water Board, with expiry on June 30, 2008.
2001	Approval of revised Interim Abandonment and Reclamation Plan.
2001 – 2005	Annual updates on progressive reclamation activities, and the results of various studies completed to date, were provided to the Board.
2005 - 2006	Final Abandonment and Restoration Plan for the TCA was submitted June 2005. Response to technical comments on the TCA Plan submitted 31 March 2006. Outstanding issues were identified by regulatory authorities in April and May 2006 following a technical meeting. Due to the sale of LMI no further revisions to the TCA Plan were

made.

2006 After sale of LMI the Site continues under care and maintenance and final reclamation activities halted while future mining and milling options are explored. Annual update on progressive reclamation activities were provided to the Board.

2007 A revised Plan was submitted November 2007.

2008 Annual update on progressive reclamation activities was provided to the Board.

2009 Licence renewal granted on 25 February 2009, as amended 25 May 2009 (2AM-LUP0914) by the Nunavut Water Board, with expiry on March 31, 2014. An updated Plan was submitted June 2009 along with various studies completed to date.

2010 A revised Plan was submitted March 2010 that addressed deficiencies in the 2009 Plan along with various studies completed to date.

2011 Annual update on progressive reclamation activities was provided to the Board.

2012 Update to the Plan was submitted to the Board for approval along with results of various studies completed to date.

2013 A revised Plan was submitted to the Board for approval along with the results of studies completed to date in advance of the water licence renewal process April 2013.

2014 An application to renew the water licence was submitted to the Board February 28, 2014. The Plan was reviewed during the Technical Meetings held on October 22 and 23.

2015 Comments were received about the Plan at the Public Hearing held February 4 and 5. Licence renewal granted October 5, 2015 (2AM-LUP1520) with expiry of August 18, 2020.

2016 Plan updated to reflect comments and recommendations made during the renewal process as required under the renewed water licence.

6 Planned Abandonment, Reclamation and Closure Activities

The facilities and specific disturbed areas of concern with regard to the Lupin Mine that require abandonment, reclamation and closure activities and special management are covered in the following section. The goal of specific restoration practices is to minimize, or preferably eliminate degradation of disturbed areas and to initiate, encourage and accelerate the natural recovery.

6.1 Building and Contents

6.1.1 Mill Complex; Mill, Administration, Maintenance, Powerhouse, Warehouse

Mill

Upon cessation of operations, the mill portion of the complex will be given a complete wash down with the intent of gold recovery (visible gold that settles within the system) and removal of any residual contaminants (from chemical use) to the tailings impoundment. The crusher area is normally washed down on a regular schedule while operating, and will also be completed at closure.

All equipment and internal components from the mill would be dismantled and removed from the building. These would either be transported off-site for use at other facilities or salvaged where possible. Non-hazardous materials with no salvage value will be deposited at the open stope and buried. The metal frame structure will be dismantled and salvaged where possible. Concrete foundations will remain in place. The floor will be covered with soil and contoured to be similar in nature to the surroundings and to provide positive drainage. All concrete footwalls which interfere with final grading of the soil surface cover will be collapsed.

Paste Backfill Building

The steel frame structure has been removed and equipment from the plant removed for resale or salvage. The residual waste cement will be disposal within the mine workings. The concrete floors and footwalls will be managed in a similar fashion to the mill.

Administration/Warehouse

These areas will have all salvageable/hazardous materials removed prior to dismantling. Demolition will take place in a similar fashion to the mill building and all materials that cannot be salvaged will be disposed of into the mine workings.

Powerhouse

The powerhouse facility remains to provide power requirements for operation of major power consumers (i.e. mill, hoist). It will remain for a reasonable time frame to support the reclamation process (i.e. during disposal of waste underground). A staged dismantling and removal of salvageable equipment will take place ending with limited power generation in the latter stages. The emergency power house will remain to provide power requirements during later stages of reclamation. The camp generators located adjacent to the 600 wing of the accommodation buildings will provide sufficient power generation during final closure. An emergency back-up generator for the camp generator is in place during care and maintenance.

Power distribution throughout the site is both above and below ground. Power lines would all be removed for salvage or disposal. Transformers containing low level PCBs were transported off site in 1994. No other PCB material is known to be at Lupin.

6.1.2 Other Major Buildings

Maintenance and Shops

All outbuildings will be evacuated, inspected for hazardous materials and dismantled for salvage or disposal. These include the carpentry shop, surface storage garages, mobile maintenance shop, warm and cold storage shops.

Explosives Magazine

The explosives storage magazine consists of a steel frame/metal clad building. During care and maintenance ANFO has been removed from the site. The numerous Sea-Containers used for the storage of stick powder and other blasting products have been removed from site. Any ANFO brought on site would be removed and the main building would be dismantled and transported to the Lupin site. Any Sea-Containers would be decontaminated if required at the tailings ponds and stored at the main compound for transportation uses. Surplus inventory of ANFO will be returned to the supplier or sent to other operations. Consideration will be given to utilizing surplus ANFO within the hydrocarbon landfarm treatment facilities to support bioremediation.

Accommodation Facilities

The steel frame buildings would be dismantled and removed from site or disposed of within the underground workings.

Arsenic Treatment Facility

The steel frame/metal clad building will be removed from the TCA and disposed of within the surface landfill located at the mine site. All remaining components will be rewashed and salvaged, if economical, or disposed of in the surface landfill.

6.2 Infrastructure Support

Freshwater Supply

Upon closure the building, electronics, pumps and approximately 1.5 km of six inch insulated pipeline will be removed and salvaged where possible. The docks will be removed, however the breakwater and causeway will be left in place due to the increased disturbance that the lake would incur during removal. Non-salvageable materials would be disposed of within the mine workings.

Tailings Lines

The tailings line will be flushed thoroughly with clean water prior to being dismantled along with associated buildings. If salvageable, the pipe will be sold or reused in another application. If salvage is not viable, the piping would be disposed of within the mine workings along with the debris from the associated buildings.

The tailings line foundation will be generally left intact with the exception of areas where drainage is controlled by culverts. The removal of culverts and the backsloping of the opening would ensure that minimal erosion takes place and proper drainage is achieved. Any other areas of water pooling along the tailings lines during spring melt would be opened up to provide unlimited drainage. The management of PAG material in the tailings line foundation and elevated metal concentrations in the adjacent soil is described in Section 6.4.

In addition to the tailings lines there are two dump stations (shallow sumps) located along the tailings line route. These stations allow the emergency dumping of line contents in the event of an unplanned mill shutdown. These stations will be cleaned of all existing tailings materials which will be disposed of at the TCA. Berms would be flattened and pushed into the depressions to become consistent with the surrounding topography. The management of PAG material at the dump stations is described in Section 6.4.

Fuel Storage

Any fuel remaining on site at the time of closure will be removed from site. The empty tanks would then be withdrawn from service and disposed of in accordance with the *Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations* (2008) under the *Canadian Environmental Protection Act*. Currently, the satellite tank farm is not being used to store fuel.

The tank farm areas would be stripped of any fuel laden sand to be remediated on-site, either through bioremediation or by being consolidated and covered and or disposal in the underground workings. Materials (esker sands) that contain residual hydrocarbons will generally be subjected to treatment by volatilization through aeration and bioremediation with nutrient amendments of nitrogen and phosphorus or burial on site. The Federal *Guidelines for Landfarming Petroleum Hydrocarbon Contaminated Soils* (2006) will be consulted during the development of the soil treatment plan.

The underlying geomembrane liner material would be disposed of within the mine workings or utilized below a soil cover in the landfill. Foundation material would be surveyed for hydrocarbon contamination. An evaluation of options for dealing with hydrocarbon contamination in the underlying waste rock will be assessed with the PAG rock as described in Section 6.4. The remainder of the site would be graded to conform to the surrounding natural topography and to provide positive drainage.

An assessment to evaluate the environmental quality of the soil and water at the Site was conducted in 2005 (Morrow 2006). The environmental site assessment identified specific areas on the mine site where the soil is contaminated with hydrocarbons. 14,000 m^3 of hydrocarbon contaminated soil was estimated to be present in the fuel storage areas (Morrow, 2006). The site entered care and maintenance shortly after the assessment was completed. An additional environmental site assessment will be carried out prior to mine closure in an effort to quantify and qualify the impacts due to fuel, oil or other chemical spills and to further inform the PAG waste rock options evaluation. The development of site-specific soil quality remediation objectives for petroleum hydrocarbons, such as those approved for by the NWB at the Nanisivik Mine in 2015, will be considered (Hemmera, 2015). All impacted areas will be remediated according to the Nunavut *Environmental Guideline for Contaminated Site Remediation* (2009).

In addition to impacted material located within fuel storage areas, any on site areas identified as impacted during abandonment and restoration (i.e., visible staining due to chemical spillage) will be remediated according to these same contaminated site remediation guidelines.

Where the results of spills or incidents pose an immediate or ongoing risk to the environment, LMI will employ the *Spill Contingency Plan* and clean up or remediate soils or other species in a timely manner, prior to final reclamation.

Chemical Storage

The mine site has carried an inventory of chemicals which include; cyanide, lime, lead nitrate, zinc dust, flocculants and ferric sulphate in major quantities and miscellaneous refinery reagents in much lesser quantities. It is expected that any reagents brought on site would be consumed through normal usage during final operations. Inventory that remains would be sold to an alternate user or returned to the supplier. Any chemicals that could not be removed through these methods would be disposed of in an environmentally acceptable manner in accordance with current regulations and guidelines.

The grounds in the immediate vicinity of the chemical storage areas including the floors of the cold storage buildings are comprised of crushed waste rock. These areas were sampled during the 2005 environmental site assessment. Elevated hydrocarbon and metal concentrations in soil and groundwater were detected (Morrow 2006). An evaluation of options for dealing with hydrocarbon and metal contamination in the underlying waste rock will be assessed with the PAG rock as described in Section 6.4. An additional environmental site assessment will be carried out prior to mine closure in an effort to quantify and qualify the impacts due to fuel, oil or other chemical spills and to further inform the PAG waste rock options evaluation. The development of site-specific soil quality remediation objectives will be considered. All impacted areas will be remediated according to the Nunavut *Environmental Guideline for Contaminated Site Remediation* (2009).

Roads and Airstrips

A considerable amount of roadway exists at the mine with the largest portion being the access to the explosives magazine and the access road to the Fingers Lake esker. The roadways are constructed in part with mine development waste rock. The management of PAG material in the roadways is described in Section 6.4. The environmental site assessment conducted in 2005 indicated that the median arsenic concentration in the roadways was 136 mg/kg and that the background concentration for the Lupin area was 179 mg/kg (Morrow 2006). Based on the preceding, the site roads will be reclaimed without a soil cover. In order to gain a better understanding of the ecological implications of this reclamation strategy, a risk assessment will be conducted to evaluate the likelihood of adverse ecological/environmental effects occurring based on future use of the property. The risk assessment will be completed during final reclamation and closure planning. Site-specific soil quality remediation objectives for metals would be derived from the ecological risk assessment.

All roadways will be generally left intact with the exception of areas where drainage is controlled by culverts. The removal of culverts and the backsloping of the opening would ensure that minimal erosion takes place and proper drainage is achieved. Any other areas of water pooling along the roads during spring melt would be opened up to provide unlimited drainage.

The roadways are probably the third most prominent feature change (next to the TCA and Mine Site) at the mine and will remain clearly visible for an indefinite period of time. In order to promote natural growth of vegetation, the road surfaces would be scarified to provide microclimate sites for seed deposition.

Removal of the main airstrip will not be carried out, however, access roads will be cut and backsloped to allow uninhibited drainage along its parallel. All ancillary equipment including signs, marker lights, strobes (associated wiring) and weather station/traffic control building will be dismantled and removed. The major components consisting of the radio beacon VOR (VHF Omni Range) and tower (Non-direction Beacon) will be removed unless other arrangements are made through the Department of Transportation and/or the City of Yellowknife.

6.2.1 Sewage and Refuse Facilities

Upon closure of the sewage facilities, the steel pipeline would be flushed with clean water, dismantled and removed from the site for reuse or sold for salvage if economically feasible. Components with no salvage value would be disposed of within the mine workings. The dam structure between the upper and lower sewage lakes would be breached at the culvert location (lowest natural location) and backfilled with rip-rap (waste rock) to provide erosion control. Dam slopes would be graded to reduce erosion at the water level. A spillway would be constructed in the dam at the lower lake.

The refuse disposal area used at the site (the landfill) will be utilized until restoration is near completion. At this time the area will be covered with waste rock/esker sands and graded to promote diversion of surface runoff, prevent water ponding on the surface, provide erosion control around the perimeter and protect human and ecological health. The management of any PAG material at the landfill will be addressed with the options evaluation described in Section 6.4.

The incinerator will continue to be used to incinerate combustible, inert solids during closure and reclamation in accordance with the *Waste Management Plan (Solid and Hazardous)*.The incinerator will be dismantled for salvage or disposed of with other scrap metal. The concrete block building will be dismantled and disposed of on-site.

Following successful remediation of soil to the applicable environmental quality standards in the landfarm facility, the treated soil is to be reused for site maintenance and soil cover. When the soil treatment facility is no longer in use it will be decommissioned and the underlying concrete pad covered with soil and contoured to inhibit the ponding of water.

6.2.2 Quarry: Fingers Lake Esker

The quarry material used for road and dam construction as well as the cover projects in the TCA is obtained from the Fingers Lake esker located approximately 11 km from the mine or 3 km from the tailings impoundment. The frozen nature of the material within the esker dictates that only shallow layers of material can be removed during excavation and hauling. In general this results in a larger area of the esker surface being disturbed but allows for easier restoration work on cessation.

After completion of restoration plans at the mine and tailings impoundment, the final contour of the esker will be developed to be compatible with the natural topography and control potential erosion through sloping. The surface will be ‘roughed’ with dozer cleats or otherwise scarified to enhance the natural re-establishment of indigenous vegetation.

6.3 Underground Mine

The Lupin underground workings include a 1,210 m vertical shaft and a decline to a depth of 1,250 m. A secondary hoist system (WINZE) was installed in 2001 allowing hoist access to 1,340 m. The current mine depth is 1,410 m with potential deepening to 1,640 m. Incorporated into the underground facility are maintenance shops, an electrical shop and a primary crushing station. Once mining has been terminated, all equipment will be considered for recovery and shipment to another site for reuse or sold for salvage value.

Where salvage is not economical, all equipment and materials will be inspected for, and any hazardous materials (e.g. batteries, fuel, lubricants etc.) removed, prior to being abandoned within the mine. The hazardous materials, as mentioned, would be treated on-site or shipped off site for disposal. Equipment and hazardous materials were removed from the mine when the mine entered care and maintenance in 2006.

Materials to be left in-place, as is, are those related to the structure of the mine and shaft/raises, the shop facilities and crusher facilities (with motors etc. removed). Prior to backfilling and sealing any raises or portal, all non-hazardous wastes generated through the closure activities that are considered to be uneconomically salvageable (buildings, equipment, etc.) would be dismantled and disposed of via these routes into the mine workings. All materials would be washed (e.g. mill components) and inspected (e.g. mobile equipment for batteries, lubricants, other hazardous materials) prior to disposal. Any materials being moved to the underground openings will be compacted as much as possible prior to being placed in a disposal location. If it is determined that rockfill bulkheads be placed at various levels to encourage water movement away from the disposal levels, then construction of these may take place prior to final closure of the mine.

All portals, raises, shafts or other entrances to the underground mine will be sealed using engineered concrete plugs and caps to prevent access. Backfilling of the openings would utilize waste-rock from surface and esker material for final cover and graded to conform with the surrounding area.

6.4 Waste Rock and Soil Remediation Objectives

The production of waste rock was considerable during the early development stages of the mine and a stockpile was generated. In the latter stages of the mine life excess waste rock generation has been lower and the waste rock produced is normally moved to other areas of the underground workings as backfill material. Very little development takes place within waste during operations.

Waste rock has generally been used throughout the site as roadbed materials, in dam construction, airstrip stabilization, underground backfill, laydown yards or for other purposes such as building foundation preparation. Approximately 1,000,000 m^3 of rock have been placed on surface (URS 2005).

In 2004 samples were collected from waste rock deposited in roadbeds, tailings dams, the airstrip and the mill complex pad. The material sampled was generally the coarse cobble fraction of the waste rock. 30% of the waste rock samples had sulphide concentrations above 0.3%; however only one of these samples had an acidic paste pH. The results of the 2004 program showed that a portion of the Lupin waste rock had the potential for acid generation. The alkaline pH values of the waste rock indicated acid generation had not yet occurred, even in those samples considered potentially acid generating (URS 2005). The median concentration of arsenic in the development waste rock is 1,140 mg/kg and that approximately 35% of the development rock is capped with sand and gravel cover 0.15 m or thicker (Morrow 2006). The data set evaluated included the analysis of coarse rock fragments. The analysis of coarse rock fragments does not directly indicate what impacts the waste rock may have on the receiving environment. An assessment to evaluate the water quality of seepage from waste rock at the mill/mine complex was conducted in 2005. 40% of the seeps sampled in 2005 were acidic (Morrow 2006).

An evaluation of options for dealing with the PAG waste rock is required to support the development of the final reclamation and closure plan. Should the preferred option require segregation of the PAG rock further work will be required to assess methods for identifying this material during excavation. For the purposes of this interim plan it is assumed that 40% of the waste rock is PAG.

Soil with elevated concentrations of metals (including arsenic) will be managed on a risk-based approach in accordance with the Nunavut *Guideline for Contaminated Site Remediation* (2009). The risk assessment will be completed during final reclamation and closure planning. Management options for soil with elevated concentrations of metals include disposal in the TCA, consolidation and burial or disposal in the underground workings. The environmental site assessment conducted in 2005 indicated that the background concentration for the Lupin area was 179 mg/kg (Morrow 2006). Site-specific soil quality remediation objectives for metals would be derived from the ecological risk assessment.

The development of site-specific soil quality remediation objectives for petroleum hydrocarbons, such as those approved for by the NWB at the Nanisivik Mine in 2015, will be considered (Hemmera, 2015). All impacted areas will be remediated according to the Nunavut *Environmental Guideline for Contaminated Site Remediation* (2009).

6.5 Tailings Containment Area

6.5.1 Impoundment Stability

The perimeter and internal structures were originally designed to have frozen cores, and constructed to impound water or tailings solids within the TCA. These structures will become essentially earthen embankments after the completion of abandonment activities. Water management at closure is to include the construction of spillways through J-Dam and Dam 1A, and a natural flow of water from the Cell 4 pond (i.e. Divider Dyke will be breached). Water in Pond 2 will not encroach on either Dam 1A or Dam 2 and will only reach the toe of the internal dam, N-Dam. Dam 4, which presently separates Long Lake from the Cell 4 pond, will have water against each toe, but this is a wide (>45 m toe-to-toe) structure that will be further enhanced by additional riprap on the sides to bring the slope to at least 2.5H:1V.

The most recent dam stability analysis was completed in accordance with Dam Safety Guidelines developed by the Canadian Dam Association (1999) (Golder 2004c, Holubec 2005). Based on the analysis presented by Golder (2004c) and Holubec (2005), the physical stability of the dams was determined to be acceptable under static and pseudo-static criteria based on conditions at the time of assessment (Golder 2004c), and during final abandonment (Holubec 2005), as measured versus the CDA 1999 guidelines.

The Dam Safety Guidelines published by the Canadian Dam Association (CDA) were updated in 2007 and revised in 2013. The CDA Technical Bulletin: Application of Dam Safety Guidelines to Mining Dams was published in 2014 (CDA, 2014). LMI is in the process of updating the stability analysis for all dams to confirm the stability meets the updated guidelines. This update is to include a review of the dam consequence classifications and incorporation of updated design criteria for floods and earthquakes. A minimum Factor of Safety (FS) of 1.5 will be expected of all perimeter and internal dams after abandonment. In accordance with Part E(6.i) of the Water Licence, annual inspections of the facility are carried out during ice free, open water conditions by a Geotechnical Engineer. These annual inspection reports are submitted to the NWB within 60 days of the inspection, and provide updates relative to the observed site conditions.

Thermistors are located within Dam 1A, Dam 2, Dam 3D, Dam 4 and K-Dam, which indicate that the active layer in the dams is approximately 2.5 to 3 m thick (measured from ground surface), below which permafrost is established (SRK 2015). The thermistors are monitored on an annual basis, as part of annual geotechnical inspections.

6.5.2 ARD Potential of Tailings

Extensive studies completed in the past have shown that the Lupin tailings, given the proper conditions, will oxidize and produce the by-products necessary for the formation of acidic runoff. Typical Lupin tailings contain approximately 3% sulphur (total) and have a Neutralizing Potential to Maximum Potential Acidity (NP/MPA) ratio of less than three.

Included in these studies were a 1991-1992, 30 week column leach program (kinetic test) and a follow-up 16 week leaching program in 1993 on mitigative measures for Cell 5 (then known as Area 3) tailings (Klohn 1992a). In addition, a 1992 study was completed on the assessment of water chemistry and remedial measures for the Lupin Tailings Management System with regard to the effects of the (formerly) exposed tailings within Pond 2 (Klohn 1992b and Klohn 1993). One of the results of this study was the decision to build M Dam, which now separates Cell 5 from Pond 2, and prevents the inflow of raw tailings into the pond.

In 1994, Echo Bay Mines Ltd. retained the services of Klohn-Crippen Consultants Ltd. for the engineering, geophysical and data interpretation of a test plot area on Cell 1 (Klohn 1995). Results of the geophysical portion of the study were inconclusive; however considerable background information was generated with regard to the chemistry of the tailings prior to covering.

In 1995, a continuation of the 1994 study incorporated the more standard physical measurement techniques of thermistors, frost probing and frost tubes at the study area. The scope was broadened when the decision to expand the esker cover program was made and Cell 1 was covered. This data, along with that generated by the additional thermistors installed in the following years, provided excellent information of the thermal response of the covered tails, and the thermistors located within Cell 1 indicate that the maximum depth of thaw is between 1.5 and 2 m. The thermistor readings generally indicate that permafrost has established within the tailings cells.

Because of the potential for acid generation from the tailings, all exposed tails will be covered by a 1 m layer of non-reactive, highly durable, saturated esker material. This layer will prevent any contact with the surface environment and the saturated zone at the tails interface will provide an effective barrier to oxidation.

6.5.3 Planned Restoration Activities

Restoration for the Tailings Containment Area will involve two physical methods for remediation and control of potential contamination from the materials that are held within its boundaries. These methods are:

- Maintaining water cover over areas that are currently used for water retention and low elevation tailings deposition (ponds), and
- Mechanical covering of the higher elevation areas containing tailings (cells) with esker material.

Of the 750 ha within the lease area, an estimated 177 ha has been affected directly by the deposition of tailings solids. The closure concept adopted by Kinross in the restoration of this area is to encapsulate the tailings (which are potentially acid generating) within a water saturated esker material cover. This would effectively isolate the tailings from the environment and limit oxygen transfer through to the sulphide contained in the tailings and so prevent acid generation.

These cells, with their respective disturbance coverage areas and approximate watershed, are listed in Table 7, along with the two ponds and their intended surface areas at closure.

Table 8 Lupin tailings containment areas.

Location	Surface Area (m^2)	Watershed Area (m^2)
Cell 1	330,000	410,100
Cell 1a	61,900	63,800
Cell 2	169,000	208,550
Cell 3	458,150	667,600
Cell 4	447,600	543,220
Cell 5	365,200	558,050
Pond 1 (elev 481)	218,000	451,820
Pond 2 (elev 480)	1,627,000	2,120,660
TOTAL	***3,676,850***	***5,023,800***

In the TCA, the total watershed area is such that accumulation of spring meltwater takes place. Even though a close to neutral evaporation environment exists, the large watershed results in an average annual increase in pond water elevation of approximately 0.5 m.

At final closure, a system of riprap spillways will be constructed to permit natural water flow to the environment. Typical water elevations in the ponds, prior to and after annual discharge, are shown in Table 8.

Table 9 TCA water elevations.

	Before Discharge (m)	After Discharge (m)
Cell 4	486.8	485.0
Pond 1	484.6	481.0
Pond 2	483.0	480.0

Currently, a gated culvert located within the north arm of the Divider Dyke controls the flow of water between Cell 4 and Pond 1. The topographic channel between these two ponds is at 485 m elevation and will provide a natural gradient when the culvert is permanently removed during closure activities. Ponds 1 and 2 are separated by J Dam, and water is presently transferred between the two ponds using a syphon. After the final transfer of water into Pond 2, J-Dam will be breached and a spillway will be constructed at an elevation of 481.0 m to permit controlled flow of water into Pond 2. Limiting maximum water level to this elevation will reduce the impoundment of water against Dam 3D and maintain a natural gradient for flow from the Cell 4 watershed. The final elevation of the water in Pond 2, following the syphon discharge to the environment, will be at a maximum of 480 m elevation. After final syphon discharge, the syphons will be removed and a spillway will be constructed through Dam 1A at an elevation of 480 m. This would allow any accumulated water from spring freshet and seasonal rain to leave the impoundment area and flow through its original natural course via Seep Creek and eventually into Inner Sun Bay of Contwoyto Lake. At a maximum water elevation of 480 m, no water will be impounded against the sides of Dam 1A, Dam 2, or M Dam.

Prior to activation of the spillway, an evaluation of the water chemistry will be made to ensure that when outflow occurs, all water quality guidelines are met. The outflow would amount to an estimated annual average water volume of approximately 250,000 m^3, the majority of flow occurring in June and early July. As there is an elevation difference of approximately 3 m from the planned outflow to the receiving stream, the channel will be easily designed to prevent the migration by fish species (e.g. arctic grayling) into the containment area through the use of a natural vertical barrier.

In addition to maintaining a water cover in the current holding pond areas of the TCA, the areas that will require the esker cover at closure are limited to the tailings cells where direct deposit of tailings solids takes place. Because there is very little additional watershed associated with the closed cells and the esker cover will be contoured to promote controlled drainage, flooding and erosion will not be a concern and the moisture retention of the cover assists the insulating value at depth and prohibiting oxidation of the underlying tails.

In general, with all the cells being situated around the perimeter of Ponds 1 and 2, there is a natural slope and drainage that results in collection within the ponds. The accumulated snow and its associated runoff naturally flow towards the two Ponds. Presently in Cell 1, runoff enters Pond 1 at the eastern end where a slight depression in the Dam 3D access road has been made to allow flow.

The source of esker material for the cell cover, as well as most of the TCA construction programs at Lupin, has been the Fingers Lake Esker, located approximately 4 km to the southeast of the TCA. This borrow source has been used for construction of K dam, Dam 4, Dam 5, Dam 6, Dam 3C and 3D, L dam and M dam, as well as an underground backfill program which utilized over 300,000 m^3 of material. The variety in the size and segregation of the material allows for selection to suit the construction required without additional screening. Historically there has been in excess of two million cubic metres of material removed from this source. Visually, this has impacted only a small fraction of the material present and the amount of material remaining (in the nearest section of the esker) is more than adequate for the 241,000 m^2 of exposed tails that remain to be covered at the TCA. Drilling associated with the installation of a thermistor (2000) at the esker had shown depths greater than 10 m, with no major ice lenses encountered.

In addition to covering all exposed tailings, a major program of dam enhancement is planned during the closure activities. The sides of all the dams will be brought to at least a 2.5H:1V slope by the addition of quarried waste riprap. This will significantly enhance both the stability and erosion protection of all the dams.

The only perimeter dams that normally impound water are Dams 1A, 2, and 4. After construction of the Dam 1A spillway, Dams 1A and 2 will no longer impound water, as the base of both dams is at the 482 m elevation and the water level will be maintained at or below the 480 m elevation. The upstream and downstream sides will be re-sloped to provide geotechnical stability and erosion protection. The upstream side of Dam 4 is already at a minimum of 3H:1V slope, and as much as 4.5H:1V at the west abutment. With the amount of waste rock present on the upstream side, Dam 4 is essentially a shoreline.

The sides of the internal dams will also be re-sloped to a minimum of 2H:1V. Pond 2 is currently in contact with the sides of K Dam, M Dam, and N Dam, while Pond 1 water contacts Dam 3D. The downstream side of K Dam, currently built with a slope averaging 1.6H:1V, will be enhanced with riprap to a 2.5H:1V slope to provide additional geotechnical stability to the dam. The dam base is at 482 m elevation and, since the final water elevation in Pond 2 will be at 480 m, no water will be impounded against the side at closure. Pond 2 will also not be in contact with M Dam at closure. The sides of M Dam are built at a slope averaging 1.5H:1V, and stability will be enhanced by adding riprap to achieve a final 2H:1V slope. N Dam is a low containment at the north east end of Pond 2, adjacent to the end of M Dam. This dam will be in contact with Pond 2 and additional riprap armour will be placed on this dam, to achieve a 2H:1V slope (the slope is currently 1.8H:1V). Dam 3D separates Pond 1 from Cells 1 and 2. It is already a substantial structure, over 30 m wide, having been reinforced with over 75,000 m^3 of riprap in 1995. It is geotechnically stable and does not require any additional material.

6.5.4 Alternative Covers

An all inclusive water cover option for the closed cells had been considered. However, the additional cost of raising perimeter dams to provide the required water depth and freeboard, the added stability risk of water retaining structures, and the need for continued monitoring indicated that other options would be more practical.

Investigations into alternatives to the granular saturated zone cover option have been considered. Among these is the incorporation of an ice lens or layer, under the placed cover, to reduce heat transfer and thereby maintain cold conditions below the cover. This could be accomplished by constructing the insulating layer during the winter, over entrapped ice and snow. The problem with this alternative is that the esker can only be farmed during the summer, while it is thawed. Winter conditions would require blasting of the esker material, and would result in a very inefficient placement of the cover.

Another alternative considered was the use of coarse waste as the cover medium. This cover incorporates the concept of convective heat transfer to promote more rapid freezing of the tailings while preventing summer thaw. Rather than using a well graded fine grained material, such as the esker material, this alternative utilizes a 1 to 2 m thickness of poorly graded, open-work waste rock to create a natural thermosyphon. Optimum size of the waste pieces would be in the order of 30 to 50 cm diameter, with minimal fines, to provide for large void spaces. The disadvantage of this alternative is that the resulting landscape would be impassable for animals and resistant to revegetation, since it is effectively a boulder field. Also, drilling, blasting and hauling of rock are significantly more expensive than farming esker material.

6.6 Revegetation

The areas at the Lupin Mine site which may require revegetation enhancements are limited in type (covered tailings, abandoned roadways etc.), most being raised above the surrounding terrain, windswept and dry. The lack of suitable growth medium and unavailable soil amendments for post use reclamation make it much more difficult. The esker deposit is the major material type that would be used in restoration activities and lacks the organic/nutrient content that the surrounding vegetation has established. The tailings cells that were covered by esker material in 1988 and 1995 have both started to re-vegetate on their own.

The procedure of scarifying reclaimed surfaces, as carried out successfully on Cell 1A, the old airstrip, and the East Zone crown pillar cover, will be continued in order to provide a microclimate for natural plant growth. Providing a rough surface enhances seed entrapment, moisture retention and wind protection.

An alternative to natural re-establishment and alien species use is the practice of native sod transplanting. This procedure involves the transplanting of blocks of soil to the restoration area which contain both the plant species and associated microflora. These ‘sod islands’ provide a nuclei that plants and microorganisms can emigrate from. Many plant species produce rhizomes, suckers or shoots that are responsible for propagation. This is especially true in harsh, northern conditions where seed production may be minimal due to the short (and variable) growing season, moisture (lack of or excess) and other variables.

Sod transplanting may be a viable method of revegetation, and has been successful on Cell 1A, however, in an area with minimal growth medium in combination with a shallow active surface layer, the placement of sod for the restoration of one site does not justify the removal of sod from another established area.

For areas that have been restored with the use of esker material, the best practical technology available is to provide the most suitable substrate by surface preparation to promote natural revegatation. This includes addition of heavy (large grain sized quarry material), surface scarification and contouring to provide proper drainage patterns to avoid erosion and ponding of water.

6.7 Tailings Containment Area Reclamation – Supporting Studies

A number of studies were carried out in 2004 which support the tailings area reclamation plan developed for Lupin. Summaries of the final reports for these studies are given below. Through the Care and Maintenance stage of this project, LMI acknowledges that there have been infrequent inspections and data collection to support the 2004 cover information. LMI has discussed the inclusion of monitoring cover performance with the engineers responsible for the annual inspections, and is intending that this be included as part of the on-going annual inspections.

6.7.1 Saturated Granular Zone Cover

The previous abandonment and restoration plans prepared by Lupin proposed that the potentially acid-generating mine tailings would be encapsulated within permafrost upon closure of the mine. A suitably thick cover of esker material would be placed over the exposed tails, such that permafrost would aggrade through the tailings and into the base of the esker cover. The seasonal active layer would then be limited to within the inert esker cover. The permanently frozen condition of the tails would prevent the oxidation of the sulphides contained in the tails and the mobility of any metals contained in the tailings pore water.

As indicated in Holubec (2005), the mean annual air temperature (MAAT) at Lupin has been rising since the first measurements were taken at the Contwoyto weather station in 1951 and the rate of increase has amplified since 1980, as has been observed in Alaska and the Northern Global hemisphere. Based on a general relationship observed between ground temperature and MAAT (Smith & Burgess, 2000), a ground temperature of 0^{o}C is observed at a MAAT of –4.4^{o}C. A trend line for MAAT data from the period 1960 to 2004 shows that the MAAT of –10.3^{o}C observed at Lupin in 2004 will warm to -4.4^{o}C (i.e. .0^{o}C ground temperature) in about 110 years. However, the trend line for the 1980 to 2004 data shows that the -4.4^{o}C point will be attained in approximately 30 years.

The thawing index, which governs the thaw depth, or thickness of the active zone, has been increasing in relation to the MAAT. This trend indicates that the thawing index increased from about 850 degree-days to nearly 1000 degree-days from 1980 to 2004. The trends of the MAAT and thawing index indicate that the longevity of using permafrost encapsulation for the Lupin tailings may be limited to a lifespan of between 30 to 110 years.

Based on the possibility that this global warming trend should continue, and using design concepts described in MEND Report 2.21.1 (1992), MEND Report 6.1 (1993), and Holubec (2003), Lupin decided to change their tailings ARD mitigation strategy from one of permafrost encapsulation to that of encapsulation beneath a partially saturated granular cover.

Research on open water covers over tailings deposits has shown that the depth of the water cover is not governed by a criterion to create an oxygen barrier but to prevent the mobilization of the tails by wave action and ice scour (Atkins et al, 1997). Research done by Noranda Technology Centre (Li et al 1997) found that 0.3 m depth of stagnant water over tailings is sufficient to inhibit their oxidation. As well, Li reports that even a thin (2mm) laminar layer of saturated inert granular material at the tailings interface could significantly reduce the amount of oxygen reaching the tails. If the saturated granular layer were as thick as 10 cm, it is reported that the oxygen flux is decreased by more than two orders of magnitude. Column testing by CANMET (MEND 2.21.1) demonstrated that a saturated zone within an esker cover provides the same benefit as an open water cover, whereby tailings oxidation is prevented even if the tailings are unfrozen.

The saturated zone cover design at Lupin consists of two layers:

- A surface layer that restricts the rate of evaporation of the saturated esker material at the base, and
- A basal saturated layer of esker material that prevents oxidation of the underlying tailings.

This thin partially saturated granular cover has many advantages:

- It provides an oxygen barrier that is not dependent on having permafrost within the tailings,
- It is not sensitive to annual temperature changes or global warming,
- It will support vegetation because the water table will be closer to the surface in a thin layer of esker material, and
- It decreases the required volumes of esker material and thereby reduces the disturbance of the esker deposits.

From the initial tails cover program in 1988, Lupin had continued to monitor the covered tailings to assess the effectiveness of the covers. As a result, Lupin has collected an extensive database on the performance of covered cells in permafrost areas.

As described in later sections of this report, various studies (Golder 2004a) have determined that the physical and chemical durability of the cover material is acceptable, that a positive water balance will be maintained within the cover during drought conditions, and pore water expulsion potential from the compacted tailings during thaw conditions is not an issue.

Data collected from the monitoring programs over the past 16 years includes ground temperatures, water levels within the cover, water quality within the cover, slope of tailings surface, thickness of tails deposition, moisture content of the cover, and particle size analyses of tailings and cover materials. Also, test pits have been excavated through the cover to the tails surface to examine for evidence of cryoturbation, oxidation at the tailings interface, presence of ice lenses, and condition of the tails/cover interface.

Ground temperature monitoring has shown that the annual thaw depth through the esker cover into the tails varies from 0.2 m to 0.9 m below the tails surface, and that the unfrozen condition, in our present climate, lasts for less than 3 months. The thaw depth was seen to be greatly influenced by the thickness of the saturated zone within the esker material, such that the thicker the saturated zone was in the esker, the less the thaw depth penetrated into the tails. As explained above, this depth of thaw will increase if the global warming trend continues.

In 2002, nine water monitoring pipes were installed in Cell 1. Holes were dug through the esker cover and 15 cm-diameter perforated pipes, lined with a geotextile filter, were installed so that their bases were approximately 15 cm above the tails/esker interface. Water levels were measured in these pipes during the summer, from August 2002 to September 2004, when the saturated zone thawed. The results of this monitoring show that the saturation zone thickness in the esker cover of Cell 1 varied from an average of about 0.2 m around the perimeter of Cell 1, where tailings discharge took place, to an average of about 0.6 m in the central portion of the cell.

Nine test pits were dug with an excavator at several locations in Cells 1A, 1, 2 and 3 in September 2004 to gain information on esker cover thickness, presence and extent of a saturated zone within the cover, penetration of tailings into the esker material as evidence of cryoturbation, and the presence and degree of oxidation of tailings. The test pits were logged, photographed and selected samples were taken for moisture content and particle gradation determination. Esker cover thickness was observed to vary from about 0.9 to 1.3 m in areas where the tailings were not covered with a waste rock layer. In the two tests pits in the northwest corner of Cell 1, the esker cover was measured to be about 0.7 m. However, in this area the esker material was underlain by a layer of waste rock approximately 0.5 m thick. In 8 of the 9 test pits, a saturated zone with free water was observed at the base of the esker material. The only pit not to show any saturation is located in Cell 3 in an area covered only 2 weeks prior to the pit excavation, so it did not have time to create a saturated zone by rainfall water infiltration.

No penetration of tailings into the esker material, or evidence of cryoturbation, was observed in any of the test pits. In the 7 test pits that encountered the tails interface, there was a clear horizontal linear boundary between the tails and sand, with no intermixing evident.

In two of the seven tests pits where esker material covers the tailings surface, minor oxidation of the tailings was observed. In both cases the tailings surface had been exposed for several years before a cover was placed and the depth of oxidation was judged to be less than 5 mm.

Moisture contents varying from 7.2% to 9.8% were determined from four samples of esker material taken from test pits in Cells 1A and 2. These samples were taken from vertical sections through the top 2/3 of the esker cover in each pit, in the unsaturated zone. As stated earlier, the zone at the base of the esker cover contained visible free water.

Water quality within the saturated zone of the esker cover was monitored between 1998 and 2004. The results of this monitoring are compared in Table 9 to the quality of ponded water atop the esker cover in Cell 1, and that of Ponds 1 and 2 to illustrate the improvement in water quality as it slowly filters through to the discharge point. The concentrations shown are averages of the results obtained in each of the areas over this period.

Table 10 Water quality data progression (average values) pre 2005.

Parameter	Units	NWB		Wells	Pit 2a	Cell 1 ponded W	Pond 1	Pond 2
		Max Avg.	Max Grab					
Arsenic	mg/L	0.5	1	1.864	0.071	0.054	0.062	0.038
Cadmium	mg/L	n/a	n/a	0.003	0.002			
Copper	mg/L	0.15	0.3	0.171	0.283	0.027	0.049	0.013
Cyanide	mg/L	0.8	1.6	0.021	0.005	0.002	0.68	0.099
Lead	mg/L	0.1	0.2	0.062	0.006	0.002	0.001	0.001
Nickel	mg/L	0.2	0.4	1.212	0.875	0.123	0.094	0.087
Zinc	mg/L	0.4	0.8	0.425	0.437	0.123	0.262	0.193
pH		6.0 to 9.5	6.0 to 9.5	4.7	3.7	3.8	7.7	6.9

The results of the monitoring illustrate the following points:

- Water quality within the saturated esker zone generally exceeds the Water Licence discharge limits. However, the volume of water within this zone is small and will take considerable time to be flushed out.
- As the saturated zone water emerges at the Cell 1 pond, the water quality meets the Water Licence metals limits.
- Additional improvement in water quality, to that of meeting discharge standards, is found in Ponds 1 and 2.

The details of the many investigations in support of the saturated zone cover design are contained in the report *Closure Plan for Lupin Tailings Containment Area*, completed by I. Holubec Consulting (Holubec 2005). This report is provided in Appendix B.

6.7.2 Gravel Material Properties

Condition 1.1.d in the previous Water License required ‘a comprehensive assessment of material suitability, including geochemical and physical characterization and availability for restoration needs, with attention to top-dressing materials, including maps, where appropriate, showing sources and stockpile locations of all borrow materials‘. The information resulting from that assessment is included in this revised plan, see below, for the purposes of reference and information

The Fingers Lake esker borrow pit, located approximately 3 km south of the TCA, has been the source of the esker material used for covering the cells since 1995, and will provide the cover material for the restoration of the remaining cells. A comprehensive assessment of the properties of the gravel material was conducted by Golder Associates in 2004. The following laboratory tests were completed on representative samples of the esker material:

- Grain size distribution and maximum and minimum density to generally characterize the esker material,
- Cyclic wetting and drying to assess the physical stability of the esker material,
- Chemical analysis of the tailings decant water, and
- Chemical analysis of leachate fluid from a mixture of esker material and tailings decant water to assess the chemical stability of the esker material.

The following conclusions were reported by Golder in 2004:

1. The results of sieve analyses indicate that the esker material is classified as gravely sand according to the Modified Unified Soil Classification System.
2. The results of 20 cycles of wetting and drying indicate that the percentage of mass lost by the specimen over the course of the test was 0.31%. This value is considered to be within the accuracy of the testing method; consequently, the results indicate that the esker material is physically stable.
3. Comparisons of the results of chemical analysis of the tailings decant water with that of the tailings decant water after it was leached through the esker material show negligible change in metals content. Based on these results, it does not appear that the esker material will physically degrade on exposure to the tailings decant water. Further, it appears that the chemistry of the tailings decant water will change relatively little if this fluid leaches through the esker material. It is, therefore, concluded that the esker material is a suitable cover material for the tailings deposition cells.

The details of this study are contained in the report *Studies Related to Water Licence Requirements and in Support of Reclamation Planning*, completed by Golder Associates (Golder 2004a). This report is provided in Appendix C.

6.7.3 Cell/Pond Interaction

Condition G.1.d in the previous Water License required a 'study of the potential for interaction between covered cells and flooded areas of the Lupin TCA, including thermal analyses and modeling of the interaction between the ponds, the frozen-core perimeter dykes, and frozen tailings within cells, as well as the thermal effects of proposed pond elevations'. The information resulting from that study is included in this revised Plan, see below, for the purposes of reference and information.

This thermal analysis was carried out in a project conducted by Golder Associates in the summer of 2004. A number of scenarios were examined in the study. The effects of a fluctuating Pond 2 water elevation upon K Dam and the frozen tailings impounded by it in Cell 3, as well as the effects on Dam 1A, were evaluated. The results of the thermal analyses indicate that, after an elapsed period of 20 years, the thaw zone does not extend to the frozen tailings when as much as 8.5 m of water is impounded against the downstream face of K Dam. This is a conservative assessment, as it is only possible at present to store a maximum of 5.5 m of water against the dam. The extent of thaw progression should be greater in gravely sand esker material, silty sand till and run-of-mine waste than in frozen tailings. The results are, therefore, considered as reasonable and a somewhat conservative representation of the interaction between flooded areas and other internal dams within the TCA.

The results of this study are moot, however, considering that the elevation of Pond 2 will be regulated by a spillway constructed at Dam 1A, which will limit the water level in the pond to a maximum of 480 m elevation. This is the elevation of the base of K Dam, so no water will be impounded against this dam. The base of M Dam is variable between 482 m to 483 m elevation, so no water will be impounded against this dam either.

The details of this study are contained in the report *Studies Related to Water Licence Requirements and in Support of Reclamation Planning*, completed by Golder Associates (Golder 2004a). This report is provided in Appendix C.

6.7.4 Pore Water Expulsion Potential

Condition I.3.b in the previous Water License required ‘an outline of methods to contain potential pore water expulsion from the TCA’. The results of the study, which was carried out by Golder Associates during the summer of 2004, has been included below for the purposes of reference and information

In order to design containment methods, the mechanisms that could potentially lead to the expulsion of pore water from the TCA must be analyzed. These were determined to be:

- Loss of pore water from the TCA via talik seepage at depth,
- Consolidation of unfrozen tailings situated against a perimeter dam (due to increased loading and/or thawing), and
- Leaching of pore water as a result of infiltration through the active layer within the tailings and cover.

The talik seepage mechanism refers to seepage of pore fluid through an unfrozen zone which has developed beneath a frozen core dam, where the unfrozen zone is the result of warming due to adjacent impounded water. Thermistors installed in all the dams which impound water in the TCA show that no thaw zones exist under these dams at present. The results of the thermal analysis conducted for the Pond/Cell interaction study indicate that, after 20 years with a maximum depth of impounded water in a pond, such a talik would not form.

Golder (2004a) concluded that ‘it is not anticipated that impounded water within the TCA would result in unfrozen zones that underlie the tailings impoundment structures. The potential mechanism of pore water expulsion from the TCA as a result of talik seepage is considered unlikely.’

The consolidation mechanism refers to pore water expulsion resulting from consolidation of unfrozen tailings due to the loading from the overlying esker cover layer. The active zone within unfrozen tailings extends for a depth of 2 m below the tails surface. Using known consolidation and physical properties of the tailings, and a 1 m thick esker cover, the Golder study determined the release of tailings water from the pore voids due to consolidation to be approximately 0.03 m^3 of pore water for each 1 m^3 of tailings within the active layer, or 0.06m^3 of pore water for the 2 m active zone depth. It was also determined that the tails would reach maximum consolidation, due to the loading of the overlying cover, within 30 days following the placement of the cover. This consolidation mechanism would only be active for a brief period and would not persist into subsequent seasons.

The thermal analyses conducted in the Golder study indicate that there is a potential of lateral pore water flow through the active layer and over the crest of the frozen dam core. This potential for lateral pore water flow and leaching is limited to the periphery of the tailings cells, adjacent to the impoundment dams, and would exist only when there is sufficient surface water infiltration (due to rainfall in the summer) to generate a significant lateral hydraulic gradient within the active layer. Two conditions must be present for this lateral flow mechanism to be active. First, sufficient infiltration must occur into the esker cover material to provide a water table within the active layer. Second, the water table within the active layer must be higher than the frozen core of the dam. The probability of the above conditions being present at the same time depends upon the climate, the amount of rainfall and its timing.

The highest net precipitation levels occur in May and June, due to the combination of spring freshet and rainfall. However, the active layer within the esker cover materials is shallow during this period and the potential for pore water to leach into the active layer water is, therefore, low. The maximum depth to the frozen dam cores beneath the dam crests is expected to be in later summer/early fall; however, based on the results of the climate and hydrology studies, evaporation typically exceeds precipitation during this period. Consequently, the potential for a water table within the active layer that is higher than the elevation of the frozen dam core is relatively low. The conclusion that can be drawn from this is that expulsion of pore water from the TCA via leaching and lateral flow would occur only with a combination of warm spring/summer and high precipitation events in the late summer/early fall, and the extent of the leaching would be limited to the periphery of the tailings cells adjacent to the dams.

Although the potential for expulsion of pore water from the TCA via the lateral flow and leaching mechanism is low, a number of approaches may be considered to further reduce it. The first approach would be to limit the active layer in the esker covered tails at the periphery of the cells by providing an additional metre of esker cover, a few metres wide, at the upstream edge of the cell, adjacent to the dam. This would maintain the tailings in a frozen state and raise the active zone to within the esker cover. The other approach would be to raise the height of the dam crest, so as to raise the level of the frozen core to an elevation above the level of the active zone in the tails. The thermal models indicate that more material would be required to carry this out than for the first alternative, and dam stability could also be affected due to the increased loading.

Implementation of the first alternative was performed as follows: a peripheral strip of esker was added to the upstream edge of Dam 3D, adjacent to Cell 1, during the cell covering program in 2004. Another peripheral strip was added to the upstream edge of Dam 6, at the west edge of Cell 3. K Dam, which separates Cell 3 from Pond 2, was constructed with an impermeable liner, and therefore does not require additional material. Additional strips of esker cover were added to internal unlined dam/cell peripheries during 2005.

The details of this study are contained in the report *Studies Related to Water Licence Requirements and in Support of Reclamation Planning*, completed by Golder Associates (Golder 2004a). This report is provided in Appendix C.

6.7.5 Climate and Hydrology Study

The granular esker material that has been used to cover the exposed tailings serves two purposes. It provides a cap on the exposed tails, thereby preventing wind dispersal of dried tailings dust, and the saturated base of the cover provides a barrier to oxidation of the underlying tails. It is critical that a positive water balance is maintained within the cover system for the oxidation barrier to be effective.

A climate and hydrological study was carried out by Golder Associates during the summer of 2004. The objectives of this study were twofold:

- Summarize the historical climate conditions of the Lupin Mine TCA, and
- Estimate the probability of maintaining a positive water balance over the surface of the TCA.

The water balance for the study area at Lupin was assessed on the basis of regional as well as site-specific information on temperature, precipitation (rainfall and snowfall), evaporation and runoff. Climatic data have been collected at the Lupin weather station, under contract to Environment Canada, on a daily basis since 1982. Monthly summaries of the temperature and precipitation data for Lupin are presented in Tables 2 3 and 4 in Section 2.4. Mean annual and mean monthly evaporation data were derived from data recorded at the Norman Wells Airport, which is located at the same latitude as Lupin and has a similar precipitation profile. Differences in mean temperature between Lupin and Norman Wells did not allow for direct transfer of evaporation data. A relationship between mean monthly temperature and total monthly evaporation was established for Norman Wells. This relationship was used to calculate pan and lake evaporation for Lupin using mean monthly temperatures. Evaporation was only calculated where the monthly mean temperatures were greater than zero.

For the purposes of the water balance analysis at Lupin Mine, it was assumed that the amounts of snowfall ‘under-reported’ and snow accumulation lost to sublimation were comparable and, thus, no adjustments to the recorded snowfall values were deemed necessary.

A monthly water balance was conducted based on a 21-year series of monthly precipitation and evaporation data derived for the study area. The objective of the analysis was to characterize the availability of inflow into or the runoff from the TCA.

Golder (2004a) reached the following conclusions in the study:

> 'The water balance results indicate that there are relatively high probabilities of surface moisture deficit during any one summer month at the Lupin Mine TCA. However, the results also indicate that the probability of surface moisture deficits in two consecutive summer months is relatively low. More specifically, the results indicate that the cumulative surface moisture deficit in two consecutive summer months is unlikely to exceed 50 mm. Given the proposed cover thickness of 1 m, the probability of drying out the entire cover is considered low. In other words, it is considered likely that partial saturation can be maintained within the cover system for the given climate and hydrological conditions at the Lupin Mine area and the cover layer are anticipated to perform as an oxidation barrier.'

The details of this study are contained in the report *Studies Related to Water Licence Requirements and in Support of Reclamation Planning*, completed by Golder Associates (Golder 2004a). This report is provided in Appendix C.

6.7.6 Ecological Risk Assessment

The main purpose of the granular cover is to isolate the underlying tailings from the surface environment. This prevents wind dispersal of dried tails, minimizes contact with the fauna, and prevents oxidation of the tailings by creating a barrier layer of saturated sand over the tails. In order to gain a better understanding of the ecological implications of this reclamation strategy, a risk assessment was conducted to evaluate the likelihood of adverse ecological/environmental effects occurring as a result of the mobility of the tailings fluids within the TCA. Aquatic risks were not evaluated because Ponds 1 and 2 are not intended to be aquatic habitat, and spillways will be constructed to prevent fish movement into the ponds. The ecological risk assessment, conducted by Golder Associates (2004), examined:

- The identification of potential ecological receptors,
- The identification of constituents of ecologic concern,
- The identification of toxicity and bioavailability of constituents of concern,
- The identification of potential exposure pathways, including potential migration into the surrounding ecosystem through overtopping of, or limited transmittal through, the containment structures,
- Ecological risk analysis and assessment, including a discussion of the uncertainties associated with the assessment, and
- Remediation alternatives, if necessary.

The following wildlife receptors were evaluated in the risk assessment:

- Muskox (*Ovibos moschatus*),
- Caribou (*Rangifer tarandus*),

- Ggrizzly bear (*Ursus arctos horribilis*),
- Wolverine (*Gulo gulo*),
- Fox (*Vulpes vulpes*),
- Wolf (*Canis lupus*),
- Hare (*Lepus arcticus*),
- Arctic ground squirrel (*Spermophilus parryii*),
- Ptarmigan (*Lagopus lagopus*),
- Rough legged hawk (*Buteo lagopus*),
- Snipe (*Gallinago gallinago*), and
- Long-tailed duck (*Clangula hyemalis*).

The risk assessment focused on the potential risks to wildlife health due to exposure to food (vegetation, invertebrates and prey, as applicable), water and incidental soil ingestion. Risks to human health were also evaluated based on consumption of caribou that may have the potential to be exposed to metals and cyanide from the TCA. Humans are not expected to be directly exposed to metals and cyanide in the TCA by incidental ingestion of tailings or by drinking effluent.

Exposure to metals and cyanide by wildlife that may inhabit areas near the mine, and by people that may consume caribou meat, was estimated by determining the following:

- The concentrations of substances in soil, sediment, plants and water,
- The types of receptors (i.e. wildlife) that could be in the vicinity of the mine or consume organisms that spend time in the area,
- The pathways by which receptors may come in contact with substances (i.e. incidental ingestion of soil, ingestion of food and water),
- The amount of time receptors may spend within the mine site (i.e. days/year),
- Typical soil, sand, water and food ingestion rates and body weights for wildlife receptors,
- Typical meat ingestion rates and body weights for human receptors, and
- The quantity of metals that receptors are likely to take into their bodies by each pathway.

In the risk assessment, the hazard potential of substances was estimated by considering the following:

- Determining whether the quantity of substances in soil, sediment and water exceeds applicable regulatory guidelines,
- Reviewing the toxicity information associated with each substance, and

- Determining the total amount of exposure from all applicable pathways that would be unlikely to cause adverse health effects in receptors (toxicity benchmarks).

Results of this ecological risk assessment show that:

1. Exposure to humans and wildlife via water from within the capped tailings is not significant. Based on the results of the engineering feasibility of covering exposed tailings with esker material, it is not expected that any appreciable amount of pore water will seep into the ponds. Nor is it expected that water at the tailings interface will move upward into the root zone of plants growing at the surface of the esker material (Golder 2004a).
2. There is no risk to human or predator health due to the ingestion of meat from caribou that migrate through the TCA. Conservative assumptions and many layers of safety were used to estimate exposure and to derive toxicity benchmarks. This means that there is a high degree of certainty that risks have not been underestimated and that all potential receptors would be safe from exposure to metals from the study area.
3. A potential for risk was identified for individual shorebirds and waterfowl (snipe and long-tailed duck) due to potential exposure to arsenic and cyanide in invertebrates in Ponds 1 and 2. However, it is very unlikely that substantial numbers of invertebrates are present in the ponds, and the numbers that might be present are unlikely to fully support dietary needs of the birds. None of the sediment samples taken from Ponds 1 or 2 for this study were seen to contain any benthic invertebrates. Risks to populations of shorebirds and waterfowl, as opposed to individuals, are unlikely due to the low numbers of birds that make use of the ponds as a resting place. Based on a literature review, 15 pairs of shorebirds and 8 pairs of ducks may use the Lupin Mine TCA as a nesting and feeding area during a given season. Again, because conservative assumptions and many layers of safety were applied to the wildlife health risk assessment, it is unlikely that any significant risk exists to shorebirds and waterfowl.

The details of this study are contained in the report *Ecological Risk Assessment for the Lupin Mine Tailings Containment Area*, completed by Golder Associates (Golder 2004b). This report is provided in Appendix D.

6.8 Tailings Containment Area Reclamation - Response to Technical Review Comments

In 2005 and 2006 comments on the Final TCA Reclamation and Abandonment Plan were provided by the Board. LMI's response to the technical review comments are provided in Appendix E. Appendix 1 of the response contains the supporting tables and figures referred to in the text. Reports on the geotechnical and geochemical considerations of seepage water which will emanate for the cells following closure and on the post-closure water management plan are included in Appendix 2 as Volumes I, II and III of *Seepage and Water Quality for Reclaimed Tailings Containment Area*.

Comments on LMI's response were received from regulatory authorities were provided by the Board in April and May of 2006. Due to the sale of LMI in June 2006 and the potential for the site to return to operating status further revisions to the Final TCA Reclamation and Abandonment Plan were not made.

LMI will take into consideration the comments received during the preparation of the Final Reclamation and Abandonment Plan for the Site.

During the 2014 and 2015 water licence renewal process technical review comments and recommendations were provided by intervening parties. This Plan has taken into consideration those comments and recommendations as summarized in a concordance table included in Appendix F.

6.9 Environmental Effects Monitoring

Discharge from the TCA is regulated under the *Metal Mining Effluent Regulations* (MMER). As required by the MMER, an Environmental Effects Monitoring (EEM) Study design was submitted to Environment Canada to conduct a combined Cycle 4 and Cycle 5 study in February 2016. The components of that biological monitoring study design include a site characterization, a fish population study, a fish tissue study, and a benthic invertebrate community study. The initial EEM study was carried out in the summer of 2005 in reference and exposure areas of the TCA. The follow up Cycle 2 EEM study was carried out in 2008, and Cycle 3 and an Investigation of Cause was carried out in 2010. The purpose of an EEM biological study is to assess the aquatic ecological effects of effluent release from active metal mines to receiving waters frequented by fish.

The overall objective of the Cycle 3 study was to further examine possible differences in the growth and/or condition of resident fish populations between the area exposed to effluent discharge from the TCA and local reference areas, and to further evaluate alternative hypotheses for any observed differences between the areas. Conclusions from the Cycle 2 report suggested that lower length and weight for young Arctic Graying may be attributed to factors such as water temperature, food availability, competition and predation. The results of Cycle 3 indicate that the hypothesis regarding lower water temperatures in the exposure area having an effect on the growth of young Arctic Grayling is not supported (AECOM 2011).

The details of the EEM studies are contained in the report *Lupin Gold Mine Environmental Effects Monitoring – Cycle 3 Interpretative Report* (AECOM 2011) and *Addendum to the Lupin Mine 2011 EEM Interpretative Report – Response to Technical Advisory panel and Environment Canada Comments (*Hemmera 2012). The report and addendum are provided in appendices G and H.

During periods of effluent discharge from the TCA water quality samples are collected in the exposure area and a local reference area. Figure 5 shows the locations of the various sites that were used in the water quality monitoring programs. The water quality monitoring program results are reported in the annual reports submitted to the NWB and in quarterly reports submitted to Environment Canada.

6.10 Rip Rap Quarry

A rip rap quarry will be developed within the footprint of the TCA to provide the course broken rock needed to enhance dam stability, provide additional armour for the faces of the embankments, and for use as inert cover material. Approximately 100,000 m^3 of broken rock will be required. The quarry location will be on a hilly barren outcrop of phyllite just north of Cell 3 and east of the perimeter road (Figure 3).

Four rock samples were taken from the area and tested for ARD potential. Table 10 lists the results of this testing. All samples show that the rock will be well suited to be used as cover material and will not be a concern for possible ARD generation.

Table 11 Rip Rap Quarry sample ARD potential test results.

Sample	Fizz	NNP	NP	pH	MPA	NP:MPA	S%
50133	1	3	5	7	1.6	3.20	0.05
50134	1	14	15	8.6	0.6	24.00	0.02
50135	1	5	5	7.8	0.5	16.00	0.01
50136	1	8	8	8.1	0.5	26.88	0.01

An area of approximately 25,600 m^2 (160 m x 160 m) will be excavated by blasting to a depth of 2.5 m. There is little to no overburden in the footprint of the quarry area, so stripping will not be required. Access to the quarry site is immediately off the road to the west of K Dam, so any effect on the tundra will be minimized.

As the quarry location is a hill top, there will be little to no depression remaining after completion of the operation. The quarry will essentially remove the top of the hill. All drainage off the existing hill drains into Pond 2. The quarry will be configured such that this drainage pattern will not change.

6.11 Wildlife Considerations

Wildlife considerations during dismantling of structures, demolition or remediation work includes mitigation measures to reduce wildlife disturbance and mortality such as:

- Dismantling structures with known nesting areas outside of the nesting season (May 14-Sept 12),
- If dismantling these structures during the nesting season is unavoidable, areas will be inspected for active nests prior to commencing demolition or remediation works, and
- If active nests are discovered, works are halted and delayed until nesting is complete.

Procedures outlined in the *Wildlife Management Plan* will be followed during closure, reclamation and post closure monitoring.

7 Closure Monitoring Plan

The mine site reclamation objectives of LMI take into consideration the physical stability, chemical stability and future use and aesthetics at the site after closure. In keeping with these objectives, this closure monitoring plan has been designed to measure the effectiveness of the planned reclamation activities, and provide the means of assessing when the activities have reached the stated goal.

7.1 Timeframe

The frequency of data collection will vary depending on the phase of reclamation activity. During care and maintenance regular monitoring will be carried out, appropriate to the activity being monitored. When the final reclamation phase has begun, (i.e., when demolition activities at the mine site are underway) this rigorous monitoring schedule will be continued. Some of the monitoring activities will be dictated by provisions in the current Water Licence (i.e. daily and weekly water sampling at monitoring program stations during TCA water effluent discharge to the environment). Water levels and quality will be monitored on a frequent basis in accordance with the *Liquid Waste Management Plan*. Geotechnical monitoring, including dam inspections and thermistors readings (as long as they are providing useable data), will continue. The present operation plan is for Lupin to remain on care and maintenance while LMI evaluates options for resuming operations.

Once the closure and reclamation activities have been substantially completed, the frequency and type of monitoring will be reduced and will focus on assessing the performance of the reclamation measures. The post-closure monitoring will provide the means of assessing when the stated goal of the reclamation measures has been reached. As the site will be unoccupied after the final demolition phase, periodic site visits will be scheduled for these assessments. The periodic visits may last one day to several days depending on site requirements. A minimal site camp will be established to accommodate the site visits. This closure phase of monitoring is anticipated to last for 5 years after site closure and reclamation.

7.1.1 Data Collection and Reporting

The following components will be monitored over the reclamation and post-closure periods:

- Water quality of effluent discharge and surrounding lakes, as per parameters stated in the Water Licence,
- Seasonal water levels,
- Thermal condition of the earthworks and tails, and
- Geotechnical inspections of earthworks, as appropriate.

Figure 5 shows the locations of the various sites that were used in the water quality monitoring program. Figure 3 shows the location of the thermistors, as well as of the major earth structures, within the TCA that will continue to be monitored.

The progress of all reclamation activities will be monitored, documented, and reported to the NWB in accordance with licence requirements. It is anticipated that the monthly progress reports will be provided during closure and reclamation and that post-closure monitoring reports will be submitted on an annual basis. During post-closure a comprehensive annual report will be prepared for submission by March 31 of the following year, which will describe the reclamation activities conducted over the previous year, the results of the current monitoring programs, a compilation of data from the monitoring programs, and a presentation of the plan of activities for the coming year. As the monitoring demonstrates that the reclamation program is achieving its objectives and that the area is environmentally stable, LMI anticipates that long term monitoring requirements will reduced. Monitoring results will be reviewed by LMI as the data is received. Where action is identified by the sampling results, such action will be carried out in a timely manner. Throughout the reclamation phase, reporting to the Board will be carried out as required by the Water Licence.

7.1.2 Water Quality Management and Monitoring

Current Status

Water management and monitoring at the Lupin site is a requirement of the Water Licence. The Monitoring Program Stations station locations with sampling frequencies and sampling parameters are specified in Schedule J of the current Water Licence and shown on Figure 5. Part E of the Water Licence specifies the conditions applying to waste disposal, including the maximum average allowable concentrations of various parameters.

During any discharge period, all monitoring requirements and frequencies stipulated by the Water Licence will be carried out. In addition to this monitoring, Lupin will also conduct biological, effluent and water quality monitoring program as required, adhering to MMER requirements.

Water quality monitoring within the TCA prior to discharge is necessary to track the performance of the system and/or identify any anomalies that may arise. Should monitoring indicate that the water quality will not meet discharge requirements water treatment measures will be implemented. Water treatment at the TCA has been reduced to that of the lime addition as required for pH control. The treatment facility, which was originally designed for the addition of ferric sulphate for the removal of arsenic, has only been used for supplemental addition of lime since 1997. The water quality within Pond 1 had improved during the years prior and treatment for the removal of arsenic was not required. Monitoring results of recent internal pond water quality are provided below in Table 12 and

Table 13. Internal pond water quality is to be reported in future annual reports to the NWB.

Table 12 2012 Internal Pond Chemistry Summary.

Location		Pond 1	Pond 2	Cell 4	Cell 5
Date Sampled		8/3/2012	8/3/2012	8/3/2012	8/3/2012
Parameter	Units				
Field pH	pH	4.01	4.48	3.44	3.31
pH	pH	4.43	4.70	3.66	3.47
Total Suspended Solids	mg/L	<3.0	<3.0	<3.0	<3.0
Acidity (as $CaCO_3$)	mg/L	10.7	5.6	30.4	44.7
Alkalinity, Total (as $CaCO_3$)	mg/L	<5.0 *	<5.0 *	<5.0 *	<5.0 *
Ammonia, Total (as N)	mg/L	1.22	0.085	4.16	1.39
Chloride (Cl)	mg/L	47.2	46.5	79	12.8
Nitrate and Nitrite (as N)	mg/L	1.19	2.15	<0.071	<0.071
Nitrate (as N)	mg/L	1.19	2.15	<0.050	<0.050
Nitrite (as N)	mg/L	<0.050	<0.050	<0.050	<0.050
Sulfate (SO4)	mg/L	180	228	348	169
Cyanide, Total	mg/L	<0.0050	<0.0050	0.0081	0.0171
Arsenic (As)-Total	mg/L	0.0295	0.0203	0.144	0.152
Copper (Cu)-Total	mg/L	0.0646	0.0109	0.0886	0.0135
Lead (Pb)-Total	mg/L	0.00186	0.00015	0.0241	0.0433
Nickel (Ni)-Total	mg/L	0.137	0.0863	0.186	0.0812
Zinc (Zn)-Total	mg/L	0.661	0.286	1.34	0.16
Arsenic (As)-Dissolved	mg/L	0.0301	0.00452	0.0539	0.159
Copper (Cu)-Dissolved	mg/L	0.0645	0.0109	0.0912	0.0138
Lead (Pb)-Dissolved	mg/L	0.00174	<0.00010	0.0225	0.044
Nickel (Ni)-Dissolved	mg/L	0.136	0.0874	0.189	0.0818
Zinc (Zn)-Dissolved	mg/L	0.684	0.289	1.34	0.165

Table 13 2015 Internal Pond Chemistry Summary.

Location	Units	Pond 1		Pond 2*		Cell 4		Cell 5	
Date Sampled		9/10/15	10/1/15	9/10/15	10/1/15	9/11/15	9/9/15	9/11/15	9/9/15
Parameter									
FIELD Conductivity	µS/cm	487	487	582	582	978	978	640	640
pH	pH	4.25		5.54		3.74	3.74	3.47	3.47
FIELD pH	pH	4.08	4.08	6.29	6.29	3.68	3.68	3.38	3.38
Total Dissolved Solids	mg/L	312		380		591	591	323	323
Total Suspended Solids	mg/L	<3.0		<3.0		<3.0	<3.0	<3.0	<3.0
Acidity (as CaCO3)	mg/L	12.8		<5.0		35.4	35.4	48.6	48.6
Alkalinity, Total (as CaCO3)	mg/L	<2.0		<2.0		<2.0	<2.0	<2.0	<2.0
Ammonia, Total (as N)	mg/L					3.79	3.79	1.44	1.44
Chloride (Cl)	mg/L	32.4		38.3		59.3	59.3	11.4	11.4
Nitrate and Nitrite (as N)	mg/L	0.716		0.975		0.0453	0.0453	0.0174	0.0174
Cyanide, Total	mg/L						<0.0050		
Arsenic (As)-Total	mg/L	0.0418	0.0324	0.00253		0.0537		0.469	
Copper (Cu)-Total	mg/L	0.0406	0.0414	0.00732		0.0710		0.0161	
Lead (Pb)-Total	mg/L	0.00513	0.00408	0.000075		0.0124		0.138	
Nickel (Ni)-Total	mg/L	0.114	0.114	0.0726		0.161		0.0951	
Zinc (Zn)-Total	mg/L	0.500	0.478	0.240		1.10		0.182	
Arsenic (As)-Dissolved	mg/L		0.0275		0.0277		0.0502		0.364
Copper (Cu)-Dissolved	mg/L		0.0412		0.0419		0.0720		0.0163
Lead (Pb)-Dissolved	mg/L		0.00405		0.00404		0.0125		0.119
Nickel (Ni)-Dissolved	mg/L		0.114		0.115		0.161		0.0948
Zinc (Zn)-Dissolved	mg/L		0.472		0.479		1.17		0.195

* Pond 2 was actively being treated with lime when samples were collected.

In addition, water quality monitoring is carried out at the sewage lakes system, the main site facilities pad run-off and leachate from the waste rock piles or building foundations. Results are reported in the annual reports to the NWB.

Additional monitoring of general site conditions and runoff may be required during the period leading up to the final Abandonment and Restoration Plan being prepared.

Demolition and Reclamation Period Monitoring

Water management and monitoring at the Lupin site during demolition and site reclamation will be, based on the approval of a final Abandonment and Restoration Plan and a revised Water Licence. All monitoring requirements and frequencies stipulated by the Water Licence for the closure activities will be carried out. The monthly reports to the water board will contain the details of all remediation activities and monitoring results.

During any discharge period, all monitoring requirements and frequencies stipulated by the Water Licence will be carried out. In addition to this monitoring, Lupin will also conduct biological, effluent and water quality monitoring program as required, adhering to MMER requirements.

Post-Closure Period Monitoring

Once the final demolition and remediation activities have been completed, the site will be unoccupied. For the purposes of this interim plan post-closure monitoring activities are separated into two phases; Phase 1 – Annual Monitoring (years 1 through 10) and Phase 2 – Decreasing Frequency with monitoring during years 11 and 25 (years 15 and 25) for a total of 12 years of monitoring over a 25 year period. The post-closure monitoring will focus on collecting information necessary to evaluate the effectiveness of the reclamation activities. As there will no longer be personnel at the site, water quality monitoring and geotechnical assessments of the spillways during the first 10 years of the closure period will be conducted during open water periods. The results of the Phase 1 monitoring program will be reviewed annually. Once the site has been determined to be physically and chemically stable the Phase 2 monitoring frequency would be initiated.

7.1.3 Progressive Reclamation Activities

Reclamation at the Lupin Mine has been on-going since the initial tailings cell (Cell 1) was filled to capacity in 1995. Prior to this in 1988, a test portion of Cell 1, referred to as Cell 1A, had been filled and covered with esker material as a final cover layer. Temperature monitoring thermistor strings were installed at various depths in this area to provide an indication of the amount of esker material needed to maintain the tailings frozen and allow the active thaw zone to be restricted to the esker cover.

In 1995, a 1 m layer of esker material was placed on Cell 1 and a portion of Cell 2 with thermistor strings installed to monitor the temperature below the ground surface. In 1997, additional cover work was completed on Cell 2 (¾ complete with a 1 m cover).

In 1998, while under care and maintenance, further reclamation work was completed where the East Zone and Centre Zone had been mined from the surface. The Crown Pillar area, the area where the ore zone is present near the surface, was reclaimed to the extent possible through filling in the mined out areas of the East Zone and Centre Zone.

In addition to the above, general reclamation has taken place in numerous other areas including many unused roads, and equipment storage areas. This included the original Twin Otter airstrip located south of the mine site parallel with the second sewage lake. All associated piping was removed from the original construction camp water supply lake and the roadway taken out of service by re-grading and scarifying the roadbed to promote natural re-vegetation of the ground. The fueling station at the main airstrip was also decommissioned and removed.

The Centre Zone Crown Pillar open stope, which was previously open from the 27 m level to surface, was filled with cemented tailings paste backfill during 2003. Approximately 100,266 dry short tonnes of paste, at a cement content of close to 1%, were placed in the opening. Once the paste dried, it was then topped with surface material that had been stored when the original ground cover was removed to obtain access for mining. This activity has served a dual purpose by backfilling of one of the open crown pillars at surface as a step towards reclamation of the site, and by reducing the amount of tailings directed towards the surface TCA impoundment.

Progressive reclamation activities in the TCA during 2003 saw two areas within Cell 3, designated cells 3A and 3B, covered by approximately 1 m of esker gravel. The work was carried out between 5 August and 23 September 2003, with a total area covered of approximately 62,350 m^2. The esker material is an effective cover medium that serves to eliminate dispersal by wind of dry tailings, and the embedded moisture layer prevents oxidation of the underlying tails and provides support for plant growth.

In 2003, additional site information was accumulated in support of the ‘Partially Saturated Granular Cover’ program for tails reclamation. Monitoring of pore water quality and the saturation status of the esker cover in Cell 1 continued from the previous year. Further to this work, a test pad was constructed in Cell 1 by effectively isolating a 20 m by 40 m area from the rest of the cell. This was accomplished by installing an impermeable liner in a 2.4 m deep trench surrounding the area, anchored well below the active zone. A thermistor and 2 water sample pipes were installed within the test pad area. The information gathered from this exercise in 2003 and ensuing years will be added to that previously obtained in support of the Partially Saturated Granular Cover program endorsed by Igor Holubec, geotechnical specialist.

Progressive reclamation activities in the TCA during 2004 saw a major portion of Cell 3, the remainder of Cell 2, and a small portion of Cell 5 covered by a minimum of 1 m of esker gravel. The work was carried out between July 6 and September 19, 2004, with a total area covered of approximately 328,794 m^2.

In 2004, additional site information was accumulated in support of the ‘Saturated Granular Zone Cover’ program for tails reclamation. Monitoring of pore water quality and the saturation status of the esker cover in Cell 1 continued from the previous two years. Further to this work, a series of 9 pits were excavated through the esker cover in Cells 1, 1A, 2 and 3 to check for cover thickness, moisture content, and condition of tails/cover interface. This work confirmed that a saturated zone exists at the base of the esker cover which effectively isolates the underlying tailings from an oxidizing environment. A detailed description of this program is contained in the 2004 Abandonment and Restoration Plan, previously submitted to the Board.

Reclamation activities in the TCA during 2005 saw a major portion of Cell 5 and another portion of Cell 3 covered by a minimum of 1 m of esker gravel. The work was carried out between 23 June and 28 September 2005, with a total area covered of approximately 383,001 m^2, bringing the total of exposed tails covered to approximately 1,280,000 m^2. There remains approximately 155,000 m^2 in Cell 5 and 86,000 m^2 in Cell 3 of exposed tailings.

In addition to the above work on the TCA, general reclamation has taken place in numerous other areas since 2005. The steel frame structure of the paste backfill building has been removed and equipment from the plant removed for resale or salvage and a cold storage building has been removed.

In 2006, the final report on the Phase 1 and Phase 2 Environmental Site Assessment of the Lupin Mine Site was provided to the NWB (Morrow 2006). Collection of data from thermistor strings installed at the TCA continued on a monthly basis until October 2006. The information collected to 2006 indicated that subzero temperatures continue to be maintained at depth with no indications of warming (BGC 2007). Temperature monitoring in Cell 1 continued. Results obtained between 1995 and 2005 showed that October is usually the month when the active layer has penetrated the deepest and significant cooling has begun on surface.

The site was under general care and maintenance between 2007 and 2011, but no significant progressive reclamation activities were undertaken. In October 2011, important maintenance was conducted on the main fuel tank and satellite tank farms. Significant progressive reclamation resumed in June 2012 with the shipment of hazardous materials and other waste off-site for disposal at approved facilities. The shipment of significant quantities of hazardous materials and other waste off-site continued in 2013 and resumed in 2015. The volume and types of materials shipped off-site for disposal are reported in the 2012 and 2013 monthly reports to the NWB and the 2015 annual report.

Progressive reclamation activities during 2014 consisted of the decommissioning and removal of numerous fuel tanks and buried pipes as reported in the 2014 annual report.

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Appendices

Appendix B Figures

Legend

Project Location

Coordinate System: NAD_1983_UTM_Zone_12N

Map Sources/Notes:
Various Canadian Government Websites - Feb 2012

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Approved By: SH
Prepared By: PW
Project No.: LUP
Date Revised: 26 Mar 2012
File Name: Lup-12-04-01-LocationMap-A.mxd

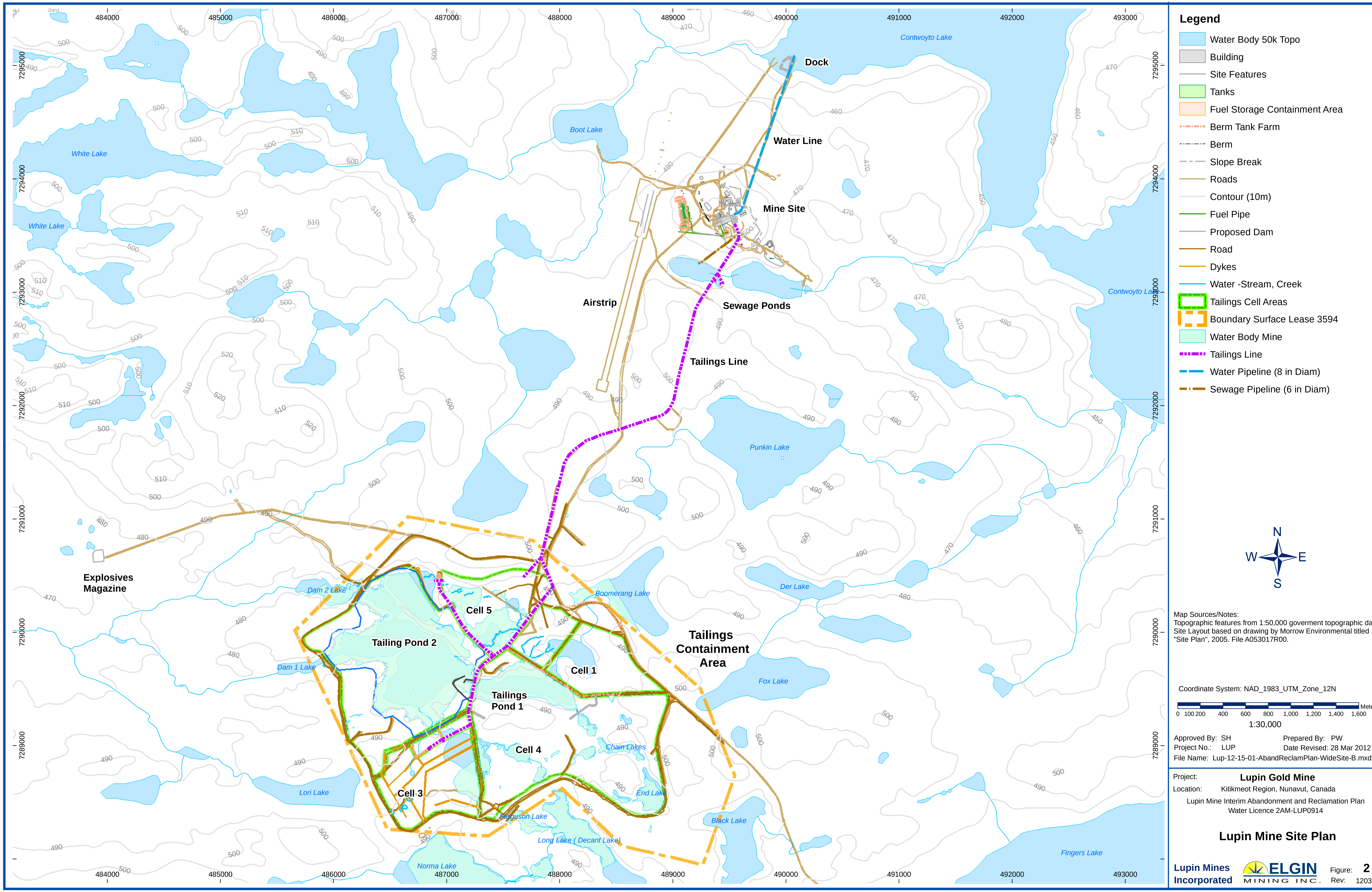
Project: **Lupin Project**
Location: Kitikmeot Region, Nunavut, Canada

Location Map - Lupin Mine

Lupin Mines Incorporated

ELGIN MINING INC.

Figure: **1**
Rev: 120326


Dock
Water Line
Mine Site
Airstrip
Sewage Ponds
Tailings Line
Explosives Magazine
Cell 5
Tailing Pond 2
Cell 1
Tailings Pond 1
Cell 4
Cell 3
Tailings Containment Area
Contwoyto Lake
Boot Lake
White Lake
Punkin Lake
Der Lake
Boomerang Lake
Dam 2 Lake
Dam 1 Lake
Fox Lake
Chain Lakes
End Lake
Lori Lake
Ferguson Lake
Long Lake (Decant Lake)
Black Lake
Norma Lake
Fingers Lake
Legend
Water Body 50k Topo
Building
Site Features
Tanks
Fuel Storage Containment Area
Berm Tank Farm
Berm
Slope Break
Roads
Contour (10m)
Fuel Pipe
Proposed Dam
Road
Dykes
Water -Stream, Creek
Tailings Cell Areas
Boundary Surface Lease 3594
Water Body Mine
Tailings Line
Water Pipeline (8 in Diam)
Sewage Pipeline (6 in Diam)
N
W
E
S
Map Sources/Notes:
Topographic features from 1:50,000 goverment topographic data.
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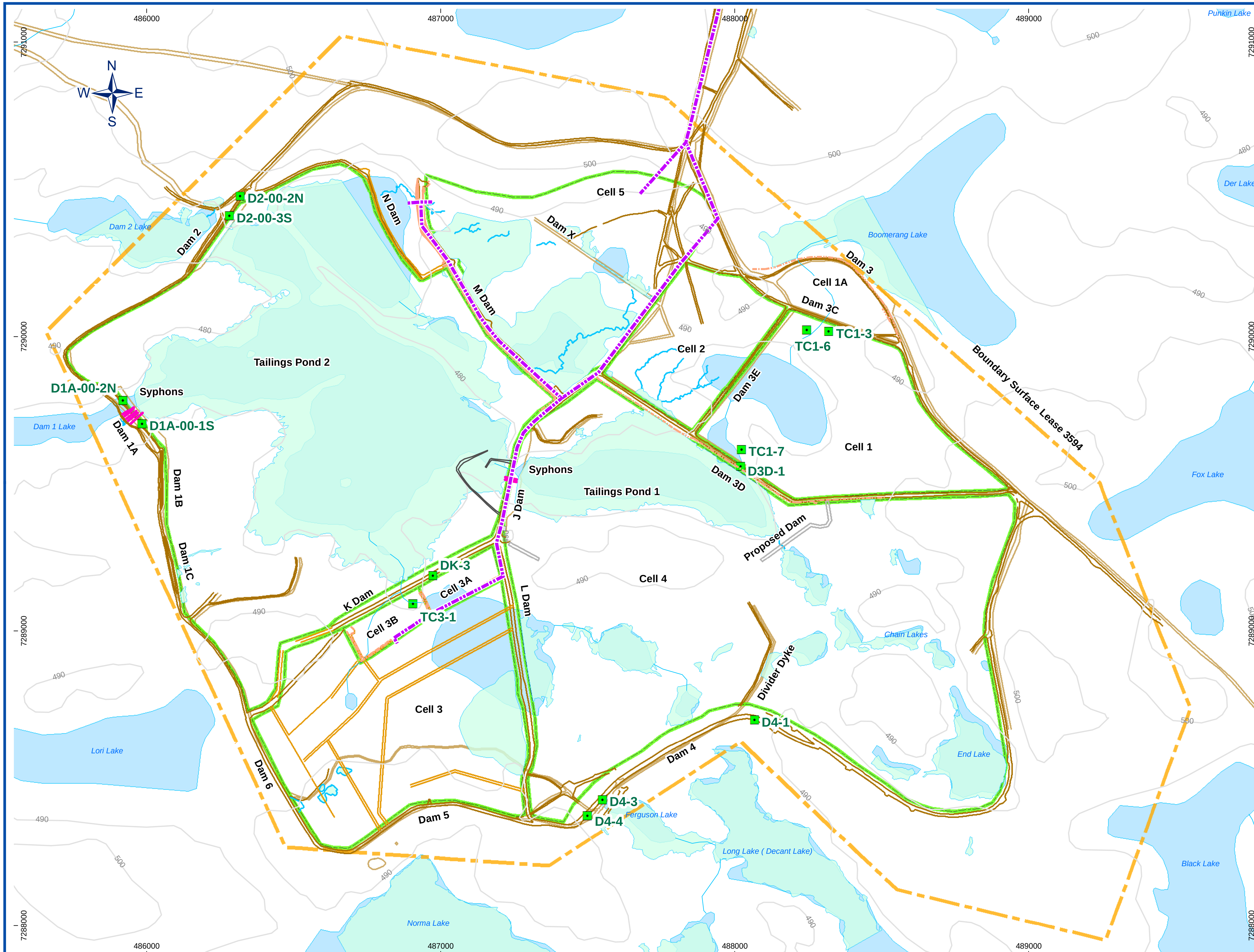
Approved By: SH
Prepared By: PW
Project No.: LUP
Date Revised: 28 Mar 2012
File Name: Lup-12-15-01-AbandReclamPlan-WideSite-B.mxd
Project: Lupin Gold Mine
Location: Kitikmeot Region, Nunavut, Canada
Lupin Mine Interim Abandonment and Reclamation Plan
Water Licence 2AM-LUP0914
Lupin Mine Site Plan
Lupin Mines Incorporated
ELGIN MINING INC.
Figure: 2
Rev: 120328



Legend

- Water Body 50k Topo
- Building
- Site Features
- Tanks
- Fuel Storage Containment Area
- Berm Tank Farm
- Berm
- Slope Break
- Roads
- Contour (10m)
- Fuel Pipe
- Proposed Dam
- Road
- Dykes
- Water -Stream, Creek
- Cell Areas
- Boundary Surface Lease 3594
- Water Body Mine
- Tailings Line
- Siphons
- Location of Thermistor

Map Sources/Notes:
Topographic features from 1:50,000 goverment topographic data.
Site Layout based on drawing by Morrow Environmental titled "Site Plan", 2005. File A053017R00.

Thermistor locations from map by MMG titled "Thermistor Location Figure 7" file Figure 7 Thermistors.dwg and 2006 Lupin

Coordinate System: NAD_1983_UTM_Zone_12N

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Approved By: SH
Prepared By: PW
Project No.: LUP
Date Revised: 28 Mar 2012
File Name: Lup-12-15-02-AbandReclamPlan-TailingsArea-B.mxd

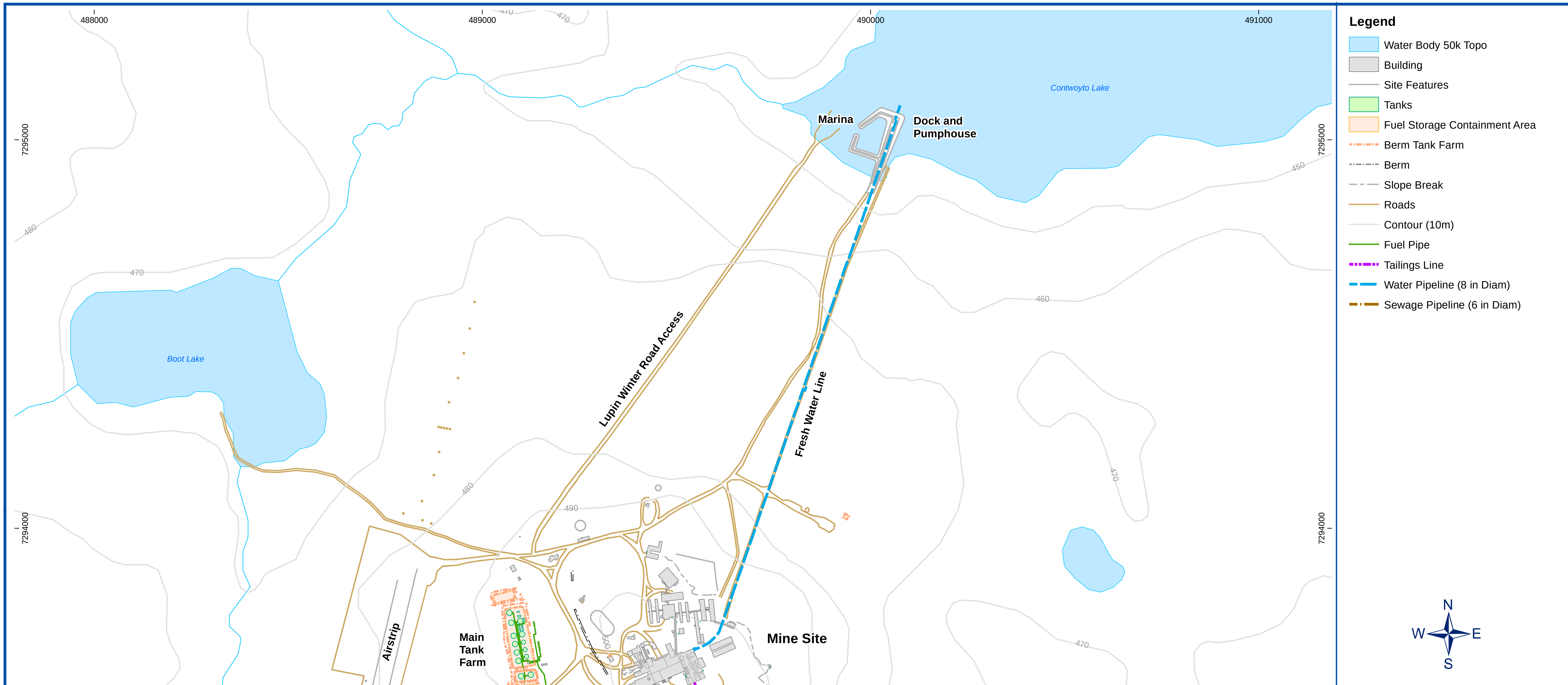
Project: **Lupin Gold Mine**
Location: Kitikmeot Region, Nunavut, Canada
Lupin Mine Interim Abandonment and Reclamation Plan
Water Licence 2AM-LUP0914

Lupin Mine Site
Mine Tailings Containment Area

Lupin Mines Incorporated

ELGIN MINING INC.

Figure: 3
Rev: 120328



Map Sources/Notes:
Topographic features from 1:50,000 goverment topographic data.
Site Layout based on drawing by Morrow Environmental titled "Site Plan", 2005. File A053017R00.

Coordinate System: NAD_1983_UTM_Zone_12N

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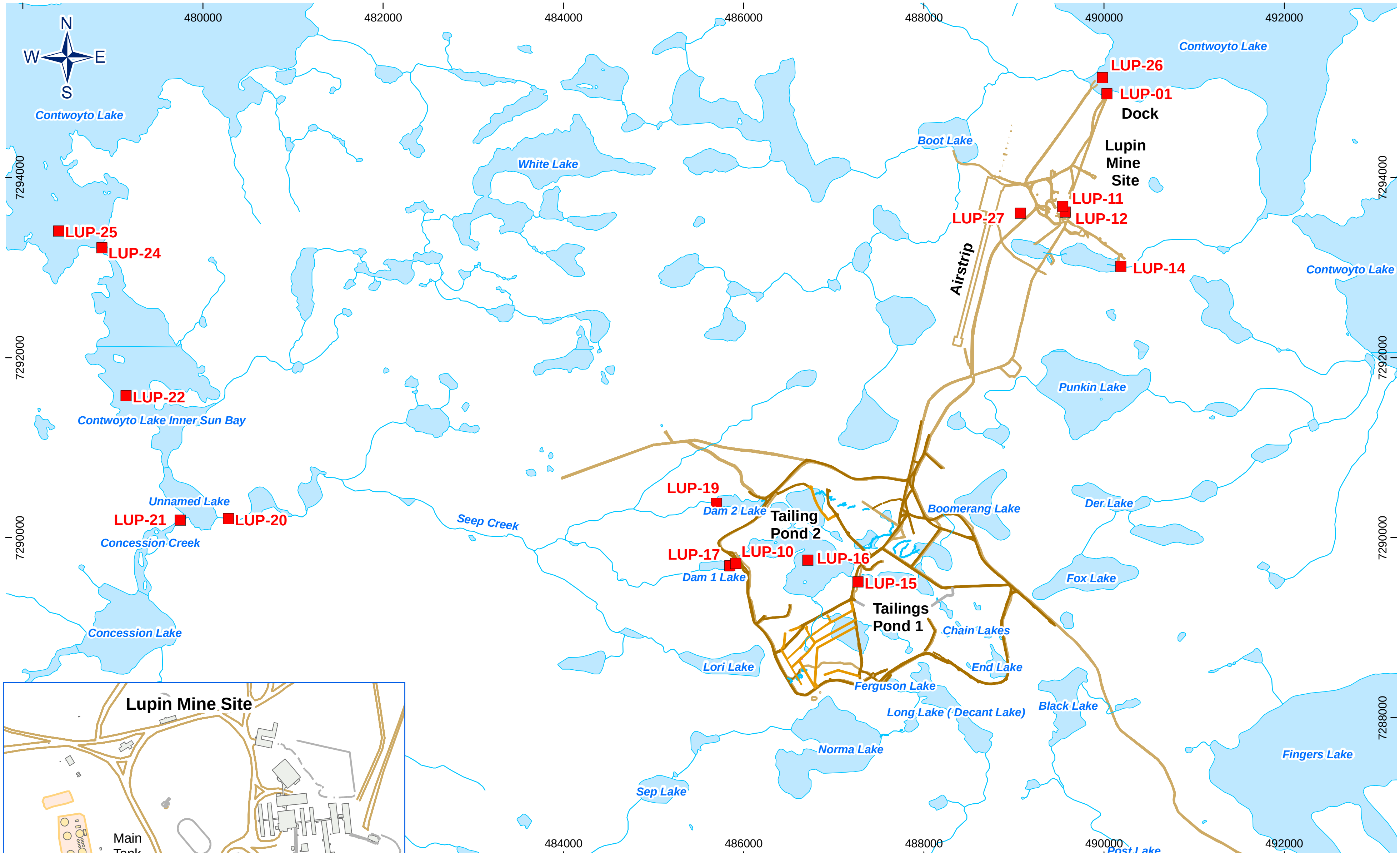
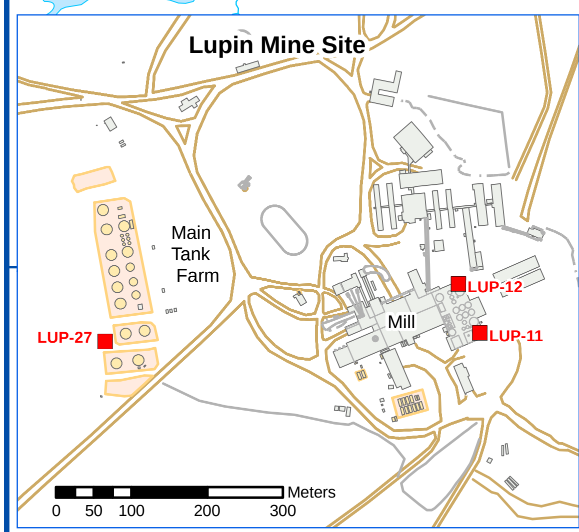
Approved By: SH
Project No.: LUP
Prepared By: PW
Date Revised: 28 Mar 2012
File Name: Lup-12-15-03-AbandReclamPlan-WaterSewage-B.mxd

Project: **Lupin Gold Mine**
Location: Kitikmeot Region, Nunavut, Canada
Lupin Mine Interim Abandonment and Reclamation Plan
Water Licence 2AM-LUP0914

Lupin Mine Site
Water Supply and Domestic Sewage Ponds

Lupin Mines Incorporated
ELGIN MINING INC.
Figure: 4
Rev: 120328





Legend

- Water Body from 50k Topo
- Roads
- Water Sampling and Discharge Location

Coordinate System: NAD_1983_UTM_Zone_12N
NTS Map Sheets 076E11 and 076E14

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Approved By: SH
Project No.: LUP

Prepared By: PW
Date Revised: 28 Mar 2012

File Name: Lup-12-15-04-AbandReclamPlan-WaterSamplingLoc-A.mxd

Project: **Lupin Gold Mine**
Location: Kitikmeot Region, Nunavut, Canada

Lupin Mine Interim Abandonment and Reclamation Plan
Water Licence 2AM-LUP0914

Lupin Mine
Monitoring Program Stations

Lupin Mines Incorporated

ELGIN MINING INC.

Figure: 5
Rev: 120328

Appendix B Closure Plan for Tailings Containment Area

Appendix C Studies Related to Water Licence Requirements and in Support of Reclamation Planning

Appendix D Ecological Risk Assessment for Lupin Mine Tailings Containment Area

Appendix E Response to Technical Review Comments on Lupin TCA A&R Plan

Appendix F Concordance Table to Technical Review Comments on 2013 IARP

Appendix G Cycle 3 Environmental Effects Monitoring Report, Investigation of Cause Reports and Addendum

Appendix H Addendum to the Lupin Mine 2011 EEM Interpretative Report – Response to Technical Advisory panel and Environment Canada Comments