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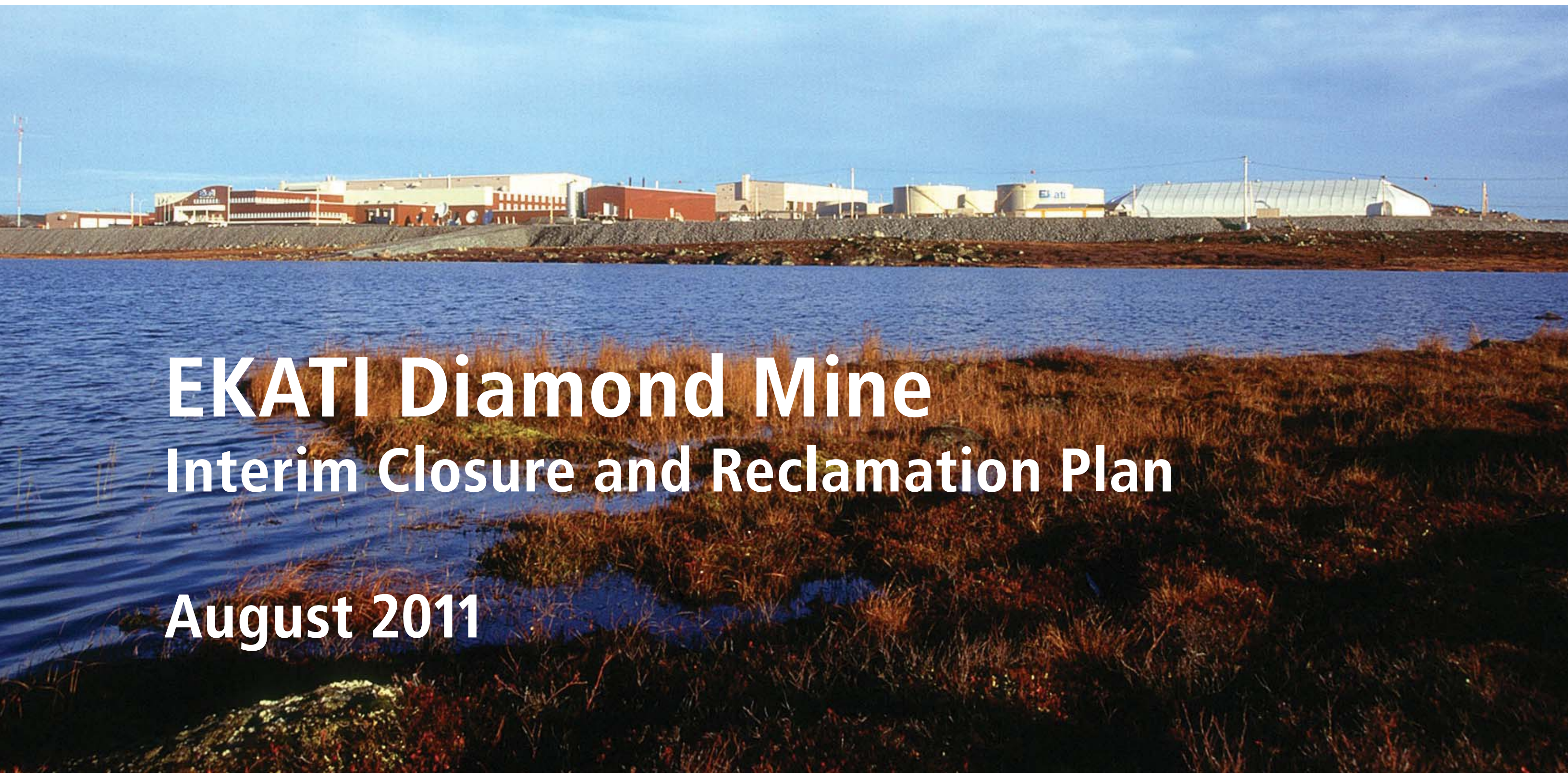

EKATI Diamond Mine
Interim Closure and Reclamation Plan

August 2011

BHP Billiton Canada Inc.
Operator of the EKATI Diamond Mine

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August 31, 2011

Wek'èezhìi Land and Water Board
#1, 4905 – 48th Street
Yellowknife, NT
X1A 3S3

Attention: Ms. Violet Camsell-Blondin, Chair

Re. EKATI Diamond Mine, Interim Closure and Reclamation Plan

BHP Billiton Canada Inc. is very pleased to provide the Board with 2 copies of the *EKATI Diamond Mine Interim Closure and Reclamation Plan, Version 2.4 (ICRP)*, which supersedes previous versions. This document is the culmination of many years of work by BHP Billiton and the parties who were involved in its review. BHP Billiton thanks the Board and its staff for their consistently professional approach throughout this long process.

This version of the ICRP represents a new landmark in planning for closure and reclamation of the EKATI Diamond Mine. One landmark aspect of this document is that it is the first Board-approved plan that encompasses the entire EKATI operation - all of its various permits and authorizations and all of its developed areas. This will enable fully integrated planning and implementation of closure and reclamation activities.

This version of the ICRP resolves all of the Board's conditions of approval that were described in its letter dated December 10, 2010 and incorporates all of the commitments documented by BHP Billiton in its letter to the Board dated April 14, 2009. The Conformity Table attached to this letter identifies where the resolution to each of the Board's conditions of approval and BHP Billiton commitments can be found within the document.

Other points of interest regarding the document include:

- Corrections of an editorial nature (punctuation, grammar, etc.) have also been incorporated.
- BHP Billiton prepared this document according to its letter to the Board dated April 7, 2011 on the Board's two new objectives related to reclamation of open pits. BHP Billiton's letter is attached to this letter for ease of reference.
- Previous versions of the ICRP included a Reclamation Engineering Study (No.6) for the "Type and Placement of Underground Plugs". That study provided for engineering design of hydraulic (water-tight) plugs in the underground workings beneath the Panda, Koala and Koala North open pits to ensure permanently independent water levels in the overlying pit lakes. Such design work would be premature prior to a risk-assessment on whether, or not, such plugs are desired, beneficial and reliable in the long-term. Therefore, this engineering study has been removed from Version 2.4 and the numbering of the remaining engineering studies adjusted.

The Board's December 10, 2010 letter refers to the upcoming discussion of reclamation security. The Board's directive mirrors BHP Billiton's intent and its previous discussions with other parties, including Aboriginal Affairs and Northern Development Canada (AANDC). BHP Billiton will prepare an updated security estimate based on this version (V.2.4) of the ICRP and, as per the Board's directive, will use that update as the basis for initiating discussion with other parties. BHP Billiton believes that the benefit of this approach will be that, because the workplan to be secured will have been established, the discussion of security will not be encumbered by the need to concurrently debate the contents of the workplan. BHP Billiton will keep the Board staff apprised of its progress on this issue. In keeping with this approach, Appendix 5.1-6 of previous versions of the ICRP titled "Expected Cost of Closure and Reclamation", which was blank, has been removed from Version 2.4.

Thank you for your efforts and those of your staff in managing this process to completion. BHP Billiton is pleased to now be in a position to use this document as the new platform from which planning for closure and reclamation of the EKATI Diamond Mine can be further advanced.

Please contact the undersigned at 669-6116 if you have any questions.

Sincerely,
BHP Billiton Canada Inc.

Eric Denholm, Superintendent – Traditional Knowledge and Permitting
EKATI Diamond Mine

ICRP Version 2.4 Conformity Table – Contains BHP Billiton Canada Inc (BBCI) Proposed Revisions Provided to the WLWB April 14, 2009, and WLWB Revisions from Directive December 10, 2010.

#	Revision Topic	Source of Request	Revision Details	Location of Final Edit
1	Formatting	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 1*	Section 1.1 Overview will be reviewed and updated to ensure that the reader has a clear description of the organization and presentation of the document.	Main Document, Section 1.1
2	Formatting	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 1*	Tabs will be provided for major sections for ICRP reports circulated in hard copy.	Throughout Document
3	Research and Engineering Studies	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 3*	Appendix 5.1.4 A and B will be split over 2 Appendices.	Appendix 5.1-4 (Reclamation Research Plans) & Appendix 5.1-5 (Engineering Studies)
4	Water Quality Criteria	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 4*	The document will be reviewed to ensure that: 1. Discussion and closure criteria related to water quality in receiving environments will be based on Effluent Quality Criteria. 2. Discussion on water quality in end pit lakes is based on water quality criteria. These criteria will be part of the closure water licence. Appx 5.1-1, Table 5.1.1D, Water 2 will be reviewed and corrected for consistency.	Throughout Document. Specifically - Tables 5.1-1 A,B,C,D,E&F were updated with 'Water license criteria are met'. Pg 5.151 King Pond Dam, Pg 5.174, Pg 5.185, Pg 7.27, Pg 5.121, Pg 5.153, Pg 5.156.
5	Watershed Boundaries	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 5*	The document will be reviewed and watershed boundaries will be included on those figures which represent pre-disturbance, development status, and projected development.	Main Document, Chapter 5
6	Revisions – data and information updates	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 6*	The following wording was included in the ICRP: "This document has been developed over a number of years of review and update. During this period BHP Billiton has attempted to maintain the alignment of the document to the 2005 LOM Plan to avoid confusion over scheduling and reporting. Where significant changes have already occurred in the EKATI LOM Plan these have been updated within this ICRP, specifically the use of Beartooth pit for water storage."	Main Document, Executive Summary
7	Seepage Flow Clarification	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 7*	The figure and/or associated text will be edited to include reasoning for arrows and destination of seepage flow.	Main Document, Section 4.3 Figure 4.3-2
8	Beartooth Pit as Mine Water Storage	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 8*	A mention will be included in the document that the use of Beartooth for mine water storage and the resulting change of timing of Beartooth pit reclamation are dependent on approval of the WWPKMP by the WLWB.	Main Document, Section 5.2.3.3.
9	Beartooth Pit Mine Water Storage	*BBCI ICRP Revisions Table, Apr 14 2009*	The research plan for pit lake water quality will be revised to incorporate concept level research (including research schedule) on the inclusion of	Appendix 5.1-4, Research Plan # 3. Task 1.

#	Revision Topic	Source of Request	Revision Details	Location of Final Edit
		Item # 9	underground or other mine water in Beartooth Pit at mine closure.	
10	Source Lakes	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 10*	The research on source lake water withdrawal will be reviewed to ensure that additional detail is provided to address the following: 1. The duration of existing flow monitoring time series and method of data collection for the outflow of proposed source lakes, 2. The duration of existing water level monitoring time series, and the method of data collection for the proposed source lakes, 3. The basis of the runoff coefficient value(s), 4. Water balance sensitivity approach to wet and dry years, 5. Methodology that uses field data on wetted perimeter, channel width and maximum channel depth to estimate potential effects over the entire range of pumping rates, to estimate potential effects on stream fish habitat during dry years, 6. The use of hydrographs to demonstrate reduction in recovery times for source lakes and streams, relative to average, wet and dry years. Verification Comment 38 (JW-21 in Verification Table) requested detail on how successive dry years would affect the time to pump fill pits. This question is now being addressed in Research Plan 3: Pit Lakes Water Quality, Task 4: Water Balance, rather than in Research Plan 2: Water Withdrawal from Source Lakes. Verification comment 39 (JW-22 in Verification Table) speaks to an ICRP statement (ICRP page 5-42) regarding a 15 day reduction of flow duration (a shortening of the open water season stream flow by 15 days). The 15 day reduction is conceptual and based on average conditions. More detailed analysis on the period of flow reduction in streams will be included in Research Plan 2 (as noted in the last bullet above).	Appx 5.1-4, Research Plan # 2. 1. Section 2.4.1.2 2. Section 2.4.1.2 3. Section 2.4.1.1. 4. Section 2.4.1.6. 5. Section 2.4.1.6 6. Section 2.4.1.6.
		WLWB Directive Dec 10, 2010.	<u>From WLWB Directive Dec 10 2010. pp 2 of 5, Section 2.1 Research Plan # 2:</u> Please make the following changes: a. Table 1 should be updated to reflect current expectations of timelines and the RRP should mention the completion of the fish habitat assessment report for Upper Exeter and Ursula and how it will be used to inform closure planning at EKATI (Appendix 1 of the *RFD* – DFO-*7)*.	Section 2.4.1.6
11	Misery Pit Filling Time	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 11*	The pumping duration for Misery pit should be 5 years. The value in the table will be corrected.	Main Document, Section 5.2.8.3, Table 5.2-15
12	Misery Pit Lake Water	*BBCI ICRP Revisions*	BHP Billiton will (if possible) provide annual estimates of the water	Appendix 5.1-4, Research Plan # 3.

#	Revision Topic	Source of Request	Revision Details	Location of Final Edit
	Quantity	*Table, Apr 14 2009 Item # 13*	volume in the Misery Pit during suspension of operations.	Section 3.3.1, Task 9
13	Fish Barriers	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 14*	The section will be updated to state that fish barriers will be designed for long term performance but in contemplation that they may ultimately be subject to removal after BHP Billiton has been released from all remaining liability for the site.	Main Document, Sections: 5.2.5, 5.2.7, 5.2.8, 5.2.9, 5.2.11, 5.5.5.6, 5.5.7, 5.5.9, Table 5.5-8.
14	Shallow Zones	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 15*	Section 5.2.8.1 will be updated to state "Reclamation strategies for open pits at EKATI include the construction of shallow zones at pit water edges. The purpose of the shallow zones will be to provide safe access and egress areas at the pit perimeter for people and wildlife. Rock armoring and/or establishment of riparian vegetation will also be used to stabilize potential erosional areas around the pit perimeters. The following research plans and engineering studies are in place to address how pit perimeters will be reclaimed: • Pit safety for wildlife during pit flooding, through the use of berms or other deterrent structures (Research Plan 1), Establishment of Self-Sustaining Plant Communities at Open Pits (Research Plan 4), • Vegetation Cover and Surface Stability at Open Pits (Research Plan 5), • Final Pit Perimeter Stability (Engineering Study 1), • Final Topography of Final Pit Perimeters (Engineering Study 2). *This study will be reviewed to ensure that concept shallow zones design has been included as a study task.* Fish habitat will not be constructed in pit lakes based on formalized agreements (Fisheries Act Authorizations) between DFO and BHP Billiton, which are referenced in Section 1.2 and Appendix 1.1-4 of the ICRP. Therefore barriers will be constructed to prevent fish access into pit lakes. Fish barriers will be designed for long term performance but in contemplation that they may ultimately be subject to removal after BHP Billiton has been released from all remaining liability for the site." The ICRP sections and tables will be reviewed to ensure the discussion on pit reclamation plans and activities aligns with the above.	Main Document, Section 5.2.8.1
15	Pit Lake Final Landscape	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 16*	Citation will be included for completed research studies outlined on page 5-27. Citation will be included to support talik zone discussion on page 5-27.	Main Document, Section 5.2.5.1. References, updated with appropriate references.
16	Beartooth Pit Figure	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 17*	The figure will be expanded to include northern portions of the developed area.	Main Document, Figure 5.2.3
17	Pit Lake Channel	*BBCI ICRP Revisions*	In Section 5.2.5.2, Reference to Appendix 5.1-5, Research Plan 2 (Task	Main Document, Section 5.2.5.2.

#	Revision Topic	Source of Request	Revision Details	Location of Final Edit
	Designs	*Table, Apr 14 2009 Item # 18*	2) will be included.	
18	Underground Plugs	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 19*	Section 5.2.5.2. Reference to Appendix 5.1-5, Research Plan 6 will be included. Main Document - Removed this wording as Underground Plugs Research is no longer included. BBCI will conduct a risk assessment to determine whether to install plugs in the underground.	Main Document, Section 5.2.8.3
19	Reclamation Activities Tables	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 20*	Tables in Chapter 5. The end of reclamation activities and the start of monitoring will be included in the Reclamation Activities tables.	Main Document: Tables 5.2-9 to 15 Tables 5.3-3 to 5.3-5 Tables 5.4-9 to 14 Tables 5.5-7 & 8 Tables 5.6-2 to 8 Tables 5.7-3 to 10.
20	Underground Facilities	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 21*	The section (Section 5.3-2) will be reviewed and checked to ensure that Table 5.3-1 contains the complete list of underground infrastructure.	Main Document, Table 5.3-1
21	Underground Elevation Levels	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 22*	The section (Section 5.3-4) will be reviewed for approximate underground mine final elevations.	Main Document, Section 5.3.4
22	WRSA Ground Temperature Data	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 23*	The relevant tables/figures in the ICRP (Section 5.4.3.4) will be updated to reflect current temperature readings.	Main Document, Figures 5.4-7 to 5.4-10
23	WRSA Design Edits	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 24*	The wording and number in the table will be edited (*see comments from JW # 55, Comment Table Jan 2009*). The section (Section 5.4) will be reviewed and updated to ensure that it clearly states the table is operations design criteria, but that many of these designs will be carried into closure of the WRSA.	Main Document, Section 5.4, and Table 5.4-2
24	WRSA Development Status	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 25*	The section and table will be updated where possible, to ensure all text, figures and tables are referencing concurrent information/data.	Main Document, Table 5.4-3
25	WRSA Hydrocarbon Site Assessment	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 26*	An assessment of the top surface of the WRSA will be completed when WRSA are no longer required for mining operations. The Reclamation Activity tables will updated to ensure this is included.	Main Document, Tables 5.4-9 to 5.4-13
26	Post Closure Monitoring Wording	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 27*	The word 'Parameter' will be replaced with a more appropriate description of focus areas for closure monitoring.	Main Document, Sections: 5.2.12, 5.3.10, 5.4.11, 5.5.12, 5.6.11, and Tables in Appendix 5.1-6
27	Airstrip Lake	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 28*	A label for Airstrip Lake will be included in the Figure 5.5-1.	Main Document, Figure 5.5-1
28	Processed Kimberlite	*BBCI ICRP Revisions*	The section (Section 5.5.3.2) will be reviewed and appropriate citation	Main Document, Section 5.5.3.2

#	Revision Topic	Source of Request	Revision Details	Location of Final Edit
	Deposition	*Table, Apr 14 2009 Item # 29*	included for the processed kimberlite volumes.	
29	LLCF Watershed Boundaries	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 31*	Watershed boundaries will be included in this figure (Figure 5.5-6).	Main Document, Figure 5.5-6
30	LLCF Vegetation	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 33*	Reference to fertilizer applications will be inserted.	Main Document, Section 5.5.5.3
31	LLCF Dikes	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 34*	The section (*Main Document Section 5.5.5.6*) will be reviewed to ensure effects to water quality downstream of filter dikes are included.	Main Document, Section 5.5.5.7 and Section 7.6
32	Panda Diversion Channel	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 35*	The figure will be reviewed to ensure the transition area (cut area to non-cut areas) at the side of the channel in included. The following revision will be made to Section 5.6.4.2. Access to the channel benching would likely be provided by ramps constructed from the channel crest on either end of the stabilization zone. Site access will be finalized during design.	Appendix 5.1-2: Fig 5.1-2E (a) and Fig 5.1-2E (b) Main Document, Section 5.6.4.2
33	Panda Diversion Dam Ground Temperature	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 36*	The figure will be updated to 2007 data.	Appendix 5.1-2: Fig 5.1-2F (a) and Fig 5.1-2F (b)
34	Bearclaw Lake Jetty	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 37*	The section will be reviewed to ensure the reason for the jetty to remain in place is included.	Main Document, Section 5.6.5.2
35	King Pond HIS Scores	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 38*	A reference for HIS scores for King Pond Settling Facility will be included.	Main Document, Section 5.6.5.3
36	Panda Diversion Channel Reclamation Activities	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 39*	The table (Table 5.6.5) will include a date for start of Reclamation Activities.	Main Document, Table 5.6-5
37	Road Reclamation	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 40*	The section (Section 5.7.9.10) will be reviewed to ensure information is provided on reclamation of berms, stream crossings and road treatment for closure. Hazardous areas will be evaluated more closely at the time of reclamation activities.	Main Document, Section 5.7.9.10
38	Buildings and Infrastructure Research	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 41*	The section (Section 5.7.7.1) will be reviewed to ensure appropriate references are included.	Main Document, Section 5.7.7.1
39	Airport Vegetation Reclamation	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 42*	The section (Section 5.7.9.11) will be reviewed and an explanation of how the monitoring results inform reclamation success will be included.	Main Document, Section 5.7.9.11, and Research Plan # 24, Section 4.5
40	Open Pits Closure	*BBCI ICRP Revisions*	Appendix 5.1-1, Table 5.1-1A Water 1 and 2 will be updated to ensure	Appendix 5.1-1. Table 5.1-1a – Water 1, b); Water 5 & 6.

#	Revision Topic	Source of Request	Revision Details	Location of Final Edit
	Objectives and Criteria	*Table, Apr 14 2009 Item # 43*	references are provided to appropriate documentation on lake and stream levels, and on water quality and fish habitat in source lakes. All tables in Appendix 5.1-1 will be reviewed to ensure all appropriate research and monitoring plans are referenced.	Table 5.1-1d – Water 2 & 3.
41	Hydrocarbon Closure Objectives and Criteria	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 44* WLWB Directive Dec 10, 2010.	The section (Section 5.7.9.13) will be updated to state that soil remediation standards for hydrocarbons will follow the the CCME guidelines. The numerical remediation criteria will be derived for the Final Closure and Reclamation Plan based on a site assessment using the Tier 1, 2 or 3 approach as described in the CCME documentation that is in effect at that time. At this time and based on the current CCME guidelines it appears that the agricultural land use classification is the most representative surrogate for the desired future land use of "wildlands" as described in the 1995 EIS as "*productive use of land, with wildlife designated as the principal land user, in additional to limited use of cultural and natural resources of the area by Aboriginals*." BHP Billiton will continue to cleanup and report hydrocarbon spills at the minesite, followed up by INAC inspection. Please refer to the attached Memorandum on the Review of Closure Remediation Requirements for Hydrocarbon-Contaminated Soils at EKATI, completed by Rescan Environmental Services Ltd, April 14, 2009. <u>From WLWB Directive Dec 10 2010. pp 2 of 5, Section 1.3:</u> BHPB must revise the ICRP to reflect an 'agricultural standard' for the remediation of hydrocarbon contaminated soils, including appropriate closure criteria where necessary (Appendix 1 of the *RFD* - IEMA-14).	Main Document, Section 5.7.9.13, and Appendix 5.1-1 (Tables 5.1-1a; Table 5.1-1c; Table 5.1-1d; Table 5.1-1e; Table 5.1-1f).
42	Wildlife Closure Objectives and Criteria	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 45* WLWB Directive Dec 10, 2010.	Tables in the Appendix 5.1-1 will be reviewed to ensure consistent wording is used for wildlife closure objectives and criteria, and that the WEMP is referenced appropriately. *Tables in Appx 5.1-1 were updated to included the RRP # 27 – for Mine Component Wildlife Closure Objectives and Criteria.* <u>From WLWB Directive Dec 10 2010. pp 2 of 5, Section 1.4:</u> See requirement below (section 2.5c) for an additional reclamation research plan to set component-specific wildlife closure objectives and closure criteria. Considering that these closure objectives need to be set before other uncertainties (e.g. wildlife movement) can be clarified, developing these closure objectives is a top priority and this should be reflected in the RRP timelines. The Board expects the company to demonstrate progress on this issue and report on this in the first *Annual CRP Progress Report* (see section	Appendix 5.1-1, All Tables. Appendix 5.1-4, Research Plan # 27.

#	Revision Topic	Source of Request	Revision Details	Location of Final Edit
			4.0 of this Directive).	
43	Reclamation Research Plan	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 46*	The Reclamation Research Plans will be updated to that outlined in the WLWB Feb 4, 2008 letter. The Engineering Studies will also be updated, using the same format in the Research Plan.	Appendices 5.1-4 and 5.1-5
44	LLCF Pilot Studies	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 47*	The section (Section 5.5.4.2) will be reviewed to ensure BHP Billiton states that opportunities for earlier research will be sought at the LLCF.	Main Document, Section 5.5.4.2
45	Salinity Stability in Fox Pit Lake	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 48*	The text associated with Figure 7.4-1 will be updated to include a definition of salinity stability.	Main Document, Section 7.4.3
46	Upper Exeter Substrate Composition	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 49*	The text associated with Figures 7.4-5 and 7.4-6 will be updated to include details of the methodology used to determine substrate percentages.	Main Document, Section 7.4.7.3
47	Reference	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 50*	Section 7.8.3. The appropriate reference for 'further work' will be included.	Main Document, Section 7.8.3
48	Units of Measure	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 51*	The document will be reviewed to ensure consistent units are used throughout the ICRP.	Full Document
49	Environmental Assessment	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 52*	Chapter 7.0 will be updated to include a summary discussion of predictive water quality modeling for specific sites at EKATI, including the LLCF at closure and pit lakes. The TOR specified the requirement for a "site-wide predictive water quality model." BHP Billiton and their consultants have reviewed this reference section and believe the development of a site wide model is neither technically appropriate or required, practical, nor reasonably manageable. Rather than developing a site-wide water quality model, BHP Billiton has developed a set of modeling tools to address water balance and water quality at EKATI. These have included published work on LLCF water balance, mass balance and water quality predictions (e.g. Rescan, 2008a,b), hydrodynamic modeling of downstream lakes (e.g. Rescan, 2007), and unpublished modeling work on water quality downstream of the LLCF. Ongoing work is in development to predict the water quality of EKATI pit lakes using a set of modeling tools. The nature of the water quality work undertaken for the EKATI site does not lend itself to a single unified site-wide model. Such a unified modeling approach would severely limit the applicability of the model by not allowing the most appropriate modeling tools to be used given the nature of the question being addressed and the available data. BHP Billiton believes its approach to water quality modeling at EKATI is technically more sound than using a single site-wide model.	Main Document, Sections 7.4.2 and 7.4.3, and References

#	Revision Topic	Source of Request	Revision Details	Location of Final Edit
			Rescan. 2007. EKATI Diamond Mine: Proposed Discharge Criterion for the Sable Kimberlite Pipe Development (Water License MV2001L2-0008). Prepared for BHP Billiton Diamonds Inc. by Rescan Environmental Services Ltd., January 2007. Rescan. 2008a. EKATI Diamond Mine: Long Lake Containment Facility Water Quality Prediction Model Version 1.0. Prepared for BHP Billiton Diamonds Inc. by Rescan Environmental Services Ltd., March 2008. Rescan. 2008b. EKATI Diamond Mine: Long Lake Containment Facility Water Quality Prediction Model Version 2.0. Prepared for BHP Billiton Diamonds Inc. by Rescan Environmental Services Ltd., March 2008.	
50	Environmental Assessment	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 53*	This section was omitted in the December 2008 Final Draft of the ICRP. It will be included in Chapter 7.0. **8.5 OTHER RESOURCE USERS** Impacts to other resource users within the localized area of the minesite will be presented in this section.	Main Document, New Section 7.9
51	Environmental Assessment	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 54*	This section was omitted in the December 2008 Final Draft of the ICRP. It will be included in Chapter 7.0. **8.6 ENVIRONMENTAL IMPACTS** Methods and procedures to stabilize and mitigate potential impacts to wildlife, terrestrial and aquatic environments during the reclamation process will be included for the overall minesite. These will include management of erosion, remediation of contaminated sites, groundwater contamination, impacts to aquatic environments, and wildlife safety.	Main Document, New Section 7.10
52	Open Pits	WLWB Directive Dec 10, 2010.	<u>From WLWB Directive Dec 10 2010. Pp 1 or 5, Section 1.1</u> 1.1 Open Pits Include the closure objective of facilitating the establishment of a self-sustaining aquatic ecosystem in the pit lakes as discussed in Sections 1.0 to 1.3.5 of the *Reasons for Decision*. The closure criteria should state that the pit perimeters and any other feature necessary to promote the objective is 'built as designed'. This	**Main Document**, Section 5.2.5.1. Figure 5.2-13, Table 5.2-4. Section 5.2.7. Section 5.2.8.1. Tables 5.2-9 to 5.2.15. Appendix 5.1-1, Table 5.1-1A (Water 5 & 6). Appendix 5.1-1, Table 5.1-1D (Water 3)

#	Revision Topic	Source of Request	Revision Details	Location of Final Edit
			criterion is recommended with the understanding that best efforts will be made in the design of the pit perimeters and connector channels and that the final design will be for Board approval. The ICRP should be updated to include all of the reclamation activities and research necessary to achieve this objective.	
53	Fish Passage	WLWB Directive Dec 10, 2010.	From WLWB Directive Dec 10 2010. Pp 1 or 5, Section 1.2 Section 1.2 Fish Passage Include the closure objective of making the pit lakes and Cell E safe for fish passage as discussed in section 1.4 to 1.4.4 of the *Reasons for Decision*. One of the closure criteria for this objective is a requirement that all parties, including DFO, agree that conditions are safe for fish before fish passage is allowed. Refine any objectives or criteria that refer to fish barriers around the pit lakes or Cell E so that it is clear that barriers may be necessary, but if installed, will be removed by BHJPB following agreement that conditions are safe for fish passage and as directed by the WLBWB. Also remove the closure objective(s) and any references to permanently preventing fish passage to the open pits and Cell E. The ICRP should be updated to include all of the reclamation activities and research necessary to achieve this objective (RFD – Section 1.4-1.4.4)	Main Document, Section 5.2.5.2 & Section 5.2.7 Appendix 5.1-1, Table 5.1-1A (Water 5 & 6). Appendix 5.1-1, Table 5.1-1D (Water 3).
54	LLCF Permafrost Research	*BBCI ICRP Revisions Table, Apr 14 2009 Item # 55* WLWB Directive Dec 10, 2010.	In the Feb 18, 2009 Verification Table # 97 the issue has been stated as resolved. This is not yet resolved since at the Feb 3, 2009 Working Group meeting INAC had not yet produced Chris Burn's review of the research plan, and BHP Billiton had not been given an opportunity to respond. BHP Billiton will review the comments received from INAC on the LLCF permafrost research and will continue to work with INAC on discussing LLCF permafrost issues, and any agreed updates will be made to Research Plan 13. From the WLWB Dec 10 2010 Directive (see Appendix 1 Table of that Directive. ID INAC-4): BHP should update Research Plan # 13 to include the information identified by INAC. Also WLWB Directive (2.2a). Modify the plan to include BHP Billiton's proposed approach for collecting deep pore-water samples in the LLCF, including potential sample locations and any additional studies that may be necessary to strengthen model predictions.	Appendix 5.1-4, Research Plan # 13
55	LLCF Permafrost Research	WLWB Directive Dec 10, 2010.	From the WLWB Dec 10 2010 Directive (see also Table in Appendix 1 of that Directive. ID INAC-5): BHP should update Research Plan # 13 to include the requested information as highlighted below.	Appendix 5.1-4, Research Plan # 13

#	Revision Topic	Source of Request	Revision Details	Location of Final Edit
			Also WLWB Directive (2.2b) Modify 'Task 9 of the plan to ensure that the 'Consolidation and Freeze Concentration Testing Study' is done on a range of grain size representatives of the different depths within the LLCF.	
56	EFPK in LLCF	WLWB Directive Dec 10, 2010.	From WLWB Directive Dec 10 2010. pp 3 of 5, Section 2.3. Please make the following changes (Refer also to Appendix 1 of the *RFD* – IEMA-8): a. Include field investigations to evaluate the extra-fine processed kimberlite (EFPK) stabilization measures as a research task; b. Include the investigation of other storage options for EFPK as a research task; c. Discuss in more detail how BHP Billiton will use all of the information they are collecting on the properties and characteristics of EFPK to confirm containment post-closure; d. Update the proposed timelines to ensure that all of the tasks are completed and the results analyzed prior to the anticipated date for when a decision would be made regarding pumping processed kimberlite into Cell D.	Appendix 5.1-4, Research Plan # 14
57	Vegetation Objective – Criteria for LLCF	WLWB Directive Dec 10, 2010.	From WLWB Directive Dec 10 2010. pp 3 of 5, Section 2.4a: Please make the following changes: a. Add the two tasks, as explained in BHPB's response to IEMA – 10 in Appendix 1 of the *RFD*, along with sufficient details of how these tasks will be carried out and inform the closure planning process. *BHPB response to IEMA Intervention July 26, 2010:* *BHPB recognizes the importance of reviewing and determining applicable closure criteria to measure vegetation success. Research Plan # 17 focuses on plant cover and the appropriate percentage of cover on the LLCF that ensures surface stability. Closure objectives and criteria are also in place for native plan use.* *The company agrees that uncertainties exist around the types of plant communities that will establish on processed kimberlite and how the success of plant sustainability will be measured. Therefore Research Plan # 16 will be updated to address this uncertainty, through the following tasks:* *a) Determine what closure objectives and criteria can be used to*	Appendix 5.1-4, Research Plan # 16, Tasks 6 & 7 (Section 16.5.1).

#	Revision Topic	Source of Request	Revision Details	Location of Final Edit
			indicate that plant communities on the LLCF have reached a satisfactory level of resilience to natural and man-made perturbations, evidencing that the community will eventually reach a stable, self-sustaining state. b) *Research plant community characteristics needed to indicate stability, and how they can be assessed using trend analysis.*	
58	Pit Lakes Aquatic Ecosystem	WLWB Directive Dec 10, 2010.	<u>From WLWB Directive Dec 10 2010. pp 1 of 5, Section 2.5 a.</u> The research necessary to achieve the objective of facilitating the establishment of a self-sustaining aquatic ecosystem in the pit lakes. This will require, at a minimum, research described in Section 3.7.1 of the Terms of Reference for the Sable, Pigeon and Beartooth Pit Lakes Studies (RFD – sections 1.3 and 2.2).	Main Document, Section 5.2.11. Appendix 5.1-5, Engineering Study # 2.
59	Emergent Vegetation	WLWB Directive Dec 10, 2010.	<u>From WLWB Directive Dec 10 2010. pp 3 of 5, Section 2.5b:</u> b. Ensure that appropriate investigations regarding the inclusion of emergent and submergent vegetation vegetation in the littoral zones of the pit lakes and habitat within the connector streams are included within the Reclamation Research Plans (RFD – 1.4.2 and 1.4.4)	Appendix 5.1-4, Research Plan # 5
60	Fish Barrier Design	WLWB Directive Dec 10, 2010.	<u>From WLWB Directive Dec 10 2010. pp 3 of 5, Section 2.5c:</u> c. Refine the `Engineering Objective` for Engineering Studies Plan #4 to accommodate the potential need for temporary fish barriers (*RFD* – 1.4.2 and 1.4.4);	Appendix 5.1-5, Engineering Study # 4, Section 4.2
61	New Research Plan for Wildlife Objectives	WLWB Directive Dec 10, 2010.	<u>From WLWB Directive Dec 10 2010. pp 3 of 5, Section 2.5d:</u> d. Add a new Reclamation Research Plan to identify appropriate wildlife closure objectives and closure criteria for the EKATI site (Appendix 1 of the *RFD* – IEMA-13).	Appendix 5.1-4, Research Plan # 27
62	Panda Diversion Channel	WLWB Directive Dec 10, 2010.	<u>From Board Directive Dec 10 2010. pp 4 of 5, Section 2.5e:</u> e. As required by Part K, Item 3, the company should include a detailed plan for the progressive reclamation of the Panda Diversion Channel, including the widening of the canyon and decreasing the shoreline slopes, timelines, a discussion of uncertainties, and details of any subsequent research or engineering studies required (Appendix 1 of the *RFD* – DFO-8).	Main Document, Section 5.6.4.2 & Section 5.6.5.2, & References.
63	List of BHP Billiton	WLWB Directive	<u>From Board Directive Dec 10 2010. pp 4 of 5, Section 5.0a:</u>	Throughout Document

#	Revision Topic	Source of Request	Revision Details	Location of Final Edit
	commitments Apr 14, 2009	Dec 10, 2010.	a. Incorporate the list of commitments as outlined within item 4 of BHPB's April 14, 2009, response to the Board's ICRP Information Request.	
64	2004 Pit Lakes Studies TOR	WLWB Directive Dec 10, 2010.	From Board Directive Dec 10 2010. pp 4 of 5, Section 5.0b: b. Ensure that all 8 tasks from the approved Terms of Reference for the Sable, Pigeon, Beartooth Pit Lake Studies (the Pit Lake Studies) are incorporated into the ICRP as per the April 30th 2007 WLWB Directive.	**Task 1 (Pit Lakes TOR) Review of the State of Knowledge of Pit Lakes** - Delivered to WLWB Dec 2005. **Task 2 (Pit Lakes TOR) Review Data Requirements –** Delivered to WLWB Dec 2005. **Task 3 (Pit Lakes TOR) Waste Characterization –** Main Document Section 7.4, Appendix 5.1-4, Research Plan # 3, Task 1. **Task 4 (Pit Lakes TOR) Water Balance at Closure** - Main Document Section 7.4, Appendix 5.1-4, Research Plan # 3, Task 2. **Task 5 (Pit Lakes TOR) Pit Lakes Stability Modeling –** Main Document Section 7.4, Appendix 5.1-4, Research Plan # 3, Task 3. **Task 6 (Pit Lakes TOR) Water Load Balance Modeling –** Main Document Section 7.4, Appendix 5.1-4, Research Plan # 3, Task 4. **Task 7 (Pit Lakes TOR) Analysis of Fish Habitat and Fish Communities.** Pit Lakes Fish Passage Design - Main Document Section 5.2.5, Appendix 5.1-5 Engineering Study # 2; Water Extraction – Main Document Section 7.4, Appendix 5.1-4, Research Plan # 2. **Task 8 (Pit Lakes Studies TOR) Studies to Develop Contingency Plans for Loss of Pit Lake Physical Water Column Stability –** Main Document Section 7.4, Appendix 5.1-3, Appendix 5.1-4, Research Plan # 3, and Appendix 5.1-6 Section 5. **Tasks 9 & 10 (Pit Lakes Studies TOR) Review Pit Infilling Scenarios and Preliminary Risk Assessment for Mine Pit Flooding Closure Options**. Appendix 2.1-1 Sections 7 and 8. Appendix 5.1-3.
65	Dates and Timelines	WLWB Directive Dec 10, 2010.	From WLWB Directive Dec 10 2010. pp 4 of 5, Section 5.0c: c. All dates and timelines throughout the ICRP, and especially within the RRP's, should be updated to reflect current expectations of deadlines and completion dates.	Throughout Document
66	Additional dates/timelines	WLWB Directive Dec 10, 2010.	From WLWB Directive Dec 10 2010. pp 5 of 5, Section 5.0d: d. Any additional direction included in the comment table (Appx 1 of the Reasons for Decision).	Throughout Document

BHP Billiton Canada Inc.
Operator of the EKATI Diamond Mine

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April 7, 2011

Wek'èezhìi Land and Water Board
#1, 4905 – 48th Street
Yellowknife, NT
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Attention: Ms. Violet Camsell-Blondin, Chair

Re. Clarification on EKATI Diamond Mine Interim Closure and Reclamation Plan

In its letter dated January 7, 2011, BHP Billiton Canada Inc. indicated a need for clarification of one aspect of the Board's December 10, 2010 Decision on the Interim Closure and Reclamation Plan (ICRP) for the EKATI Diamond Mine.

BHP Billiton wishes to again emphasize that it shares the Board's view that this update of the ICRP is a very comprehensive document. The ICRP reflects the many areas of agreement that were achieved through the Company's engagement process and the Board's Working Group process.

BHP Billiton also appreciates the level of thought and effort that the Board put into creating Conditions 1.1 and 1.2 of its Decision, providing two new reclamation objectives for open pits. The reason for this clarification is to make sure that we properly understand what the Board is saying. This is a complex topic and the Board's wording is new. We believe that this clarification increases certainty in the ICRP, which continues to be one of BHP Billiton's primary environmental and business goals for this issue.

BHP Billiton has recently held helpful discussions on these two objectives with Board staff and DFO. BHP Billiton believes that it now has the clarity, as described below, needed for preparation of an amended ICRP that meets all of the Board's conditions of approval.

Condition 1.1 as provided by the Board is as follows:

> *Include the closure objective of facilitating the establishment of a self-sustaining aquatic ecosystem in the pit lakes as discussed in sections 1.0 to 1.3.5 of the Reasons for Decision.*

> *The closure criteria should state that the pit perimeters and any other feature necessary to promote the objective is 'built as designed'. This criterion is recommended with the understanding that best efforts will be made in the design of the pit perimeters and connector channels and that the final design will be for Board approval. The ICRP should be updated to include all of the reclamation activities and research necessary to achieve this objective.*

Condition 1.2 as provided by the Board is as follows:

> *Include the closure objective of making the pit lakes and Cell E safe for fish passage as discussed in section 1.4 to 1.4.4 of the Reasons for Decision. One of the closure criteria for this objective is a requirement that all parties, including DFO, agree that conditions are safe for fish before fish passage is allowed. Refine any objectives or criteria that refer to fish barriers around the pit lakes or Cell E so that it is clear that barriers <u>may</u> be necessary, but, if installed, will be removed by BHPB following agreement that conditions are safe for fish passage and as directed by the WLWB. Also, remove the closure objective(s) and any references to permanently preventing fish passage to the open pits and Cell E. The ICRP should be updated to include all of the reclamation activities and research necessary to achieve this objective. (RFD - section 1.4-1.4.4)*

Common to Conditions 1.1 and 1.2 is that:

1. The ICRP already provides separate closure criteria for water chemistry in the pit lakes. Those criteria provide for water chemistry that is not harmful for fish and, therefore, already provide the most fundamental requirement for facilitation of an aquatic ecosystem.

BHP Billiton's understanding of Condition 1.1 is as follows:

2. The phrase "facilitating the establishment of a self-sustaining aquatic ecosystem in the pit lakes" means constructing an environment in the pit lakes that may naturally evolve over time into an aquatic ecosystem that may support fish and that may be naturally self-sustaining; BHP Billiton is not responsible for monitoring or proving the establishment of a self-sustaining aquatic ecosystem.
3. Approval of the Final Design of the pit perimeters and connector channels will represent the Board's complete review of the work that is required to achieve the facilitation objective. Specifically, the concepts of "facilitating", "establishment", "self-sustaining" and "aquatic ecosystem" will be fully resolved with approval of the Final Design.
4. The facilitation objective and the "built as designed" criteria will be fully achieved when BHP Billiton has constructed according to the approved Final Design using good engineering practice.
5. The phrase "best efforts in design" means that BHP Billiton will make the good faith efforts that a reasonable and well-informed person would believe to be sufficient to achieve the best design considering the information available at the time of design.
6. The Final Design will be developed on a pit-by-pit basis, working within the unique physical and environmental constraints of each pit lake.

7. The Final Design will acknowledge that fish access into and out of the pit lakes through connector channels may be intermittent and may not be possible every year in some instances, being dependent on natural flow conditions in the small catchment areas around the pit lakes.

BHP Billiton acknowledges that the Board does not want there to be any permanent fish barriers constructed by BHP Billiton. Aside from this, BHP Billiton's understanding of Condition 1.2 is as follows:

8. The phrase "safe for fish passage" means that fish should not have any more risk of physical injury than they would typically experience elsewhere in their natural range.

9. The phrases "all parties, including DFO, agree that conditions are safe for fish before fish passage is allowed" and "barriers … will be removed by BHPB following agreement that conditions are safe for fish passage" mean that the Board will solicit comment from DFO and other parties once BHP Billiton has submitted to the Board that it believes conditions are safe for fish passage (see definition above) and that the decision on whether to allow fish passage will rest solely with the Board.

Thank you for your efforts and those of your staff in creating a path forward on this issue. BHP Billiton will amend the ICRP according to this clarification and the conditions of the Board's December 2010 approval. The amended ICRP will be submitted to the Board in August and will include new Reclamation Research Plans that support these two new objectives.

Please contact the undersigned at 669-6116 if you have any questions.

Sincerely,
BHP Billiton Canada Inc.

Eric Denholm, Superintendent – Traditional Knowledge and Permitting
EKATI Diamond Mine

EKATI DIAMOND MINE
INTERIM CLOSURE AND RECLAMATION PLAN

Version 2.4
August 2011
Rescan Project #0648-105-01

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BHP Billiton Canada Inc.

Formatting and Technical Support by:

Rescan™ Environmental Services Ltd.
Yellowknife, Northwest Territories

EKATI DIAMOND MINE
INTERIM CLOSURE AND RECLAMATION PLAN

August 2011
Project 0648-105-01
Report Version 2.4

This document was developed by BHP Billiton Canada Inc. with technical assistance provided by:

- Rescan Environmental Services Ltd.
- SRK Consulting
- Alexco Resources Corporation
- EBA Engineering Consultants Ltd.

Rescan Environmental Services Ltd. assisted with final formatting and publishing. This document is Rescan version G.1.

Executive Summary

Engineers and Scientists

Executive Summary

The EKATI Diamond Mine (EKATI) is located in the Northwest Territories, approximately 300 km northeast of the city of Yellowknife, within the Lac de Gras watershed, at the headwaters of the Coppermine River drainage basin. The EKATI Claim Block covers an area of 344,000 ha. The mine is located 100 km north of the tree line in the Arctic tundra and is accessible by air year-round or winter road for 10 weeks of the year. The closest community is Wekweèti, located 180 km to the southwest.

BHP Billiton Canada Inc. (BHP Billiton) is required under Water Licences MV2001L2-0008 and MV2003L2-0013, an Environmental Agreement and BHP Billiton Closure Standards to have in place an approved Interim Closure and Reclamation Plan (ICRP) for EKATI during active mining operations, and to update that plan on a regular basis, and when there is significant change to the Life of Mine Plan.

The purpose of this ICRP document is to satisfy both BHP Billiton's Closure Plan framework used throughout the company and the ICRP Terms of Reference established by the Water Licence MV2003L2-0013. Regulatory process of review and update of the ICRP is guided by the Wek'èezhìi Land and Water Board's (WLWB) Terms of Reference for a Working Group made up of representatives of communities, governments and the Independent Environmental Monitoring Agency (IEMA). The purpose of the Working Group was to review and comment on the working drafts of the ICRP to ensure compliance with the ICRP Terms of Reference and to recommend any changes to the WLWB and to BHP Billiton. Based on the input and recommendations from the Working Group, the WLWB makes its determination as to the content and approval of the ICRP as established by the Water Licences. Tables of Conformance have been included in the ICRP which summarize and demonstrate where specific regulatory requirements for reclamation and closure have been addressed in this document.

The ICRP is based on the EKATI Diamond Mine 2005 Life of Mine (LOM) Plan, which anticipates active mining operations until 2020. This interim plan will be updated throughout mining operations and a final closure plan will be prepared and submitted at least 2 years before end of active mining. The current reclamation and closure schedule anticipates final ICRP implementation and post-closure monitoring to be complete in approximately 2060.

This document has been developed over a number of years of review and update. During this period BHP Billiton has attempted to maintain the alignment of the document to the 2005 LOM Plan to avoid confusion over scheduling and reporting. Where significant changes have already occurred in the EKATI LOM Plan these have been updated within this ICRP, specifically the use of Beartooth pit for water storage.

The ICRP has been developed with input from many groups and agencies. Valuable contributions have come from communities impacted by EKATI operations (Kugluktuk, Lutsel K'e Dene First Nation, Yellowknives Dene First Nation, the Tlicho Government, and the North Slave Métis Alliance), and from representatives of the various government agencies: Indian and Northern Affairs Canada (INAC), the WLWB, Government of the Northwest Territories, Environment Canada, and Fisheries and Oceans Canada (DFO). Recommendations and technical information have been provided by the IEMA and technical consultants with expertise in environmental and engineering disciplines. The ICRP incorporates specific reclamation activities and objectives detailed in conformance documents that include Water Licences, the Environmental Agreement, Land Use Permits, Land Leases, Fisheries Agreements, and BHP Billiton Closure Standards.

Reclamation of the mine site is guided by the Reclamation Goal to return the EKATI site to viable, and wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment, human activities, and the surrounding environment. Closure objectives have been developed which guide the reclamation activities, and define "what success looks like" for the return of the EKATI claim block to Government authorities after closure and reclamation have been completed. Closure criteria are a set of performance-based standards that measure the performance of closure activities in successfully meeting closure objectives.

The reclamation plan for EKATI is to flood the seven open pits and connecting underground mines to create pit lakes which are once again connected with their surrounding watersheds. Three lakes have been identified as potential water sources for flooding, namely Ursula Lake, Upper Exeter Lake and Lac de Gras, and flooding will take place over a period of approximately 35 years. Additional research to determine strategies for pump flooding and other potential water sources will continue in order to optimize the pumping schedule and strategy. In addition to pump flooding, access berms will be constructed around the perimeter of the pits to deter wildlife during the flooding period. Placing fine processed kimberlite into the Panda and Beartooth pits during operations is an alternative which BHP Billiton will continue to investigate.

There are currently three waste rock storage areas (WRSA) in place and two additional WRSA are planned in the LOM plan. All WRSA have been constructed based on the original approved plans and will remain in place, encapsulating waste rock, landfill materials and coarse kimberlite rejects from processing. Permafrost has already aggraded into the piles and will continue to grow over time. The aim of closure is to maintain the permafrost status quo whereby the WRSA is at a colder temperature than the surrounding natural tundra. The design of the WRSA takes into account the permanent structure by including a stepped profile, and a flat top that prevents snow build-up and encourages growth and maintenance of permafrost in the stockpiles over the long term.

The Long Lake Containment Facility (LLCF), which contains the fine processed kimberlite, will be capped with a combination of rock and vegetation. The choice of combination addresses many of the concerns raised during the consultation process, and the ongoing research identified in this plan aims to provide answers to uncertainties associated with water quality and wildlife safety. The facility will be reconnected with the surrounding watershed through a system of external and internal drainage channels and ponds. All dikes and dams will be breached to allow flow through to occur.

In addition to the constructed drainage channels at the LLCF, the Panda Diversion Channel (PDC) and the Pigeon Stream Diversion will remain in place after mine closure. The Panda Dam will continue to assist in the diversion of watershed flow through the Panda Diversion Channel with a spillway to allow freshet flow to the Panda and Koala pit lakes. The Panda Diversion Channel will continue to direct flow around the Panda and Koala pit lakes with ongoing use as fish habitat. The Pigeon Stream Diversion will also remain in place, directing stream flow from the upper Pigeon stream to Fay Lake.

All buildings and other physical infrastructure will be removed and either buried in a landfill or shipped off site. The ground that this infrastructure was placed on will be landscaped to once again become part of the surrounding tundra ecosystem. Areas with the potential for erosion will be stabilized with either vegetation cover or waste rock. All roads, laydown pads and the airstrip will remain in place but will be decommissioned so that they are safe for human and wildlife use after the mine site is closed.

Because reclamation of the EKATI is in the interim planning stages research remains a key component of the interim closure plan. Reclamation research at EKATI is based on uncertainties that may exist in the type and extent of environmental effects remaining after mine closure. Key uncertainties such as water quality, wildlife safety and sustainability of vegetation cover, are addressed through research and engineering studies because the environmental consequences of successful reclamation are high, and in some cases there is a low amount of information available on how to complete the reclamation work. The Reclamation Research Plan for EKATI is a comprehensive document which assists in answering the question of how to reclaim mine components and define quantitative closure criteria so that closure objectives are met. Traditional Knowledge, which is given consideration alongside western science, is also included in reclamation research.

A closure monitoring plan is also in place as a method of observing and tracking the performance of reclamation work against closure criteria. Monitoring programs and schedules are tailored to individual criteria, with identified indicators, methods, evaluation, and response thresholds. Monitoring results indicate when reclamation work has been successful, or if there is a need for further reclamation work.

BHP Billiton has adopted a progressive reclamation policy, which means that reclamation will begin as early as possible, starting with areas no longer needed for mine operations. Reclamation is scheduled to continue throughout the life of the mine. For those sites that are no longer required for operations and that will be progressively reclaimed, prior to the submission of the Final Closure Plan, a detailed closure plan for these mine components will be submitted to the WLWB for review and approval.

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EKATI DIAMOND MINE
INTERIM CLOSURE AND RECLAMATION PLAN

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1. Introduction

1. Introduction

1.1 OVERVIEW

This document is Version 2.4 of the Interim Closure and Reclamation Plan (ICRP) for the EKATI Diamond Mine (EKATI) (Figure 1.1-1). It is an interim plan because EKATI's 2005 Life of Mine Plan (LOM Plan) states that mine operations will run to at least the year 2020 (Figure 1.1-2). The ICRP is conceptual in nature because BHP Billiton Canada Inc. (BHP Billiton) is still in the process of developing closure concepts, learning from its operating history and undertaking various research studies that assist with how the mine will be reclaimed. A final closure plan will be prepared and submitted at least 2 years before mine closure.

Sections 1 to 4 of this document have been organized so that the general information on project setting, mining overview and regulatory requirements for EKATI are presented as an introduction and background to the reclamation planning. Also included in the introductory sections is an outline of the communities directly affected by mining operations and closure. Appendix 1.1-1 lists of acronyms and abbreviations, and Appendix 1.1-2 lists technical terms used in this document in five languages: English, Inuinnaqtun, Inuktitut, Tlicho and Chipewyan.

The structure of the ICRP is driven by a Terms of Reference (TOR) approved by the Wek'èezhìi Land and Water Board (WLWB). Appendix 1.1-3 shows the TOR, and Appendix 1.1-4 contains a table of conformance that cross-references the components of the ICRP and the requirements of EKATI's Class A and B Water Licences, Environmental Agreement, Land Use Permits, Land Leases, *Fisheries Act* Authorizations, and *Navigable Waters Protection Act*. Appendix 1.1-5 is a plain language summary of the reclamation activities described in Section 5.

Community participation in closure planning has been a significant part of this plan's development. Appendix 2.1-1 provides the work projects and results from engagement, including community visits, mine site tours and workshops.

Section 5 is a key part of the document and provides a more detailed overview, in addition to pre-development, development status, projected development, final landscape, reclamation activities, research and post closure monitoring for the following six mine component areas:

1. Open Pits
2. Underground Mines
3. Waste Rock Storage Areas
4. Processed Kimberlite Containment Areas
5. Dams, Dikes and Channels
6. Buildings and Infrastructure

Supporting information for the reclamation activities in Section 5 is found in the following appendices:

- Appendix 5.1-1 shows the Closure Goal, Objectives and Criteria for each of the mine components.

gis no. EKA-15-002 Job No. 0648-016-01 October 14, 2008

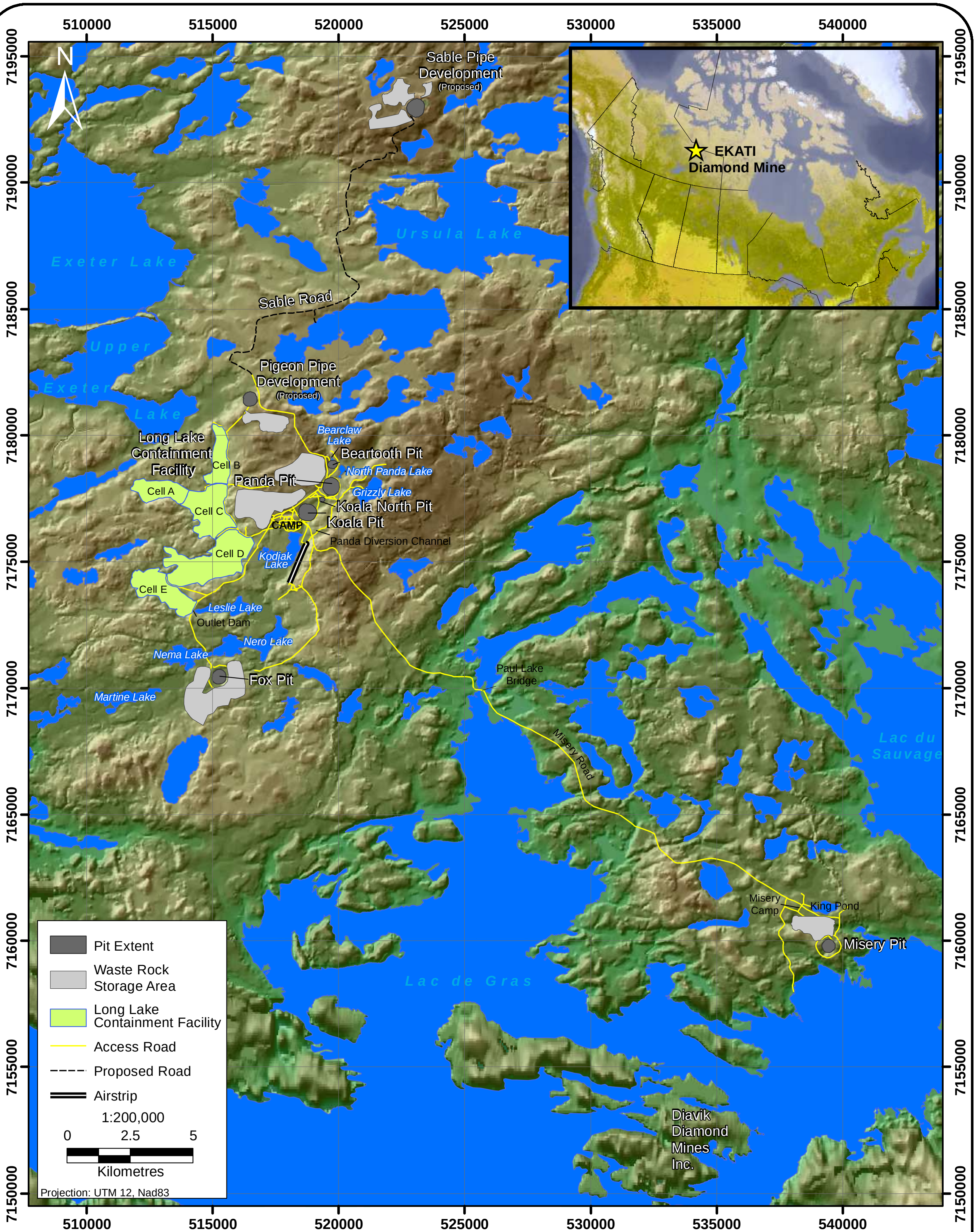

FIGURE 1.1-1

EKATI Location Map

PROJECT # 0648-105-01 ILLUSTRATION # a20927f-U July 22, 2011

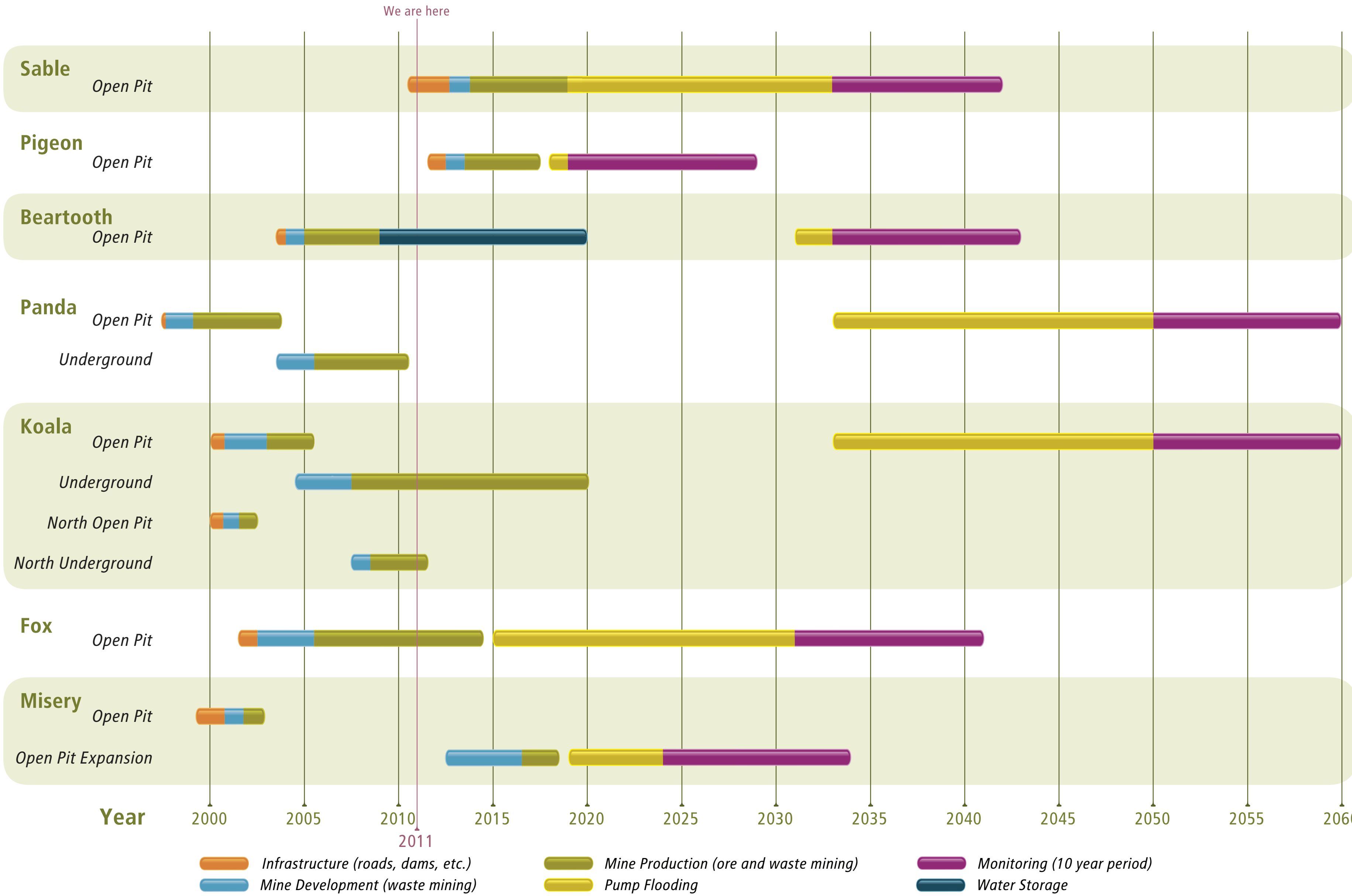

Figure 1.1-2

EKATI 2005 Life of Mine Plan (LOM) and Closure Plan

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- Appendix 5.1-2 includes the engineering summary for major infrastructure reclamation.
- Appendix 5.1-3 describes the risks and contingencies of closure planning.
- Appendix 5.1-4 describes the reclamation research studies, and Appendix 5.1-5 describes the engineering studies, that will address reclamation uncertainties.
- Appendix 5.1-6 outlines the post-closure monitoring activities and schedule following the reclamation work described in Section 5.

Section 6 outlines the work activities necessary in case of temporary closure, Section 7 describes the environment assessment that identifies the potential residual environmental effects following mining and reclamation, as well as research focused on reducing those effects, and Section 8 describes progressive reclamation reporting and scheduling.

1.2 REGULATORY CONTEXT

EKATI is a joint venture of BHP Billiton Canada Inc. (80%) and geologists Charles Fipke and Dr. Stewart Blusson (10% each). The mine is operated by BHP Billiton Canada Inc., which is a Canadian subsidiary of BHP Minerals Holdings Pty. Ltd. EKATI was first proposed in 1990 by the NWT Diamonds Project as part of a joint venture with Dia Met Minerals, the company that discovered the first diamonds in the Northwest Territories in the fall of 1991.

The application for licences and permits to conduct mining operations at EKATI began with the collection of baseline environmental data from 1993 to 1995. The Environmental Impact Statement (EIS) was completed in July 1995 (BHP and Dia Met 1995). After hearings by the federal Environmental Assessment Review Panel, approval for the mine was granted in November 1996 with 29 conditions. The permitting process concluded in January 1997 with the granting of a Class “A” Water Licence (N7L2-1616) by the Northwest Territories Water Board, an Environmental Agreement with federal and territorial governments, and a Fisheries Authorization from Fisheries and Oceans Canada (DFO) for the Harmful Alteration, Disruption or Destruction of fish habitat in six lakes and a number of interconnecting streams that would be affected by mining operations.

As part of the conditions for Part K of Water Licence N7L2-1616, an Initial Abandonment and Restoration Plan was submitted to the Northwest Territories Water Board on October 1, 1997, and approved on February 19, 1998. As part of Article VIII (section 8.1) of the Environmental Agreement, a Closure and Reclamation Plan was also required. To streamline these requirements, the 1997 Abandonment and Restoration Plan was updated to encompass both plans and to reflect changes in the plans due to new information. The resulting 2000 Abandonment and Restoration Plan (or Closure Plan) was submitted to the NWT Water Board in February 2000 (BHP Billiton 2000a) and approved in 2002.

An update to the 2000 Interim Closure Plan to include the Sable, Pigeon and Beartooth kimberlite pipes and recent development of underground infrastructure was submitted to the Mackenzie Valley Land and Water Board (MVLWB) in June 2003, as part of the requirements of the Class A Water Licence MV2001L2-0008. This closure plan was not approved by the MVLWB on the basis that it did not contain sufficient detail should the mine close before the expected end of the LOM. BHP Billiton received the renewal to Water Licence MV2003L2-0013 in September 2005. Part L of Water Licence MV2001L2-0008 and Part J of Water Licence MV2003L2-0013 require that EKATI’s 2000 Interim Closure Plan be further updated to reflect the addition of the Sable, Pigeon and Beartooth pipes to the mine plan and additional infrastructure such as Fox Pit and the underground mine developments.

Part J of Water Licence MV2003L2-0013 includes the requirement to provide a TOR for an ICRP. The TOR are the key drivers of the content of this ICRP and are based on the requirements for closure and reclamation that were outlined in the Class A Water Licences. In December 2005, the WLWB established a Working Group to review and comment on the TOR for the ICRP which were proposed by BHP Billiton, and to review and make recommendations on the ICRP Working Draft and the Final ICRP Working Draft (Delivered in December 2008). The Working Group includes representatives from the communities, regulatory agencies, the Independent Environmental Monitoring Agency (IEMA) and BHP Billiton. Based on the recommendations from the Working Group, the WLWB will then make its determination as to the ultimate content and approval of the ICRP.

EKATI's ICRP addresses all closure requirements as outlined in all of the following regulatory documents:

- ***Class A Water Licence MV2003L2-0013***. The licence was issued in January 1997 as N7L2-1616 and it expired in December 2004. The licence was amended in 2001 to incorporate the addition of the Fox development. The licence was renewed as MV2003L2-0013 on August 19, 2005, and will expire on August 18, 2013.
- ***Class A Water Licence MV2001L2-0008***. The licence was issued in August 2002 for the Sable, Pigeon and Beartooth expansion, and will expire in August 2009.
- ***Environmental Agreement***. Issued January 1997 and expires with full and final reclamation of the Project.
- ***Class A Land Use Permits***. MV2002C0040 (EKATI Claim Block) expires October 2009; MV2001F0032 (Sable Road) expires October 2008 – undergoing renewal; MV2001X0071 (Sable Pipe) expires August 2009; and MV2001X72 (Pigeon Pipe) expires August 2009.
- ***Land Leases***. 76 D9/-3-2; 76 D/9-4-2; 76 D/10-2-2; 76 D/10-5-2; 76 D/10-3-2; 76 D/10-4-2; 76 D/15-4-2; and 76 D/10-7-2. Main site lease expires November 2026, Sable November 2015 and Pigeon November 2012.
- ***Fisheries Act Authorizations***. Numbers SCA96021, SC00028, SCO1111, SCO1186 and SC99037 for the harmful alteration, disruption or destruction of fish habitat.

The following regulatory instruments have also been referenced in the update of the Closure Plan:

- ICRP TOR;
- Mine Site Reclamation Policy for the Northwest Territories 2002; and the Mine Site Reclamation Guidelines for the Northwest Territories (INAC 2007);
- *Navigable Waters Protection Act* Authorization;
- Explosives Magazine Permit;
- Licence to Manufacture Explosives; and
- Workers Compensation Board (WCB) Regulations.

1.3 BHP BILLITON'S POLICY AND STANDARDS

BHP Billiton's Sustainable Development Policy objective is to create sustainable value for our shareholders, employees, contactors, suppliers, customers, business partners and host communities. Figure 1.3-1 shows the policy.

POL.004
SUSTAINABLE DEVELOPMENT POLICY

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We stand for Zero Harm to people, our host communities and the environment and work to achieve leading industry practice. Sound principles to govern safety, business conduct, social, environmental and economic activities are integral to the way we do business.

Wherever we operate we will develop, implement and maintain management systems for sustainable development that drive continual improvement and ensure we:

- do not compromise our safety values, and seek ways to improve the health of our workforce and the community;
- identify, assess and manage risks to employees, contractors, the environment and our host communities;
- uphold ethical business practices and meet or, where less stringent than our standards, exceed applicable legal and other requirements;
- respect and promote fundamental human rights within our sphere of influence, respecting the rights of Indigenous peoples and valuing cultural heritage;
- encourage a diverse workforce and provide a work environment in which everyone is treated fairly, with respect and can realise their full potential;
- take action within our own businesses and work with governments, industry and other stakeholders to address the challenge of climate change;
- set and achieve targets, including energy efficiency and greenhouse gas intensity, that promote efficient use of resources and include reducing and preventing pollution;
- enhance biodiversity protection by assessing and considering ecological values and land-use aspects in investment, operational and closure activities;
- engage regularly, openly and honestly with our host governments and people affected by our operations, and take their views and concerns into account in our decision-making;
- develop partnerships that foster the sustainable development of our host communities, enhance economic benefits from our operations and contribute to poverty alleviation;
- work with those involved through the lifecycles of our products and by-products to enhance environmental and social performance along the supply chain and promote their responsible use and management;
- regularly review our performance and publicly report our progress.

In implementing this Policy, we will engage with and support our employees, contractors, suppliers, customers, business partners and host communities in sharing responsibility for meeting our requirements.

We will be successful when we achieve our targets towards Zero Harm, are valued by our host communities, and provide lasting social, environmental and economic benefits to society.

Through the Sustainable Development Policy and BHP Billiton's Closure Standard the company strives to achieve a number of objectives with respect to responsible reclamation and closure worldwide. The Closure Standard does not take the place of legislative or regulatory requirements within the country of operation. Therefore, when applying the procedures set out in the Closure Standard, relevant legal frameworks shall also be complied with.

The following is an extract of the seven closure requirements in the BHP Billiton Closure Standard:

- ***Closure plans are required for all investment opportunities***. Systems are in place to ensure that closure plans are developed for all investment opportunities in accordance with the requirements of the BHP Billiton Investment Process Manual, Capital Investment Standards and this Closure Standard, irrespective of the estimated closure cost.
- ***Closure plans are required for all operations***. Systems are in place to ensure that closure plans are prepared for all existing operations. Closure plans shall be reviewed annually and updated every 3 years to ensure that they continue to remain relevant and accurate, particularly with respect to the estimated cost of closure.
- ***Identify risks and potential outcomes***. The closure planning process must identify the full range of risks and potential outcomes associated with the closure of an operation in order to control or minimize negative impacts on components of Health, Safety, Environment and Community (HSEC) and on finance.
- ***Estimating the expected cost of closure***. Systems are in place to ensure that closure plans have matched valuations in accordance with the BHP Billiton Investment Evaluation Standards, and that the accounting provisions for closure apply with the BHP Billiton Accounting Policy Manual.
- ***Timely and efficient execution of closure plans***. Systems are in place and key performance indicators are aligned to ensure that those parts of an operation that are available for closure and/or contemporaneous rehabilitation are attended to efficiently and without delay or deferral.
- ***Reporting, audit and governance procedures***. Closure planning processes and closure plans shall be subject to reporting, audit and governance procedures.
- ***Application of project management practices***. Operations in the closure execution phase shall employ appropriate project management practices (BHP Billiton 2004b).

1.4 RECLAMATION FRAMEWORK

The reclamation goal, closure objectives and closure criteria in the ICRP will be used to define specific performance requirements to be met during progressive reclamation and implementation of the ICRP. Figure 1.4-1 shows the framework of the reclamation goal, closure objectives and criteria for EKATI.

The following sections outline reclamation definitions specific to EKATI, and summarize the closure objectives and closure criteria for the mine site components and infrastructure. These objectives and criteria have been developed through onsite mining and reclamation experience, from successful examples of closure at other northern mining operations, as well as reference from the INAC Mine Site Reclamation Guidelines for the Northwest Territories. Applicable information was also drawn from other industries. The following definitions are provided as a guide to establishing consensus on how the Reclamation Goal, Closure Objectives and Criteria will be achieved at EKATI.

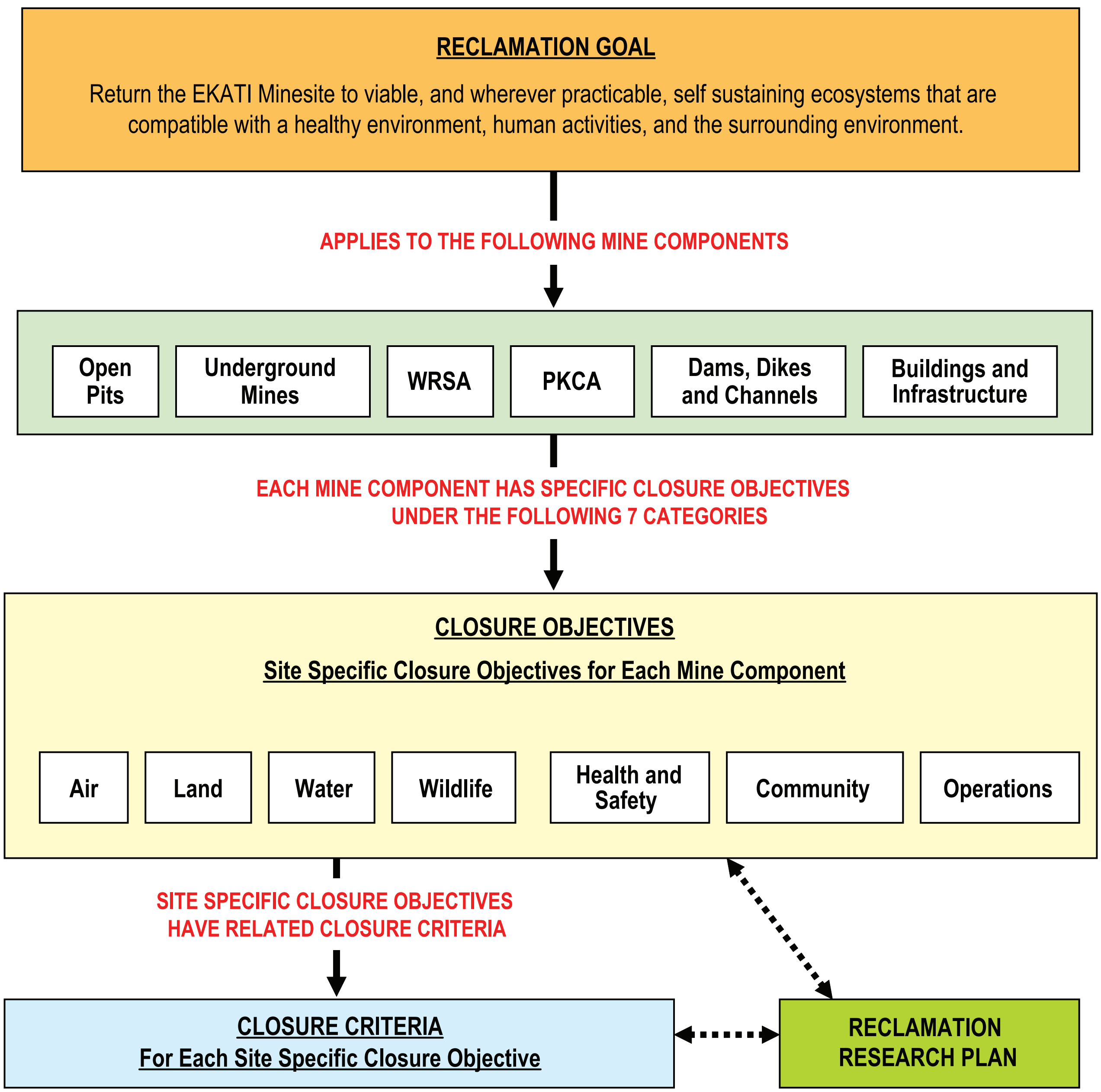


Figure 1.4-1

ICRP Reclamation Framework

- ***Reclamation Goal.*** The reclamation goal is referenced from the INAC Mine Site Reclamation Policy for the NT, and provides the paramount vision and purpose of reclamation at EKATI. The goal is met when BHP Billiton has satisfied all closure objectives.
- ***The Reclamation Goal for the EKATI Diamond Mine is to return the EKATI Mine site to viable, and wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment, human activities, and the surrounding environment.***
- ***Mine Component Groups.*** The mine components have been organized into the six major sites and/or infrastructure groups which have similar physical and/or chemical structures, and are similarly related in reclamation planning and application of closure objectives and criteria.
- ***Closure Objectives.*** The closure objectives define and describe what the ICRP is aiming to achieve for each of the six mine component groups. They are narrative statements established to protect and maintain the physical, chemical, and biological integrity of the land and water after mine operations have ceased and the mine site has been reclaimed.

  The closure objectives have been organized into seven categories. Air, Land, Water, Wildlife and Community (Heritage Sites) represent the major Valued Ecosystem Components (VEC's) developed through environmental assessment and which attribute to having scientific, social, cultural, economic or aesthetic value. The category of Health and Safety takes into account BHP Billiton's Sustainability Policy which aspires to "zero harm to people, our host communities and the environment" and to making sure the land and water are safe for people to use after the mine site is closed. The Operations category ensures that the reclamation objectives related to administrative and compliance requirements are met. These include appropriate management of documentation and compliance with standards outside of the water licences and Environmental Agreement (*e.g.,* the Mine's *Health and Safety Act* and ISO 14001 Standards). Appendix 5.1-1 summarizes closure objectives for EKATI.
- ***Closure Criteria.*** Closure criteria are a set of performance-based standards that measure the performance of closure activities in successfully meeting closure objectives. Response thresholds are in place to trigger investigation when closure criteria may not be met, and if corrective actions are necessary, reassessment of the monitoring period is required, or if the deviations to the reclamation performance should be managed through an adaptive management approach. Appendix 5.1-1 summarizes closure criteria for EKATI.
- ***Important Linkages with Closure Objectives and Criteria.*** When assessing the effectiveness of the closure objectives and criteria, it is important to recognize the relationship these have with environmental uncertainties, reclamation research and engineering studies, closure monitoring, and adaptive management. Closure objectives are target points for closing mine components, and criteria provide the measure for the end point. Early identification of uncertainties and research planning help to achieve success. Reclamation monitoring follows the progress towards reaching objectives. Unforeseen deviations are identified through monitoring and corrected through adaptive management.
- ***Environmental Uncertainties.*** These are areas of limited knowledge, or where there may be more than one possible outcome for environmental conditions after mine closure. Uncertainties may exist in the type and extent of environmental effects remaining after mine closure, whether or not reclamation activities can be completed successfully to meet closure objectives, or how to define practical, obtainable and quantitative closure criteria. Key uncertainties exist when the environmental consequences of successful reclamation are high, but there is a low amount of information available on how to complete the reclamation work, or define measurable criteria so that closure objectives have the best opportunity for being successful. Environmental uncertainties are addressed through effective reclamation

research. Chapter 5 discusses environmental uncertainties that have been identified for the individual mine component groups. The following key environmental uncertainties have been identified which BHP Billiton must address in order to achieve successful reclamation at EKATI:

- water quality in the LLCF and pit lakes;
- stability of Extra Fine Processed Kimberlite (EFPK) in the LLCF;
- wildlife safety across the mine site; and
- sustainability of vegetation.

- ***Reclamation Research.*** The reclamation research investigates, interprets and develops how reclamation will be completed. Research needs evolve through the operations, closure, reclamation and monitoring phases, with a significant portion of research effort put forward in the operations phase. Research plans also change with the direction of the LOM Planning, and when there are changes in how mine components will be closed. The Reclamation Research Plan for EKATI is a comprehensive document which assists in answering the question of how to reclaim mine components and define quantitative closure criteria. Traditional Knowledge, which is given consideration alongside western science, is also included in reclamation research. Specific focus at this stage of research is given to working with communities to identify the process of how Traditional Knowledge can be incorporated into the research plans and research activities. Individual research plans are organized under the six mine component groups and contain the following sections:

  - ***Uncertainty***. States the uncertainty that the research plan will address. Uncertainty is identified as an outstanding question on how a physical, biological, chemical, and/or geographical aspect of the mine will be addressed through reclamation and closure.
  - ***Research Question***. Identifies the question to be answered by the research.
  - ***Research Objective***. States the purpose and desired outcome of the research.
  - ***Data and Information Required***. Describes what data and information are necessary to meet the objectives and address the uncertainty.
  - ***Scope of Work (by Task)***. States the work to be completed, by task, to address the uncertainties.
  - ***Data Available and Research Completed***. Describes the data that has been collected, and research completed to date.
  - ***Identified Data and Information Gaps***. This includes an assessment of data and information gaps remaining after completed research.
  - ***Linkages to Other Research and LOM Plan***. Lists other areas of research that are linked to the research outlined. Also discusses how and when the research is linked to the LOM Plan.
  - ***Project Tracking and Schedule***. Describes the deliverables of each task in the research plan. Deliverables are presented alongside task delivery dates. As a QA/QC function the deliverables and dates are monitored and tracked by the Senior Advisor for Reclamation, as part of the reporting of reclamation planning and projects in the BHP Billiton organization (see Section 4.10).
  - ***Cost***. States the approximate costs for the reclamation research project.
  - ***References***. Includes references for completed research as well as any references available for research to be completed.

  Appendices 5.1-4 and 5.1-5 provide comprehensive schedules for all research tasks and engineering studies.

- ***Reclamation Monitoring.*** The monitoring plan for EKATI is a method of observing and tracking the performance of reclamation work against the closure criteria. Monitoring programs and schedules are tailored to individual criteria, with identified indicators, methods, evaluation, and response thresholds. Monitoring results indicate if there is a need for future management of the site being reclaimed. If monitoring results indicate a negative change from the expected progression in the reclamation process adaptive management is used to problem solve how performance is improved through corrective action. Appendix 5.1-6 summarizes the Closure Monitoring Plan, monitoring frequency and Quality Assurance/Quality Control (QA/QC) protocols for monitoring indicators and methods for EKATI.

- ***Adaptive Management.*** This is loosely defined as 'learning by doing'. It is a systematic process of modeling, experimentation and monitoring to compare the outcomes of alternative management actions. Throughout the research and reclamation process uncertainties associated with natural variability of ecosystems, incomplete knowledge of natural systems and real world constraints of management policies will arise. Adaptive management will be used to problem solve when environmental effects or deviations from measurable criteria differ from those anticipated. The watershed adaptive management plan being used by EKATI during operations is defined in Rescan (2007f), and Section 5 of Appendix 5.1-6 provides a general summary of the adaptive management proposed for reclamation.

1.5 LESSONS LEARNED

The goal, objectives and closure criteria for reclamation at EKATI have been developed and refined since the EIS was first developed in 1995. The EIS outlined the initial Reclamation and Closure Plan for EKATI. Table 1.5-1 provides a summary comparison of how the closure terminology has developed from the EIS in 1995 through to the 2000 approved Closure Plan and the current ICRP. This ICRP contains clearly defined reclamation objectives that are more comprehensive and detailed than the goals and strategies/objectives in either the EIS or the 2000 approved Closure Plan. The reclamation objectives in the current update capture all of the objectives outlined in the EIS, with the additional provision of closure criteria to measure the successful completion of closure objectives.

Capturing the experience of other reclaimed and closed mines is an important element and step in reclamation and closure planning. Lessons learned from reclamation planning throughout BHP Billiton, as well as lessons learned from actual reclamation and closure planning and execution from other northern mines, are summarized in Table 1.5-2. These lessons learned have been integrated into EKATI reclamation and closure planning within the ICRP. The table provides a current 'snap shot' of lessons learned from BHP Billiton and other northern mine sites. The table will be updated as the mine develops through operations and progressive reclamation, and as more lessons are identified from other northern sites, and from other BHP Billiton assets.

Table 1.5-1. Comparison of Reclamation Goals and Objectives

1995 Environmental Impact Statement	2000 Approved Interim Abandonment and Restoration Plan	2011 Interim Closure and Reclamation Plan
Goals • Provision of stable physical land forms. • Re-establish productive use of the land. • Protect the water resources of the project area through effective designs of water management facilities and post mining landforms. **Reclamation Strategies** • Protect the environment through sound reclamation practices. • Re-establish the pre-existing productive condition of the land or an acceptable alternative through re-vegetation or natural colonization. • Re-establish the primary use (wildlife) by creating habitat and/or promoting habitat recovery. • Minimize water quality impacts by designing and implementing landscape features and proper drainage control measures. • Ensure that the abandoned areas do not pose safety problems or health risks. **Closure Criteria** • No criteria established for closure completion.	**Goals** • Re-establish stable landforms. • Protect the water resources in the local area. • Facilitate natural recovery of areas affected by mining. **Objectives and Criteria** • No objectives or criteria established.	**Goals** • Return the EKATI mine site to viable, and wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment, human activities, and the surrounding environment. **Closure Objectives & Criteria** • Objectives and Criteria for each mine component developed and provided in Appendix 5.1-1.

Table 1.5-2. Lessons Learned in Mine Closure Planning

#	Mine Site Name	Activity Which Led to the Learning	Lessons Learned	Adaptive Management Which Resulted from the Learning
1	EKATI Diamond Mine	Infrastructure development in areas where there are caribou migration paths.	Caribou travel through and around the mine site during migration. There is a potential for caribou passage to be impeded or for caribou to be hurt or killed by mining operations infrastructure.	Wildlife access ramps were constructed on haul roads such as Misery and Fox and will be incorporated into the Sable haul road. Inokhok were constructed around the perimeter of mine components. Aboriginal elders believed that the inokhok would be most effective at deterring caribou during spring migration.
2	EKATI Diamond Mine	Reducing the volume of hydrocarbon contaminated material during operations and immediately after contamination occurs.	The volume of hydrocarbon contaminated material which is remediated at the closure of a site is often more than planned for because it was not cleaned up immediately after the spill.	Spill reporting, spill cleanup, marking the spill location and record keeping during project construction and operations are conducted at EKATI. This will reduce or eliminate the volumes remediated at closure, assists more accurate planning and costing, and helps identify the 'hot spot' (or concentrated) spill sites.
3	EKATI Diamond Mine	Construction, maintenance, operation and monitoring the Panda Diversion Channel.	The Panda Diversion Channel has successfully established fish passage and habitat.	The performance of the PDC will be used to design and construct the Pigeon Stream Diversion.
4	EKATI Diamond Mine	Reclamation research plots on the LLCF.	Direct re-vegetation on processed kimberlite and natural colonization is possible on the LLCF.	The research lessons from the re-vegetation on the LLCF can be used to design the rock/vegetation cover for the LLCF.
5	EKATI Diamond Mine	Operational monitoring programs.	Monitoring programs in place at site are effective in detecting changes and to date EKATI has had limited effect on the environment, within the bounds of the original Environmental Impact Statement.	The operational monitoring programs can be used to design effective post closure monitoring programs.
6	EKATI Diamond Mine	Wildlife monitoring.	Processed kimberlite in the LLCF is stable and safe for caribou access and travel.	Safe movement of caribou across the LLCF can be used to incorporate design features into the LLCF rock / vegetation cover.
7	EKATI Diamond Mine	Changing regulatory regimes and regulations and water licences with different water quality discharge criteria.	Changing regulatory regimes and regulations can create uncertainty in Life of Mine plans and closure planning.	Life of Mine plans and schedules may have to be altered to take into account the ability to meet new water licence discharge criteria that were not considered before.

(continued)

Table 1.5-2. Lessons Learned in Mine Closure Planning (continued)

#	Mine Site Name	Activity Which Led to the Learning	Lessons Learned	Adaptive Management Which Resulted from the Learning
8	Brewery Creek - Yukon	Dismantling of mine infrastructure and support facilities.	Removal of the fence around the process facilities exposed wildlife to a hazard in the lined ponds before the liner was removed. Removing the fence was a condition of the closure plan. Once an active human presence diminished at site, the frequency of wildlife at site increased.	A new fence was installed around the ponds until the lined ponds are reclaimed. A condition of the closure plan for Brewery Creek stipulates the liners in the ponds need to remain in place for 5 years.
9	Brewery Creek - Yukon	Construction of store and release evapotranspiration cover over surface of heap leach pad and WRSA.	The rate of infiltration in the engineered cover was significantly lower (better) than predicted by the models. Model predicted 30% infiltration compared to <10% actual. Model inputs were overly conservative.	NA
10	Brewery Creek - Yukon	Biological detoxification of heap leach pad for metals reduction.	Biological treatment systems can be successfully applied in extreme northern conditions.	NA
11	Brewery Creek - Yukon	Re-vegetation of reclaimed slopes.	The primary driver for successful re-vegetation efforts at the Brewery Creek Mine is ongoing fertilization over a period of 3 years after seed has been applied. The rate of seed application is less critical than the need for ongoing fertilizer application.	Adjust the future re-vegetation programs to include maintenance fertilizing for two additional years that were not planned.
12	Brewery Creek - Yukon	Implementation of the closure plan using company equipment and labour versus contractor.	The costs for a company to reclaim and close the Brewery Creek Mine themselves versus using third party contractors and government required security calculations resulted in a cost reduction of approximately 35% compared to the amount held in security. The costs for the company to implement and execute the closure plan were significantly lower than the costs estimated using third party contractor rates and therefore the company was over-secured.	N/A

(continued)

Table 1.5-2. Lessons Learned in Mine Closure Planning (completed)

#	Mine Site Name	Activity Which Led to the Learning	Lessons Learned	Adaptive Management Which Resulted from the Learning
13	Brewery Creek - Yukon	Negotiation and signing a Reclamation Security Release Agreement (RSRA) between the company and the government.	An RSRA provides certainty for both the company and government on security release mechanisms and provides significant incentive to the company to accelerate progressive reclamation because there is a mechanism to receive credit for the progressive reclamation.	The company initiated and secured a mechanism to release security through a Reclamation Security Release Agreement (RSRA) with the government, even though this mechanism was not already in place when the government required securities provision by the company at start up of operations.
14	Colomac Mine - NWT	Installation of fence around tailings pond during reclamation period.	Caribou became trapped in the corners of the fence by predators (wolves) due to unnatural conditions.	Fence will be removed once the tailings reclamation is complete.
15	Minto Mine - Yukon	Progressive reclamation measures linked to operational development plans for waste rock storage, overburden dumps and tailings management areas.	Reduced financial liability for closure costing and bonding. Tax incentive for company to implement progressive closure measures during mine operations.	Review operational plans and procedures to incorporate rigorous assessment and implementation of progressive closure measures.
16	Minto Mine - Yukon	Remediation hydrocarbon contaminated material during operations and immediately after contamination occurs.	Hydrocarbon soil contaminated material is expected during operations. Establishing a land treatment area for hydrocarbon contaminated soils during operations ensures prompt cleanup, remediation of material and reduced closure liability.	Design and permit on site land treatment facility for hydrocarbon soils and facility during operations to remediate contaminated soils. Reduce/eliminate the closure liability and provides source material for re-use.
17	Island Copper Mine	Reclaiming of open pit as a pit lake did not proceed as originally designed.	Use of fertilization to boost biological productivity led to a significant reduction in metals in the upper levels of the water column.	Adaptive Management based on monitoring needs to be incorporated into closure planning.
18	Polaris Mine and Nanisivik Mine	Management of hydrocarbon contaminated materials.	Placement of hydrocarbon contaminated materials in underground mine workings.	Hydrocarbon contaminated materials stabilized by encapsulation within the permafrost zone.

2. Community Involvement

2. Community Involvement

2.1 ABORIGINAL COMMUNITIES

EKATI is located in the North Slave Region of the Northwest Territories and within the Tlicho Land Claim Agreement. Aboriginal communities that are directly affected by mining at EKATI include Kugluktuk, Wekweèti, Wha Ti, Gameti, Behchoko, Ndilo, Dettah and Lutsel K'e (Figure 2.1-1).

The community of Kugluktuk is located in Nunavut north of EKATI on the Coronation Gulf. The population of 1,302 is predominantly Inuit and the traditional language of the area is Innuiaqtun. The communities of Wekweèti (the closest community to EKATI at 180 km, and population of 130), Wha Ti (located by Lac La Martre, about 164 km northwest of Yellowknife, and population of 460), Gameti (located halfway between Great Slave Lake and Great Bear Lake, and population of 283), and Behchoko (located approximately 100 km west of Yellowknife, and a population of 1,950) are all located within the Tlicho Government jurisdiction and the traditional language for these communities is Tlicho. Two Akaitcho communities of Ndilo and Dettah are located close to Yellowknife (populations 200 and 247 respectively) and are part of the Akaitcho Treaty 8 First Nation. The traditional language of these two Yellowknife Dene First Nations is Tlicho and Chipewyan. Another Akaitcho community of Lutsel K'e is located on the south shore of the eastern end of Great Slave Lake (population of 318) and the traditional language is Chipewyan. Although the North Slave Métis Alliance does not have a defined community center, it is recognized as a distinct group with values, beliefs, technologies, economy and history, with historical evidence of the ancestral use of the land within the 320 km radius of Old Fort Rae.

2.2 COMMUNITY CONSULTATION

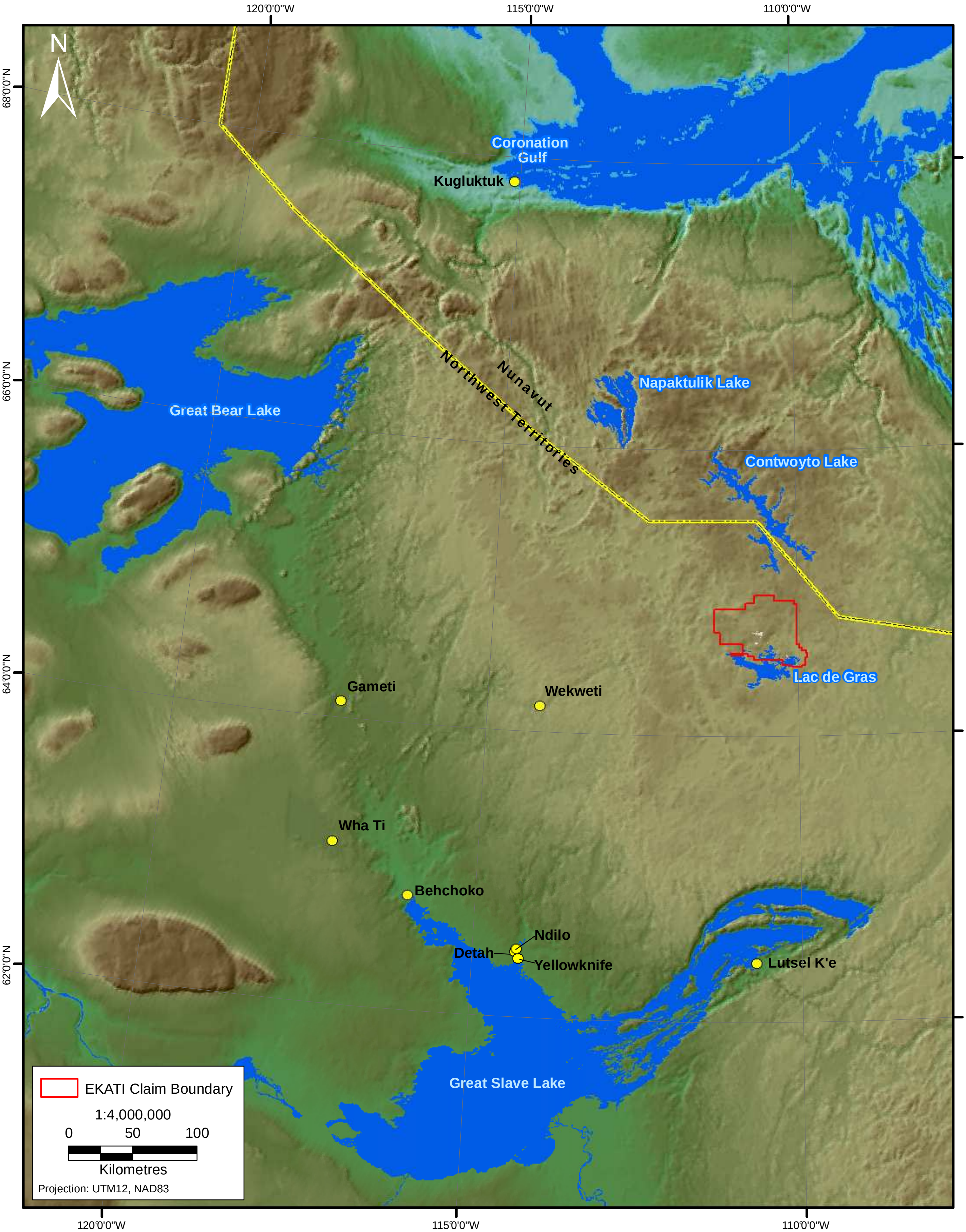
Consultation with communities is an important component of the ICRP, and it is also required by the BHP Billiton Closure Standards. Consultation requires that the Aboriginal communities noted above be provided with information on the options, have time to consider that information, be given an opportunity to respond and have the proponent respond as to their ultimate course of action in consideration of stakeholder input. Appendix 2.1-1 provides more details on the questions, comments and concerns received from the above communities during the consultation process for the development of this ICRP.

Table 2.2-1 summarizes BHP Billiton's community and regulatory consultation timelines throughout the development of this ICRP.

2.2.1 Incorporation of Traditional Knowledge

2.2.1.1 Overview

BHP Billiton's Closure Standard requires that stakeholder concerns be taken into account when considering closure. In addition, the 1997 Environmental Agreement states that all available Traditional Knowledge (TK) will be given full consideration in BHP Billiton's management of the environment. Closure and reclamation objectives for EKATI consider the expectation of stakeholders for post-closure land use and respect of traditional values. TK is currently used at EKATI in environmental operations, particularly in areas related to wildlife safety.



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EKATI Location in Northwest Territories

FIGURE 2.1-1

Rescan

Table 2.2-1. Community Consultation Summary

Date	Community/Agency
Closure Feedback during 2005 Community Mine Site Tours Opportunities were taken to discuss concerns and expectations of closure and reclamation with visiting community groups	
June 6, 2005	Community of Wekweèti
June 7, 2005	Community of Behchoko
June 13, 2005	Community of Kugluktuk
June 14, 2005	Community of Lutsel K'e
Presentation of Closure Plan Development, and Request for Closure Concerns and Suggestions Presentation of approved Closure Plan and request for concerns and aspirations for closure at EKATI	
	BHP Billiton sent invitations to the communities of Kugluktuk, Lutsel K'e, Yellowknives Dene, the North Slave Métis Association (NSMA) and the Tlicho Government, and the following agencies: WLWB, Indian and Northern Affairs Canada (INAC), the Government of the Northwest Territories, Environment Canada (EC), DFO and IEMA.
October 28 ,2005	IEMA
November 8, 2005	Community of Kugluktuk
November 15, 2005	Community of Lutsel K'e
January 30, 2006	NSMA
February 23, 2006	NSMA sent written comments on the ICRP
March 31, 2006	IEMA sent written comments on the ICRP
No responses were received from the Yellowknives Dene or the Tlicho Government	
Closure Options Discussions 1. Presentation, 2. Mine Site Tour and 3. Workshop Presentation of options under consideration for closing the large mine components, mine site tour to provide information and a chance to see the mine site, workshop to review the options and provide further input to assist BHP Billiton in selecting the methods for closure	
May 9, 2006	BHP Billiton sent invitations to the communities of Kugluktuk, Lutsel K'e, Yellowknives Dene, NSMA and the Tlicho Government, and the following agencies: WLWB, INAC, the Government of the Northwest Territories, EC, DFO and IEMA.
1. Closure Options Presentations Presentation of options for Open Pits, Waste Rock Storage Areas, Long Lake Containment Facility and the Panda Diversion Channel. This was an information session and included a request to nominate four representatives from each community and one from each agency for more detailed involvement.	
June 9, 2006	Inter-Agency Coordinating Team (IACT)
June 12, 2006	IEMA
June 25, 2006	NSMA
July 4, 2006	Kugluktuk Community (including the Community Beneficiary Committee and the Kitikmeot Inuit Association]
June 30, 2006	Community of Lutsel K'e unable to set up presentation due to other commitments in the community – BHP Billiton sent a written presentation of closure options.
No responses were received from the Yellowknives Dene or the Tlicho Government	
2. Mine Site Tour Selected representatives were given the opportunity to tour the mine site to view the components and discuss the closure options in more detail	
July 7-9, 2006	Lutsel K'e, NSMA, Kugluktuk, INAC, Government of the Northwest Territories, EC, DFO and IEMA

(continued)

Table 2.2-1. Community Consultation Summary (completed)

Date	Community/Agency
3. Closure Options Workshop Reviewed the closure options for the open pits, Waste Rock Storage Areas, Long Lake Containment Facility and the Panda Diversion Channel. Provided input (both as a group and individually) to assist BHP Billiton in their selection of the closure option for the 2011 ICRP	
July 18-21, 2006	Lutsel K'e, Kugluktuk, NSMA, INAC, Government of the Northwest Territories , EC, DFO and IEMA
June 19, 2006	The Tlicho Government declined participation due to unavailability
No response was received from the Yellowknives Dene	
Closure Objectives Review Written request for input on the global closure objectives for the EKATI site	
October 13, 2006	BHP Billiton sent outline of proposed closure objectives to the communities of Kugluktuk, Lutsel K'e, Yellowknives Dene, NSMA and the Tlicho Government, and the following agencies: WLWB, DIAND, the Government of the Northwest Territories, EC, DFO and IEMA.
October 16, 2006	Kugluktuk responded
October 31, 2006	IEMA and NSMA responded
November 6, 2006	DIAND responded
Presentation of Interim Closure and Reclamation Plan	
November 17, 2006	BHP Billiton sent an invitation to a presentation of the ICRP to the communities of Kugluktuk, Lutsel K'e, Yellowknives Dene, NSMA and the Tlicho Government, and the following agencies: WLWB, INAC, the Government of the Northwest Territories, EC, DFO and IEMA.

BHP Billiton has funded a variety of TK projects. Each Aboriginal group has determined their own level of participation in these studies, as well as the role of BHP Billiton. With some projects BHP Billiton has been an active partner and in others it has been a silent partner. BHP Billiton will continue to support TK projects at a pace determined by Aboriginal groups themselves.

Beginning with the initial environmental assessment in 1994, BHP Billiton has attempted to help Aboriginal people document and apply their TK in a way that would add to and improve environmental management at EKATI. Two examples – the Naonaiyaotit Traditional Knowledge Project and the Caribou and Roads Project – are outlined below.

2.2.1.2 Naonaiyaotit Traditional Knowledge Project

The Naonaiyaotit Traditional Knowledge Project collected information on regional movements of species such as caribou, bears and waterfowl over a span of time that covers decades and provides regional understanding of migratory paths. Although a direct translation is difficult, "Naonaiyaotit" means "seeking knowledge" or "attempting to understand". The English name for the project is "Walking in the Path of the Caribou". It is a long-term project that was initiated in 1996 during the environmental assessment of EKATI. From that initial impetus, the project developed into a land-use planning tool that provides Inuit with a means of responding to land-use applications and of integrating TK into environmental assessments throughout their area of historical and current use (KIA 2006). The project is ongoing, and throughout it there has been an ongoing dialogue between Inuit and industry about the appropriate application of traditional Inuit cultural and natural history knowledge to environmental assessment and management. The level of biological detail in the project will permit the information to be useful in mine site management. The first product – the Placenames Atlas – was released early in 2004 (KIA 2006). A series of reports in English on land use and wildlife was compiled and printed in 2006, and a GIS database was transferred to the Kitikmeot Inuit Association (KIA) by BHP Billiton in 2006 with the intention to continue training and building capacity within the community to use and apply the database.

2.2.1.3 Caribou and Roads Traditional Knowledge Project

The Caribou and Roads Traditional Knowledge Project was initiated in 2002. The objective is to address current issues with caribou on roads and near pits at EKATI. The project resulted in the formation of an Inuit Elder's Advisory Group. Examples of the types of recommendations the Elder's Advisory Group have made include:

- The use of inokhok at the mine site to deter caribou during spring migration.
- The use of gates across roads in specific areas such as on the Sable Road near the Beartooth Pit.
- The construction of a temporary fence at Beartooth Pit to protect caribou (implemented in 2006).
- New caribou road crossings where needed on the Misery, Fox and Sable Roads.
- Improving existing caribou crossings on roadways.
- Removing road berms where less obstructive solutions would meet mine safety requirements.
- Constructing berms to act as barriers where caribou needed to be deterred.
- Continuing to use people on the ground to divert caribou when necessary.

2.2.2 Traditional Knowledge in Closure and Reclamation

TK is available from Inuit, Dene and Métis who are all traditional users of the EKATI area. The Caribou and Roads Traditional Knowledge Project has demonstrated that a process and relationships can be developed involving elders and TK in a practical way. Some of the current applications of TK, such as using inokhok to deter caribou and recommendations to improve roads and berms for wildlife, will continue to be applicable for activities during reclamation and closure.

BHP Billiton is committed to the inclusion of TK in the development and implementation of the Closure and Reclamation Plan for EKATI. In order for this to be successful it is important that recommendations and plans come from the communities and their elders. There are methods currently in place to develop and include TK in the current operations and these will be further developed to include closure and reclamation. TK has been included in the ICRP as a distinctive research plan, to seek ways in which communities can bring TK into the reclamation and closure of mine components. The utilization of TK will continue to be sought and researched during the ongoing development of the ICRP and ultimately the Final Closure and Reclamation Plan.

Some preliminary areas where TK information and suggestions can be incorporated in to Closure planning include the following:

- Berms will be constructed around the pits to deter wildlife access during pit filling. Elders have already commented on areas where berms have been necessary to protect caribou, and where berms should be modified to allow wildlife to exit roads and other dangerous situations.
- Advice on the location, and design of access ramps to be used by wildlife, that will be constructed on the waste rock storage areas (WRSA) to allow wildlife access and exit from the piles.
- Advice on the cover materials on the kimberlite beaches of the LLCF can be made more wildlife friendly, including suggestions on the best types of vegetation to be used.

2.3 SOCIAL AND ECONOMIC BENEFITS

2.3.1 Overview

A number of social and economic benefits to the local and regional communities have been provided through the development and operation of EKATI. Through direct employment, contracting opportunities (for both northerners and northern Aboriginals), and a number of programs and initiatives, BHP Billiton believes the foundation has been set to create a lasting and proud legacy for the local and regional communities well after the time when EKATI has closed.

It is the vision of BHP Billiton that the staff of EKATI will eventually leave the operation with the necessary skills and abilities to provide for their families and their communities and to contribute to ongoing sustainable development in the north. The following are some examples of the positive impacts that EKATI has made with respect to northerners and northern Aboriginal peoples:

- In 2005, the total northern employment for EKATI was 73% (over the target of 62% as part of the Social and Economic Agreement), and northern Aboriginal employment was 38% (over the target of 31 %).
- In 2005, EKATI had a total of 48 apprentices working with BHP Billiton and allied contractors, of which 27 were Aboriginal and 20 were other northerners.
- From 2002 to 2004, approximately 50 employees have graduated from the General Equivalency Diploma (GED) Program conducted at EKATI to assist in adult learning.
- An employee enrolled in the Workplace Learning Program won the 2005 Canada Post Literacy Award for Individual Achievement.
- Total cumulative spending from the start of construction up and including 2005 by BHP Billiton through northern and northern Aboriginal businesses exceeds $2.8 billion.
- Expenditures of goods and services by BHP Billiton in 2005 were approximately $474 M of which $374 M (or 79%) was with northern businesses.

2.3.2 Socio-Economic Agreement

In 1996, BHP Billiton signed a Socio-Economic Agreement with the Government of the Northwest Territories, which committed the company to create opportunities for Aboriginal and non-Aboriginal northern residents. The commitment includes the provision of direct employment, employment training and business opportunities. The commitment BHP Billiton has made to the north is expected to continue into the reclamation and closure phase of the mine operations.

2.3.3 Impact and Benefit Agreement

Four Impact and Benefit Agreements have been reached with four local Aboriginal groups to provide for cash payments, scholarships, preferential hiring, training, business opportunities, transportation links between the mine and home communities, and appropriate environmental management at EKATI.

2.3.4 Employment and Training

Preferential hiring is directed at those communities covered by the Impact and Benefit Agreements, as well as other northern Aboriginal residents and northern non-Aboriginal residents. Specific activities include:

- recruitment drives in northern communities;

- working with contractors to support hiring commitments;
- support for scholarships for northern Aboriginal programs;
- summer employment for northern students;
- relaxation of minimum entry level education requirements;
- on the job training; and
- career counselling.

These efforts will continue during the reclamation and closure phase of the mine.

2.3.5 Training Programs

BHP Billiton has established at EKATI multi-skill development training programs for employees that include orientation, training in job safety, skills training in jobs leading to certification, supervisory and management training. The latter programs are aimed at qualifying employees who are northern residents for supervisory roles. The benefits of these training programs will extend into the reclamation and closure phase, and provide employees with transferable skills to similar employment at other mine sites and related industries.

2.3.6 Business Opportunities

BHP Billiton is committed to creating business opportunities for northern Aboriginal and non-Aboriginal owned businesses. BHP Billiton purchases goods and services in the north where they are available and economically viable, and this commitment will continue through the closure phase. BHP Billiton is assisting its partners in Impact and Benefit Agreements in attaining joint venture/business partnership where goods and services are currently not available or where more competitive bidding is required. Where practical, BHP Billiton tenders to partners first. Local suppliers are assisted in a variety of methods in providing BHP Billiton with goods that may be available currently only in the south, and southern suppliers are encouraged to move to Yellowknife or the north.

A number of joint ventures have been formed with Aboriginal businesses to provide a range of goods and services from catering to explosives and blasting supplies. Many of these joint ventures will continue to provide services during the reclamation and closure period.

2.4 WORKPLACE LEARNING PROGRAM

2.4.1 Overview

The Workplace Learning Program is the cornerstone of BHP Billiton's efforts to ensure that employees are prepared for the post-closure economy. The origin of the program was the need to ensure that safety remained the first priority in the planning and execution of all activities. The program focuses on weaving essential skills into the work requirements, personal and functional needs of everyday life, and Aboriginal culture. There have been approximately 180 participants in the program since its inception in 2001. The program, staffed with Adult Educators, addresses a wide range of skill levels ranging from non-reader/non-writer to those working towards their high school equivalency. The Pre-Trades Adult Educator has prepared participants to write the Pre-Trades exam and has supported the candidates throughout their apprenticeship training.

2.4.2 Initiatives

The Workplace Learning Program has developed eleven initiatives, as follows:

High School Upgrading

- The program provides weekly classes and supports workers towards completing their high school equivalency diploma and writing the exams on-site.
- The high school initiative offers internal and external employment opportunities. It offers a chance to practice structure in life, organization and discipline and perseverance, once a goal is set.
- Support is extended via telephone, email and fax to workers and to their spouse or children who are off-site.
- A total of 48 participants have successfully completed their high school diploma equivalency since 2003. Forty percent of these candidates were northern Aboriginal employees. There is a significant impact in a small community when an employee completes his high school diploma equivalency.

Workplace Literacy - Individual Work-Related Specific Focus

- Some employees work one-on-one to improve basic reading, writing, oral communication and mathematics as it relates to their jobs.

Apprenticeship and Pre-Trades Preparation

- Adult Educators work with candidates to prepare and write the Pre-Trades entrance exam.
- The Trades Educator coaches and provides support to employees interested in entering the trades, as well as to indentured apprentices who require additional support throughout their technical training.

Independent Learning/Post Secondary Education

- Adult Educators work with independent learners following correspondence courses and distance learning to achieve learning goals for professional or personal development.
- Educators support employees pursuing educational goals by developing timelines, providing study strategies, additional materials support when appropriate, invigilating exams, advocating to supervisors for approval of courses, and preparing proposals for educational initiatives.

Money and Financial Management

- Adult Educators bring in key speakers and experts on financial management topics, as well as provide resource information packages.
- Money management topics focus on calculating interest for purchases, amortization tables, payment schedules, and all the detailed components to a bill of sale, pension information and calculations, discussions and action towards preparing for retirement.
- Educators have partnered with the Akaitcho Development Corporation to offer “Start a Small Business” workshops. Employees are exposed to the reality of what it takes to run a business, in terms of risks, benefits, responsibilities, advantages and disadvantages.

Community Impact and Examples

- The Workplace Learning Program has played a role in contributing to the Tlicho Technology Trade Centre curriculum, concepts and material in its early stages.
- Educators support the Tlicho Trades and Technology Program in Bechoko by providing on-site instruction and materials development for high school students twice a year (typically November and May). The interactive workshop with high school students identifies essential skills for the workplace.
- Adult Educators are active in collaborating with the Northwest Territory Literacy Council by providing learning materials and piloting training materials.
- Adult Educators of the Workplace Learning Program support other Adult Educators in northern communities where workers can access additional help on their two weeks off (for those employees at EKATI that work 2x2 weeks shifts).

Introduction to Computers

- The Workplace Learning Program has developed and implemented a 9 hour Introduction to Computers interactive course and learner manual. The course includes overview, word processing, setting up personal email accounts and internet searches.
- Employees have realized the vast amount of information available through the internet. Access to information is dependent on having basic computer skills, especially in small, remote communities.
- Participants learn to apply some criteria to do an internet search and sort through the overwhelming amount of information available on the internet.
- Workers are learning to use the computer and want to buy computers for their children at home. In many cases, they want to model good learning for their children. They want to be involved in the education of their children.

Career Support

- Adult Educators assist workers with writing resumes and cover letters and in educational and career searches. The process of writing a resume is self-realizing because individuals are pressed to identify their strengths, both existing and potential. This can be a very powerful process if it is guided by an encouraging, realistic and action-oriented person.
- There is an emphasis on individual career planning to identify skills that are transferable to other positions and other industries.
- Educators work to identify opportunities for further education to enable career path planning.

Study Skills and Test Preparation

- Adult Educators develop learning materials, study materials, practice tests, cue cards, comprehension questions and test writing strategies to help participants faced with learning some of the more technical aspects for their job (e.g., the Mine Rescue exam or the Workers Compensation Board Supervisor’s exam).
- Workers learn strategies to overcome test writing anxiety which often holds them back from being successful in life.

Individual Achievements

- Germaine Ewaykfo (from the community of Gameti) received the Canada Post Learner Award in 2005.

Other Successes

- An employee in the Environment Department has successfully completed his high school equivalency and is pursuing further education in the environment field. He participates in guiding and environmental initiatives in his home community and is a role model to students at home. He sends the message that young students need to stay in school to be considered for good jobs later on.
- One worker started cleaning rooms. She enrolled in the high school equivalency course and 8 months later passed and received her high school equivalency. She was then promoted to manage the office that coordinated all the cleaning and janitorial staff. Within 2 years she then applied to a college for an Office Administration Program. She has resigned her position to attend full time college studies and pursue office administration work. She didn't believe she could ever hold a job other than cleaning rooms at the mine.
- Another worker has been doing some translation contracts on her own time. She would eventually like to start up her own company. The Adult Educator and employee got together and wrote a list of all the essential skills she would need to start and run her own company. Then they checked off the skills that she already has and noted the ones she would need to work on developing. She realized how close she was to her goal and what would be required to realize the goals.
- Other workers are at a higher skill level and are working on essential skills to move into supervisory roles. They are working on decision-making, dealing with difficult people and critical thinking skills. One worker in particular has the right combination of interpersonal skills and leadership qualities to be very successful. He is receiving additional support in report writing because English is not his first language.

2.4.3 Long-Term Benefits

Employees have experienced the following benefits from the Workplace Learning Program:

- Gradual movement toward considering individual responsibility and potential for developing a unique skill set.
- A learning model and process to put together a formal proposal for a request for support for special training.
- Improvement of oral communication skills, public speaking, speech and agenda writing, minute taking and how to run a meeting.
- Ability to use a decision making model to carefully consider their choices when faced with important decisions.
- Co-workers, who were successful in their learning initiatives, serve as role models and provide encouragement and support for other Aboriginal employees.
- Ability to succeed and be proud of reaching milestones. By achieving different awards, learners experience success and are able to be proud of these milestones.

- Increased confidence that allows individuals to take further risks in learning and other areas of their lives.

2.4.4 Comments from Employees on Mine Closure

The following comments are from northern Aboriginal employees at EKATI who were asked, "What kind of situation do you want to be in when the mine closes? Where do you want to be in your life?"

- Workers want to have a trade, skill, or certification of some sort that is recognized and allows them to work anywhere they choose.
- Some employees mentioned that they want to be financially independent when the mine closes, which mean that they have paid off in full their houses and vehicles.
- Employees said they want to understand retirement planning and know how much they would need to retire on, and have that amount set aside. They want to learn how to deal with bills so that debt is kept to a minimum.
- Other employees talked about being Team Leader for a Day. This would give the shy person a chance to gain experience in conducting meetings, speaking in front of a large group, and understanding the stress Team Leaders face. They also thought it would give the Team Leader the chance to take care of other tasks for one day.
- Employees indicated other initiatives that BHP Billiton could put forward including sponsoring annual courses and updates on traditional hunting practices such as how to skin animals. Some employees suggested the company give hunting gear as incentives or Safety awards.
- Some workers spoke about the environment and being able to better understand global warming and its effect on water, animals, health and traditional hunting practices. They spoke about the dangers of chemicals and the need to learn fundamental aspects such as how to purify water when it might be contaminated. They are concerned about people in small communities handling chemicals and being unaware of the potential hazards.
- Other areas mentioned were about the opportunity to create and follow a career path. Employees stressed the importance of setting career goals that have transferable skills to other mines or other industries. In some cases, workers spoke honestly about people who are undecided as to which job or career they might pursue. In those cases, workers proposed scholarships to return to school for a 2 year diploma which could be continued into a 4 year program if the candidate is successful in that chosen field.
- Many workers have commented on the need to develop computer skills because they believe they will be left behind if their computer skills are not upgraded. Computers are the main access to information and the link to what is going on around them.
- A common theme in speaking with workers is the need to build confidence in all areas. A confident employee is one who can accept challenges on the job, take risks in learning new tasks, is able to manage stress, solve problems, and communicate with supervisors and co-workers. Confidence is built up through opportunities to achieve smaller successes, and being encouraged and supported along the way.

2.5 MINE CLOSURE COMMUNITY TRANSITION PLAN

2.5.1 Overview

Based on the feedback obtained through community consultation and employee interviews, future updates to the ICRP will include a Community Transition Plan that will address participatory planning, employee training for employment relocation, a disposition plan for physical assets, capacity building within those communities with high reliance on employment at EKATI, and monitoring of social impacts.

2.5.2 Participatory Planning

A targeted consultation plan will be developed reflecting the needs of the communities. Closure information distributed to the communities will be provided in a timely and coordinated manner and, when a response is requested, adequate time will be provided. This is particularly important when infrastructure is being retained for community use or where post-mining land use involves community input.

2.5.3 Employee Training

In response to the planned closure of the mine, BHP Billiton will broaden the existing training programs to provide training that will prepare employees to seek opportunities post-closure. This broadening will be developed in consultation with key stakeholders as described above and may include:

- training in job search skills;
- matching training activities to the needs of the broader business community; and
- developing strong partnerships with community learning centers and its Adult Educators to increase participation in learning at the community level.

2.5.4 Disposition Plan

At this time the planned disposal of the physical assets of EKATI includes the sale of remaining equipment with a useful remaining life, the removal of all recyclable material and the burying of all inert demolition material.

It is recognized that the buildings and facilities at the Main Camp Complex could have potential use well beyond the closure phase of the mine. During discussions with the communities a number of very valuable suggestions were made for alternative use and ownership of the facilities, such as a hunting camp, summer residential community, prison, hazardous waste disposal facility and Arctic university or college.

This ICRP has been prepared on the basis of full reclamation of all the facilities. This is necessary to prepare a comprehensive closure plan for the whole site. As EKATI moves closer to ultimate closure, the aspects of alternative use (and change in ownership and responsibility for remaining liability) for the facilities and the airstrip will be considered in more detail.

BHP Billiton's intent is for the effective and complete closure resulting in the return of all land and mineral leases to relevant Government authorities. The Government will then be in a position to assign leases to relevant parties as is appropriate.

A full disposition plan will be developed for the Final Closure and Reclamation Plan with input from the local communities. This will allow identification of any physical assets which may be considered useful.

2.5.5 Capacity Building

BHP Billiton will work with communities to encourage and assist the development of community discussions related to closure planning. The potential changes to communities that may arise from the closure of EKATI will be discussed in the context of the current economy, current mining projects in the area and the specific needs of the community. Opportunities will be identified where individuals and local industries can persist after closure. Working with communities through community consultative committees will assist in the development of transition programs.

3. Project Background

3. Project Background

3.1 GENERAL

EKATI is located in the Northwest Territories, approximately 300 km northeast of Yellowknife, within the Lac de Gras watershed, at the headwaters of the Coppermine River drainage basin. The Aboriginal word for ‘Ekati’ means ‘fat lake’ because the rocks in the Lac de Gras region contain white quartz veins which resemble caribou fat. The EKATI claim block covers an area of 344,000 ha. To date, mine development has occurred in 0.58% of the claim block. The mine is located 100 km north of the tree line in the Arctic tundra and is accessible by air year-round or winter road for 10 weeks of the year. The closest community is Wekweèti, located 180 km to the southwest. Figure 2.1-1 shows EKATI’s location in the Northwest Territories.

In 1989, kimberlite indicator minerals were discovered in the Lac De Gras area. Under a 1991 joint venture agreement that made BHP Billiton the Project operator, the first diamonds were discovered by drilling at Pointe Lake in the fall of 1991.

A number of small exploration camps were operational on the lease area as part of diamonds exploration prior to mining operations. Marks Camp and Culvert Camp were located near the Airport Esker and have since been reclaimed. Boxcar Camp, a mobile drill camp, was located at Paul Lake from 2000 to 2005 to assist with winter drilling programs that supported exploration. Norm’s Camp, which is located on the west shore of Upper Exeter Lake, was constructed in 1991 for the purpose of exploration activities. This camp continues in use today. Old Camp (also known as Koala Camp) opened in the fall of 1993, and included a small processing plant and a 12-person camp with associated infrastructure. The camp was expanded for the construction phase of EKATI.

Baseline environmental data were collected throughout the EKATI Claim Block from 1993 to 1996. In 1995, BHP Billiton submitted its Environmental Impact Statement (EIS) for EKATI to the federally appointed Environmental Assessment Review Panel. After a comprehensive review, the Government of Canada approved the development of EKATI in November 1996. Construction of the mine began in 1997 and the EKATI opened officially on October 14, 1998.

3.2 CLIMATE

EKATI is located in an area classified as Arctic tundra with a continental polar climate. The climate in the Lac de Gras area is extreme with short, cool summers and long, cold winters. Daily temperature extremes range from 25ºC in the summer to -50ºC in the winter. Precipitation is sparse, averaging 333 mm/year, and consists of approximately equal amounts of rain and snow. Precipitation is usually highest during the late summer to early winter period, although some precipitation usually falls in all months of the year. Winds are moderate and prevail from the northwest. For more detail on the local climate the reader is referred to the EKATI Diamond Mine Aquatic Effects Monitoring Reports (1999-2007). Table 3.2-1 shows the estimated total annual precipitation for various return periods, and Table 3.2-2 shows average air temperatures by month.

Table 3.2-1. Estimated Total Annual Precipitation for EKATI

Return Period (years)	Total Annual Precipitation (mm)
100 dry year	162
50 dry year	179
25 dry year	199
10 dry year	231
5 dry year	264
2 average year	333
5 wet year	417
10 wet year	468
25 wet year	531
50 wet year	576
100 wet year	621

Source: Rescan (2008c).

Table 3.2-2. Mean Monthly Air Temperatures for EKATI

Month	Mean Monthly Temperature (°C)
January	-27.3
February	-28.1
March	-24.2
April	-14.1
May	-4.9
June	7.4
July	13.1
August	9.5
September	2.8
October	-6.4
November	-18.4
December	-23.8

Source: Based on data from the Koala Meteorological Station from 2000 to 2008.

3.3 TERRESTRIAL ENVIRONMENT

The physical environment of the mine area has developed largely in response to multiple glaciations, the most recent of which ended 9,500 years ago. The glaciations have resulted in a landscape dominated by numerous lakes and interconnecting streams. There are over 8,000 lakes within the EKATI claim block. The mine area lies within the zone of continuous permafrost, which occurs everywhere except under large lakes. Permafrost depths have been recorded through ground temperature cables (GTC) as greater than 330 m, with the deepest measured at Misery to a depth of 440 m. A thin zone near the ground surface, known as the active layer, thaws during the summer. The depth of the active layer depends on soil composition, but is generally thin (30 to 40 cm) in organic-rich soils and thicker (>2 m) in areas of exposed bedrock. The volume of ice associated with permafrost depends on terrain type, but generally lodgement tills on upland or sloping terrain are relatively ice-free, whereas ablation tills and ice occur within most eskers, usually at their basal contact with the underlying till.

Well-developed soils are generally lacking within the mine area as a result of extensive glaciation and climatic influence. Surficial deposits consist of tills and postglacial lacustrine and glaciofluvial deposits. Extensive areas of exposed bedrock are also present. Soil development is restricted to pocketed areas within bedrock and till blankets (<0.5 m thick), within floodplains and alluvial terraces (1.0 to 3.0 m thick), and in depressions where organic matter has accumulated (0.5 to 2.0 m thick).

3.4 SITE GEOLOGY

The EKATI claim block is located within the central portion of the Archean Slave Structural Province. The following rock types are present on the property, in order of decreasing age (based on geological time scales of millions (Ma) and billions (Ga) of years ago):

- Archean (>2.66 Ga) metasediments (occur primarily at Misery pipe in minor amounts at Beartooth pipe and are also expected at Pigeon) of the Burwash Formation (Yellowknife Supergroup) formed by the action of heat and pressure on muddy and sandy sediments deposited underwater. The metasediments weather to a buff brown to rusty brown colour.
- Archean (2.63 to 2.58 Ga) granitic to dioritic plutons (all pipes) of various types intruded as hot melts into the metasediments. The granites are generally weathered to a white to light grey colour.
- Proterozoic (2.23 to 1.27 Ga) diabase (observed in Fox, Misery and Beartooth kimberlite pipes) dikes of the Mackenzie Dike swarm intruded as hot melts into cracks in the metasediments and granites.
- Phanerozoic (75 to 45 Ma) kimberlite pipes intruded into all of the above, but dominantly in the granitic intrusions. The kimberlite is a dark, ash- or mud-rich to coarse grained material with varying amounts of olivine. Variable amounts of carbonized wood, mudstone clasts and host rock fragments are found to varying quantities.

The composition of these rocks is predictable regionally and locally across the property. The rock units at EKATI are visibly very distinctive and the contacts between the different rock types are well defined and easily observed in the field. The host rocks generally show no effects from contact with kimberlite, due to the nature of kimberlite emplacement. The kimberlite pipes were intruded rapidly and explosively as relatively cool rock from deeper in the crust, resulting in no significant mineralogical or chemical alteration of the surrounding host rocks. This contrasts sharply with the formation of metal and gold ore deposits, which typically result from circulation of hot water through the rock and often result in alteration of the host rocks adjacent to the ore body, and can later result in generation of acidic runoff when exposed to the atmosphere (BHP and Dia Met 1995).

Very low concentrations of sulphide minerals are found in all rock types on the property. Granites and diabase contain rare disseminated grains of pyrite and chalcopyrite at concentrations typically less than 0.05%. Metasediments contain low concentrations (<0.5%) of fine-grained disseminated pyrite, pyrrhotite and chalcopyrite. These rock types also have low concentrations of carbonate minerals (typically calcite) which mostly occur as fracture fillings. Kimberlite also contains low concentrations (<0.5%) of fine-grained disseminated pyrite, and has abundant associated carbonate (*i.e.*, calcite).

Overall, in terms of chemical stability, the country rocks and subsequently the waste rock are non-reactive or have low reactivity.

3.5 WATER QUALITY

Water quality baseline studies at EKATI have been discussed in numerous baseline reports (Bryant 1996; Rescan 1997, 1998; Rescan and Dillon 2000, 2002; BHP and Dia Met 2000). These studies showed that streams and lakes are characterized by clear, soft, low-nutrient waters typical of pristine northern aquatic environments. As previously discussed, the surface runoff that accumulates in these lakes contains few particulate or dissolved components. Baseline studies showed that total dissolved solids (TDS) concentrations are low in all watersheds, generally less than 35 mg/L, which is reflected in low water conductivity. Major ions rarely exist in quantities more than a few mg/L, and most metals are below analytical detection limits. The watershed averages of all measured parameters are at or below federal Canadian Council of Ministers of the Environment (CCME) water quality guidelines for protection of freshwater aquatic life. The pH of tundra waters are typically slightly acidic to neutral, which is characteristic of waters flowing over granitic and gneissic terrain that is recharged by rainfall.

Despite the oligotrophic nature of most of the lakes, the sediments host relatively high concentrations of organic matter. Hydrodynamic sorting has caused the deposition of fine-grained sediments to the calm and deeper regions of the lakes while coarse-grained deposits are more predominant in the shallows. The fine-grained sediments are enriched in organic matter, metal oxides and associated trace metals.

3.6 PLANTS, ANIMALS AND THE AQUATIC ENVIRONMENT

The terrestrial vegetation community is composed of species adapted to freezing temperatures, low nutrients and localized areas of drought and standing water. The most common vegetation communities are mats of low shrubs, including dwarf birch, Labrador tea, crowberry and bearberry. Lichen communities are found in areas with very thin layers of soil. Taller shrubs such as willows and scrub birch are found in sheltered areas such as in ravines and along streams where there are depressions in the depth of the permafrost. The vegetation surrounding lakes and streams is dominated by weathered lichen-covered boulders interspersed with depressions containing dense, spongy peat mats of moss and lichen. Wetland communities, comprised of water sedges and sedge-willows, exist in poorly drained areas where standing water accumulates. Figure 3.6-1 shows the habitat types within the EKATI area.

The short growing season, cool soil temperatures, and lack of soil development limit the establishment of productive, diverse plant communities. Typically, vegetation is low in stature and dominated by willow and ericaceous (heath) shrubs, lichens, and mosses. In low-lying, wetter areas, tussock sedge meadows and emergent marshes are present. Mesic and dry herb-dominated communities generally are restricted to eskers. The dominant ecosystem unit at EKATI is Heath Tundra which occurs on well to moderately drained upland sites.

The EKATI claim block is predominantly wildlife habitat, with limited human use, mainly for hunting. The Bathurst caribou herd migrates through the area to access spring calving and winter forage grounds. Grizzly bears, wolves, foxes, wolverines and small mammals are also present at various times of the year. Most bird species are only summer residents but include loons, sandpipers, passerines and a few raptor species. Ravens and snowy owls are present year round. The lakes support predominantly lake trout (*Salvelinus namaycush*), round whitefish (*Prosopium cylindraceum*), slimy sculpin (*Cottus cognatus*), ninespine stickleback (*Pungitius pungitius*), cisco (*Coregonus artedii*), longnose sucker (*Catostomus catostomus*) and Arctic grayling (*Thymallus arcticus*).

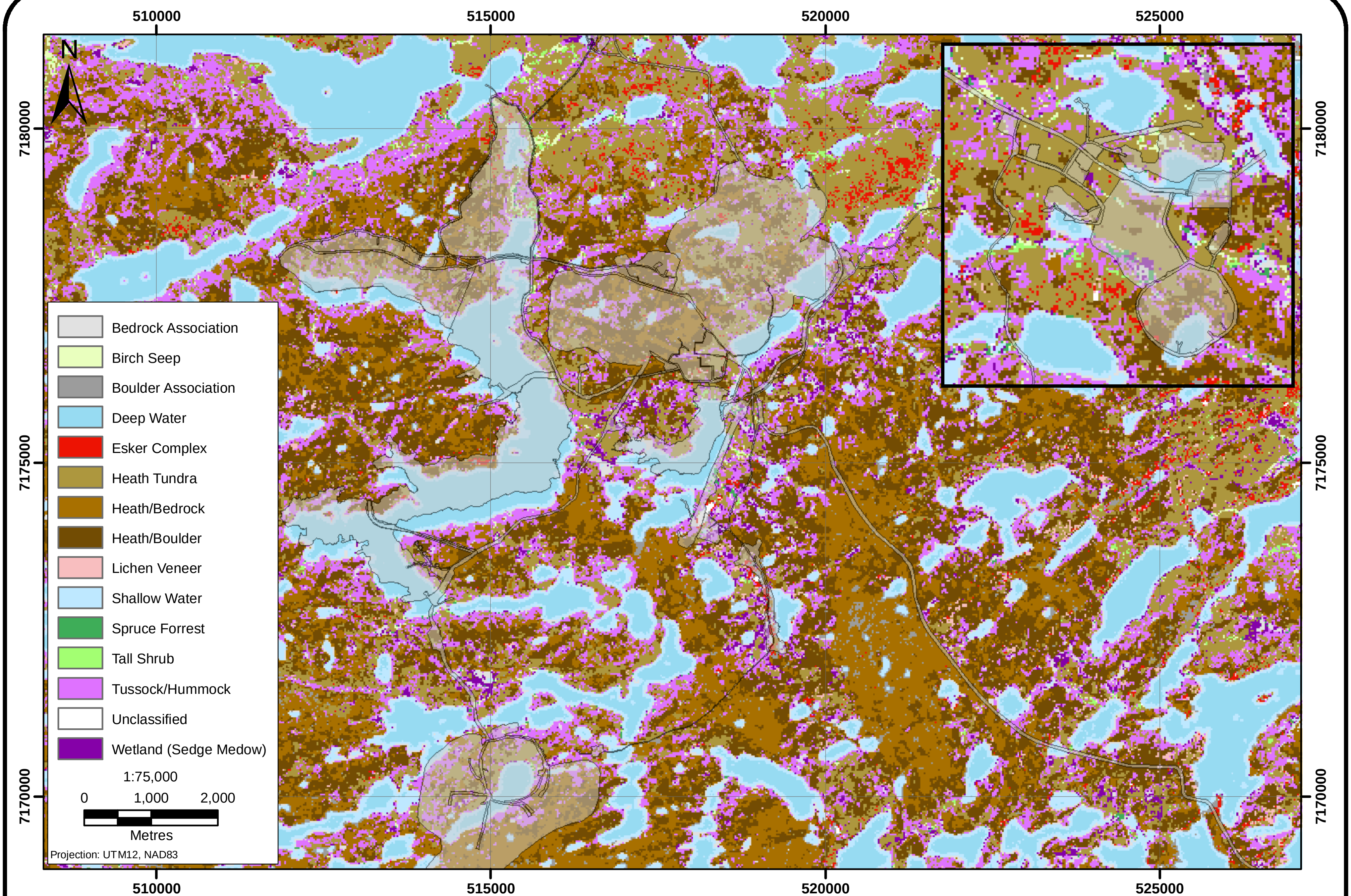

FIGURE 3.6-1

Habitat Types Within the EKATI Area

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Tundra lakes are relatively shallow; averaging 5.3 m deep and 1.4 million m^3 in volume (based on the size of the seven original lakes and ponds proposed to be mined in the 1995 EIS). They are typical of Arctic tundra lakes in that their biological productivity is low. Ice is approximately 2 m thick in winter and covers the lakes for all but four months each year. After the ice has cleared in mid-June, water temperatures increase rapidly, reaching a relatively stable level by the end of July. Water temperatures reach approximately 17ºC in August and wind mixing penetrates to the lake bottom. In many cases there are no physical, chemical or temperature stratifications. There is little oxygen depletion in summer, even in deep water. Compositional uniformity (in water quality and TDS), is evident regardless of lake depth or degree of thermal stratification. This situation arises from the brief ice-free window on the tundra when there is insufficient time to establish vertical gradients in the water column. Also, the majority of the lakes are oligotrophic, which means that primary productivity is low, and the intensity of biogenic cycling within the water column is also low. These watersheds (Figure 3.6-2) also lie in the erosion-resistant Precambrian Shield and have lakes that are chemically homogeneous (BHP and Dia Met 1995). Near-shore areas up to 3 to 4 m deep are composed of boulders and broken rock (glacial till), the result of ice scour during break-up. Beyond the relatively narrow littoral region, the bottom drops steeply. Beyond the rocky nearshore region, the bottom sediments are composed of silt and sand. These sediments are unconsolidated and may cause high turbidity when disturbed.

Phytoplankton – one-celled plants that float in the water column – are the base of the food chain in lakes. Phytoplankton are grazed by zooplankton – mainly rotifers and small crustaceans – that float in the water column and by filter-feeding members of the benthic invertebrate community attached to the lake bottom. Zooplankton and benthic invertebrates are eaten by a small community of fish. Small-bodied fish such as lake chub (*Couesius plumbeus*), slimy sculpin and ninespine stickleback eat zooplankton and benthos, while round whitefish eat mainly benthos. Arctic grayling eat a mixture of zooplankton and benthos. Large-bodied fish such as burbot and lake trout eat smaller fish as well as benthos and the larger species of zooplankton.

Food fragments, faeces and carcasses sink to the bottom of lakes where they are consumed by detritus-eating benthic invertebrates. Many benthic invertebrates are aquatic insects, particularly the early life stages of dipteran flies such as midges and mosquitoes. Terrestrial insects that fall on lake surfaces are consumed by surface-striking fish such as Arctic grayling.

Periphyton – dense strands of algae attached to rocks – are the base of the food chain in streams. Mats of periphyton serve as substrates for bacteria, protozoa and benthic invertebrates. Stream drift – a mixture of zooplankton from upstream lakes and insects that release themselves from the stream bottom – is an important component of stream ecology. Arctic grayling is the predominant fish species in streams, followed by slimy sculpin and burbot. Obligate lake dwellers such as lake trout are rarely found in streams, but their juveniles occasionally use streams as refuges and as migration corridors.

Streams in the EKATI claim block can be divided into two distinct categories: streams connecting lakes and headwater streams. Most connecting streams are characterized by predominantly boulder substrate with intermittent cobble patches. Cover in connecting streams consists mainly of boulders. Minimal overhanging vegetation, undercut banks and organic debris is present along stream margins. In contrast, headwater stream substrates have a greater fine and organic component; however boulders dominate some sections. Stream flows in connecting and headwater streams are similar with flows rapidly decreasing following spring freshet. In fact, most headwater streams are ephemeral, drying by mid-summer. Connecting streams generally maintain surface flow longer, although some are ephemeral or consist of sub-surface flow by late summer.

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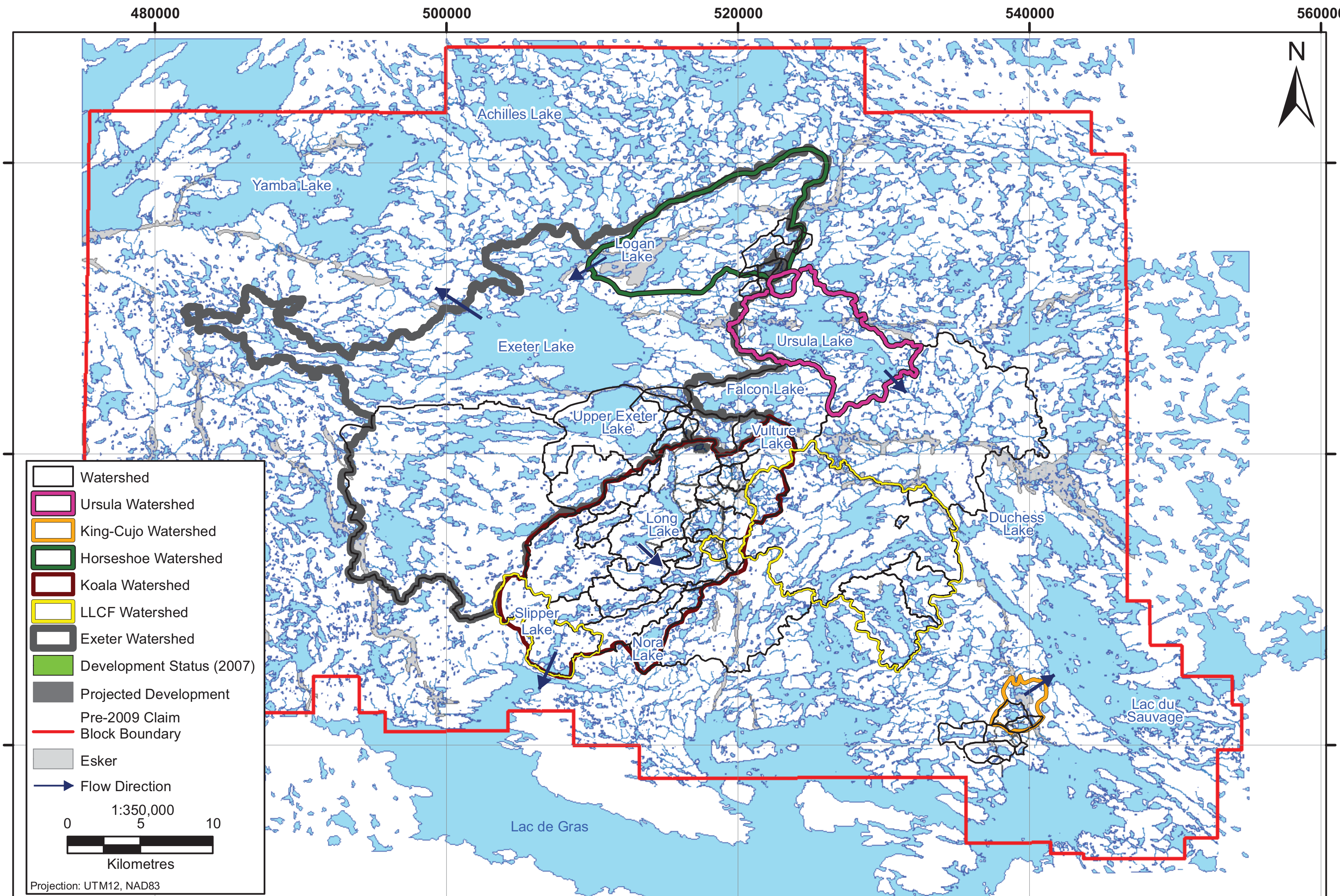

FIGURE 3.6-2

EKATI Watersheds

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All streams are characterized by diffuse drainage patterns as a result of the region's typical low relief. Stream flow typically occurs in several interconnected sub-channels in each drainage rather than in distinct single channels which is typical of most streams.

3.7 LAND USE

3.7.1 Historical Land Use

The history of Aboriginal land use on the EKATI Claim Block is demonstrated by the physical remains of stone tools, oral traditions of the Dene and Inuit, and the historic accounts of early European travelers on the barren lands. Ancient hunting traditions on the barrens continue today among the descendents of the traditional Dene and Inuit users of the Lac de Gras Region. Today, the Aboriginal people are joined by hunting outfitters who have also followed the caribou to Lac de Gras. Outfitters operate lodges near the inlet and outlet of Lac de Gras at the edge of the EKATI claim block.

One hundred and ninety-nine archaeological sites have been found on the EKATI claim block (Figure 3.7-1). These sites mainly contain the remains of materials used for making stone tools – called flakes by archaeologists. They also contain a range of "features from human use" including tent rings and ancient fire hearths, and artefacts that include stone tools, fragments of animal bones and a birch bark basket. Most of the sites have been found on glacial eskers, which are the beds of streams that once ran under the glacial ice. Since the ice age they have made dry, high, easily walked highways that snake across the barren lands. Eskers are used by both people and animals for this purpose. Stone tools such as projectiles for spears and arrows, scrapers and knives have been found on a more limited number of archaeological sites. The archaeological sites have been dated to the Paleo-eskimo Tradition (Arctic Small Tool), which makes them between 4,000 and 2,200 years old. These sites were probably used by the earliest ancestors of the modern Inuit.

The Taltheilei Tradition, which is generally agreed to represent the ancestors of the modern Dene people, extends from about 2,500 years ago to approximately 1840 AD when the last of the Dene groups came in regular contact with European trader and begin using European trade goods.

At contact in the 17th century, the Chipewyan, Yellowknife and Tlicho were all forest-edge people who moved out onto the barren grounds in the summer and fall to intercept the migrating caribou and moved back into the trees during the winter. The Lac de Gras region was in the annual range of the Yellowknife who occupied the Coppermine and the Yellowknife rivers and the eastern end of Great Slave Lake. Yellowknife territory overlapped that of the Tlicho who occupied the lands from the south side of Great Bear Lake east to Contwoyto Lake and south to Great Slave Lake. Lac de Gras was also within the summer caribou hunting range of the Tlicho. At contact the caribou-eater Chipewyan from further east traded into the Lac de Gras country. The Coppermine River was known to them. The descendents of Chipewyan and Yellowknife are present today in the communities of Lutsel K'e, Dettah, Yellowknife and Fort Resolution. The Tlicho live in Behchoko, Wha Ti, Wekweèti and Gameti.

From the north, the Copper Inuit know regions around Great Bear Lake, Coppermine River, Contwoyto Lake, and east along the Back River to Beechy Lake. Lac de Gras was at the very southern extent of Copper Inuit territory in 1900 shortly before regular contact with European traders. The Copper Inuit who live inland today are based in Kugluktuk, Kingaok (Bathurst Inlet), Omingmaktok (Bathurst Inlet – northeast) and Ikaluktuiak (Cambridge Bay), and continue to hunt their traditional lands as far south as Lac de Gras. Figure 2.1-1 shows the locations of those communities.

Figure 3.7-1

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Archaeological and Heritage Sites Found on the EKATI Claim Block

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3.7.2 Protection of Archaeological and Heritage Sites

By listening to the Dene and Inuit elders and adhering to regulatory requirements and contractual agreements, BHP Billiton has designed an adaptive archaeological and heritage management strategy for EKATI that seeks to avoid sites when possible, recover data when avoidance is not possible, and involve the communities in decision-making.

BHP Billiton avoids known or suspected archaeological and heritage sites (including graves) whenever possible. This requires the company to start archaeological investigations as early in the mineral development sequence as possible; during land-based summer exploration drilling. Each drill setup is assessed by a permitted archaeologist prior to the drill being put into place. When appropriate, archaeologists also consult with elders and review the range of TK studies that have been performed in the region. The same procedure is followed for potential infrastructure expansions. One of the first planning steps for potential expansion is an archaeological survey to confirm the presence of physical locations associated with traditional sites.

Despite good planning and efforts to avoid archaeological and heritage sites, some disturbance to archaeological sites has occurred. Since 1992 nine archaeological and heritage sites have had to undergo data recovery due to the proximity of development. Disturbances of a few archaeological sites occurred at a camp used in diamond exploration prior to the formal archaeological surveys, which started in 1994. Archaeological sites that were too close to the Misery Mine to ensure avoidance were mitigated prior to the mine's construction.

The other potential source of site disturbances is from the unauthorized "collection" of artefacts by mine workers. Despite warnings against such activities given at worker orientations, one site was damaged by a collector in 1997. The contract employee was removed from the site.

A list identifying all known cultural areas of significance on the EKATI property has been filed with the Prince of Wales Heritage Museum as required by law. This list is regularly reviewed and updated when necessary. At closure a final list will be submitted to the Museum identifying all know sites with cultural significance.

3.7.3 Recent Land Use

The tradition of coming to the barren lands to hunt has not faltered although there have been changes in frequency and type of hunting.

Sport hunting for caribou and musk ox which started a century ago with English sportsmen like Warburton Pike has blossomed into an important business for the Northwest Territories and Nunavut. Many Dene and Inuit are involved as guides and lodge owners and today sport caribou hunting exists at Lac de Gras alongside diamond mining. Modern caribou outfitting camps are located at either end of Lac de Gras.

Dene and Inuit families are no longer spread across the barrens in small extended family groups, and although many people have moved into communities, some still remain near the resources they have always used to live.

In the early 1950s the Contwoyto Lake Inuit were trading caribou skins to the coastal Inuit for clothing. Estimates at the time suggested that 95% of the clothing skins used by coastal people came in local trade from the interior. Government concern over perceived decline of the Bathurst caribou herd in the 1950s led to an attempt to re-focus the inland Inuit on a commercial fishery located at Pellatt Lake in Nunavut, south of Contwoyto Lake. Despite these efforts many families remained on their own, and scattered on the land. Over time the commercial fishery was not successful but a core of the inlanders who congregated at the Pellatt Lake Outpost Camp still use the area and continue to hunt south to Lac de Gras.

In the 1970s Chief Alexi Arrowmaker organized the movement of several Tlicho families from the old "Edge of the Wood People" to move back to the traditional outpost camp at Wekweèti at Snare Lake. Arrowmaker and his followers sought a more traditional Tlicho life in a community situated in the migration path of the Bathurst caribou herd. Wekweèti hunters still hunt annually northeast of Wekweèti toward Lac de Gras.

3.7.4 Future Land Use

While the families associated with Pellatt Lake Outpost Camp and the Community of Wekweèti are the closest and most frequent users of the Lac de Gras region, the Yellowknives Dene, Chipewyan from Lutsel K'e and North Slave Métis continue to regularly hunt to MacKay Lake south of Lac de Gras and still occasionally make the journey north to Lac de Gras. Inuit from Kugluktuk and other regional communities continue to hunt in the Lac de Gras area.

Traditions that are thousands of years old change slowly and there remain strong ancient ties to the land. BHP Billiton is aware of the company's position on the traditional lands of different Aboriginal peoples. Decisions on running the mine are made with an awareness of the company's responsibility to value the cultural heritage of people that were at Lac de Gras before diamonds were discovered and who will still come to Lac de Gras long after the diamonds have been mined.

4. Mine Overview

4. Mine Overview

4.1 LIFE OF MINE PLAN

The EKATI Life of Mine (LOM) Plan describes the planned extraction and processing of the ore from the EKATI mine (Figure 4.1-1). It defines the period of the mine life and ore sources to be extracted during this time. The EKATI LOM Plan is confirmed or amended during the annual LOM planning process. The LOM Plan is used to guide mine planning and capital expenditure for the budget year to ensure the long term objectives are accomplished.

Mine planning is an iterative process and changes in response to changing economic and geologic information. The LOM Plan is a dynamic, living document and it is expected to change over the remaining term of the operation. For example, recent iterations extended the Beartooth Open Pit operating life until 2020. Also, conceptual plans for underground operations in the Misery Open Pit as well as a larger and deeper Fox Open Pit are also in the review process. Future versions may include these changes in the mine plan; in which case updates will also be made to the ICRP.

This ICRP is based on the 2005 LOM Plan which uses open pit and underground mining methods to extract kimberlite ore from seven kimberlite pipes and assumes an average daily ore processing rate of 12,500 tonnes, assuming that all of the pipes in the plan will be developed, and that no new pits will be discovered. The Sable and Pigeon pipes are located north of the Main Camp approximately 17 km and 5 km respectively. Sable and Pigeon have not been developed at this time. Beartooth, Panda and Koala are located adjacent to the Main Camp. Fox is located approximately 7 km south of the Main Camp, and Misery is located about 27 km southeast of the Main Camp, adjacent to Lac de Gras. Misery is currently in a temporary suspension of operations. Approximately 96 million tonnes of ore and 476 million tonnes of waste rock are projected to be excavated from the pits and underground operations over the life of the mine (based on the 2005 LOM Plan). The granite waste rock is used in part for construction (*e.g.*, roads, dams and dikes), while the remainder is stored in the WRSA adjacent to each of the respective open pits. Some of this stored rock will be used in closure for capping facilities.

The Panda Pit was the first to be developed. Waste rock removal began in 1997, mining of ore began in 1998 and the open pit was closed in 2003. Preparation for underground mining below the original Panda open pit began in 2003 and mining of ore from the Panda Underground began in 2005, and is expected to continue until 2010.

The Koala Pit and the Koala North Pit began waste rock removal in 2000 and 2001, respectively. Ore production from Koala North Underground began in 2001 and ended in 2002. Ore production from Koala Pit began in 2003 and ended in 2005 and the Koala Underground (below the original Koala open pit) began development in 2004 with ore production beginning in 2007. Koala North Underground operation is expected to resume in 2009 for approximately 2 years of production.

Excavation of the Fox Pit started in 2001 and ore production began in 2005. That operation is expected to continue until 2014. There is potential for further mining at depth and this is being evaluated.

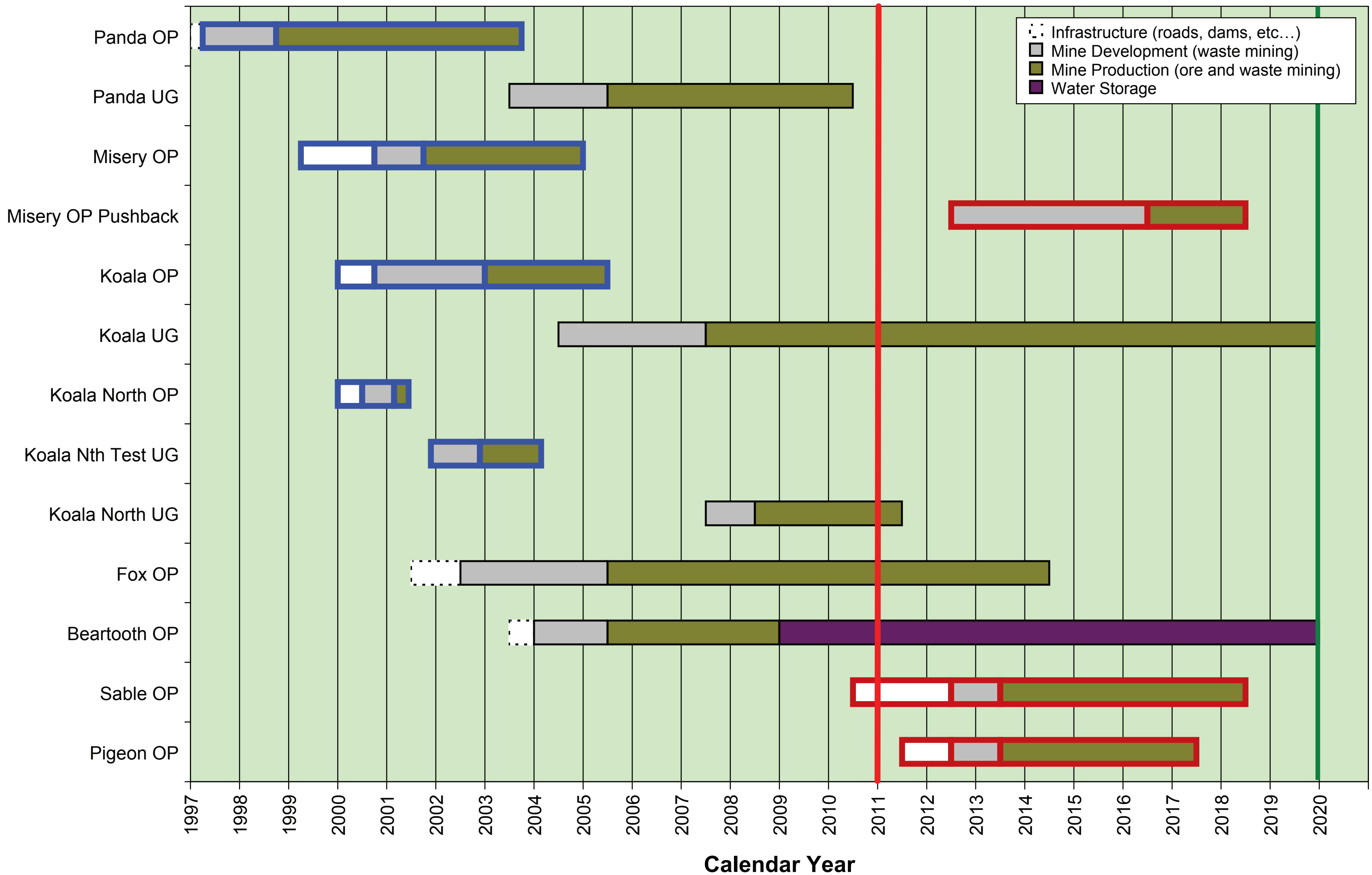

Figure 4.1-1

EKATI 2005 Life of Mine Plan (LOM)

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After 2 years of road and camp construction and waste rock removal the Misery Pit began producing ore in 2001. Ore production was suspended in April of 2005 and stockpiled ore was trucked to the process plant through 2006 and 2007. Future operations at Misery are now in the planning stage. A 4 year-long pushback of the Misery Pit walls to allow deeper mining is tentatively planned to commence in 2012. If it proceeds, then it will result in another 2 years of ore production from Misery Pit. A review of the potential for Misery Underground operation is also planned, and may replace the pushback.

Beartooth Pit construction started in 2003 and ore production began in 2005. Mining is expected to continue until 2009. After 2009 the Beartooth pit will be used as a repository for underground mine water until 2020. During this period extraction methods to access remaining kimberlite ore in Beartooth may also be reviewed.

Construction of the Sable and Pigeon pits is expected to begin in 2010 and 2011, respectively, and mining of the pits is expected to continue until 2017 for Pigeon and 2018 for Sable.

The EKATI site continues to support extensive exploration drilling programs with the intention of finding new kimberlite pipes and extending the knowledge on the existing pipes. At this time there is potential for an additional pushback of Fox Pit, a pit pushback or underground operation at Misery, and underground operations at Fox at depth plus two to three additional new pipes at various stages of preliminary study.

4.2 MINING METHODS

4.2.1 Open Pit Mining

The method of open pit mining is similar for all of the open pits at EKATI. All of the kimberlite pipes in the EKATI LOM Plan, with the exception of Pigeon, are located under lakes which require dewatering prior to mining. Pigeon pipe is located on rolling moraine that is partially covered by a small pond. Prior to dewatering each lake is fished out by Aboriginal fishers and the fish are either distributed to local communities or transferred to other nearby water bodies. The lakes are then drained of water, and overburden (lakes sediments and glacial till) are removed. Fish habitat lost through the removal of these lakes is compensated for through *Fisheries Act Authorizations* (Appendix 1.1-4). The Panda, Koala and Misery Pits were dewatered between 1997 and 2000. Fox Lake dewatering began in early 2002 and was completed in 2003. Beartooth Lake was also dewatered in 2003. Development of the Sable and Pigeon Pits has not yet commenced.

In comparison to other types of ore deposits, kimberlite pipes are very regular and contacts between kimberlite and the host rock are readily defined. The kimberlite pipe is roughly circular in plan view and lies within competent host rocks. The ore-waste boundary is structural and easily defined on rock type. Figure 4.2-1 shows typical core drilling around a well defined kimberlite pipe, with the concept for future open pit in granite. The kimberlite pipes at EKATI have distinct physical characteristics – they are predominantly carrot shaped, that results in a high stripping ratio, which in turn must be met with a high capacity materials handling fleet.

The first step in open pit mining is to remove the overburden material, which at EKATI includes beach areas and tundra, lake sediments and glacial till that lie within the designed pit perimeter. The removal of surface till, waste rock, waste kimberlite and kimberlite ore requires the use of explosives and standard truck and shovel techniques (Plate 4.2-1).

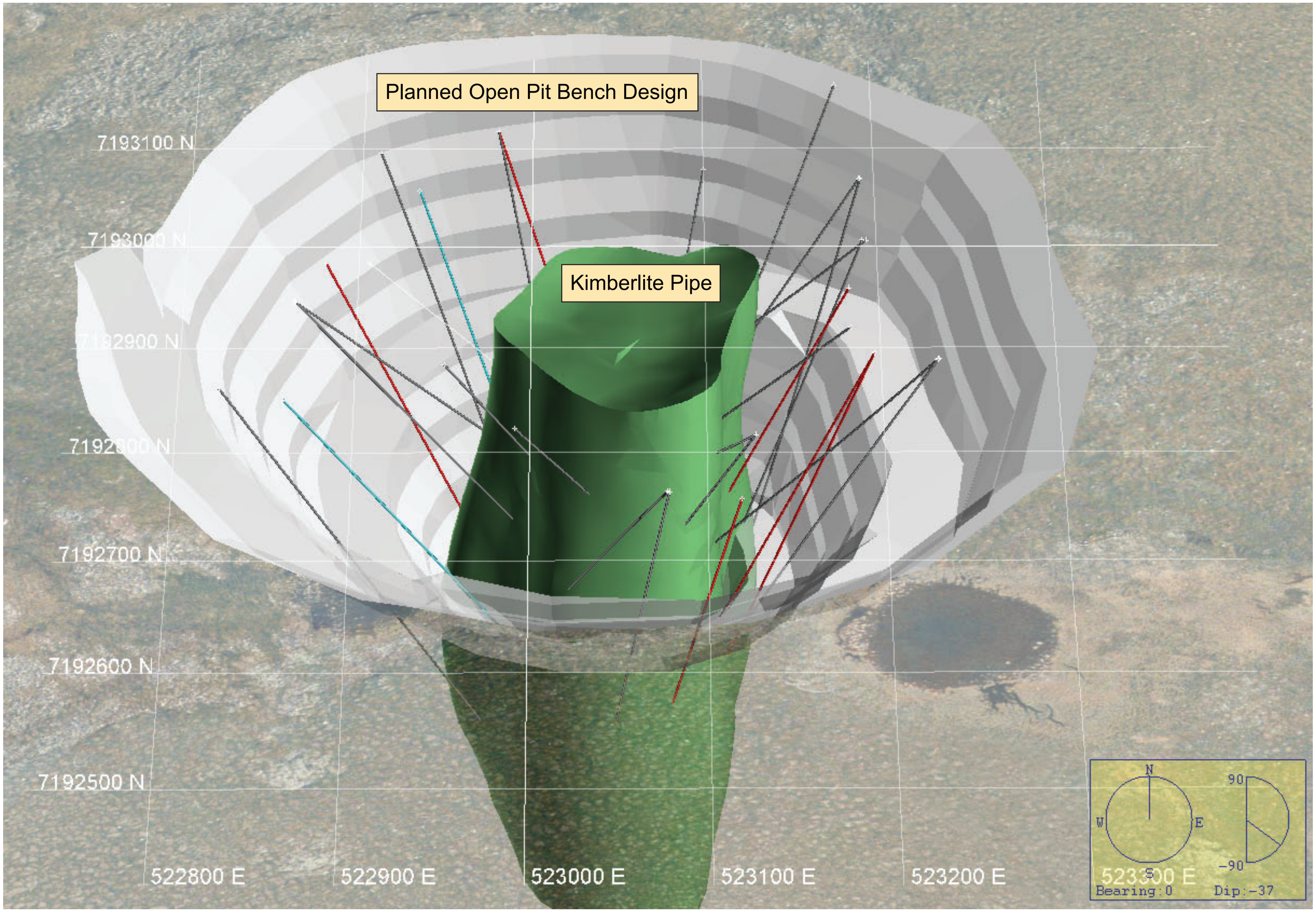

Figure 4.2-1

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Core Drilling at an EKATI Kimberlite Pipe, Showing Concept for Future Open Pit

Figure 4.2-1

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Plate 4.2-1. Open pit mining equipment and operation.

The primary explosive used at EKATI is a 70/30 mixture of emulsion and ANFO – a mixture of ammonium nitrate, fuel oil and emulsifiers. Excavated rock is loaded into large haul trucks with an 85 to 200 tonne capacity and is transported to the WRSA, or to temporary ore storage locations or to the Process Plant.

The design of open pits is similar for all pits at EKATI. Single, double or triple 10 m benches are used depending on geological conditions. The majority of the final pit slopes will be in granite host rock. The Misery Pit walls contain 60% granite and 40% metasediments, and the Pigeon Pit walls are expected to contain 50% metasediments and 50% granite.

4.2.2 Underground Mining

Underground mining is currently being undertaken below the Panda, Koala North and Koala Pits. Panda and Koala Underground are in production, and Koala North Underground mine is in suspension of operations with a planned future resumption. The process of underground mining starts with access development, which involves blasting and excavating tunnels – known as declines – through the granite bedrock to the kimberlite pipe. Typically, an underground ramp leading progressively to the top section of the underground kimberlite is constructed as a spiral. Deeper kimberlite sections are accessed by blasting spiral-shaped declines in the bedrock adjacent to the kimberlite pipe. The ore is excavated by cutting horizontally into the kimberlite pipes from the spiral ramps. Ore is transported from the underground developments by a combination of specialized underground haul trucks and conveyors.

Kimberlite ore from the Panda and Koala pipes is extracted from underground using sublevel retreat (Figure 4.2-2) and sublevel cave techniques (Figure 4.2-3), respectively. Sublevel retreat and sublevel caving mining methods are “top down” techniques for regularly shaped ore bodies with weak to strong ore. The ore is drilled and blasted in rings called upholes from multiple drill drifts on each sublevel and extracted in a controlled manner. Production then continues from successive lower sublevels in the kimberlite pipe. The sublevel retreat method is commenced from directly beneath the depleted open pit, while the sublevel cave method is started from beneath a block of low grade kimberlite. The low grade kimberlite will be allowed to cave in a controlled manner as the higher value ore is extracted. Both sublevel retreat and sublevel cave are recognized and well documented mining methods. With the sublevel retreat method a relatively small portion of the ore is left in the stope, to reduce the requirement for remote controlled extraction, and to provide a measure of protection for personnel and equipment from waste rock failures in the pipe/pit walls above the active workings, as well as control ventilation through the draw points. With sublevel cave the cave material performs this function. At the conclusion of mining the amount of ore removed is essentially the same for both mining methods.

A connecting underground conveyor system from Koala to Panda Underground was commissioned in late 2007. A 2.4 km-long conveyor system (commissioned in 2006) transports kimberlite from the Panda Underground crusher to the ore storage area at the Process Plant. The movement of ore on these conveyor systems is monitored from a control room at the surface.

Due to the close proximity of the Panda, Koala and Koala North underground operations, a common access decline to the undergrounds has been developed through the Koala North Portal. Ventilation shafts have been sunk to ensure ventilation to all areas of the underground. Other facilities which are wholly underground include an underground maintenance shop, lunch rooms, refuge chambers in case of emergency and sizing facilities to regulate ore fragmentation size on the conveyor system.

Underground mines require extensive ventilation, dewatering systems and carefully developed safety and emergency response procedures. Safe areas with independent air supply are located in each of the Panda, Koala North and Koala Undergrounds to provide refuge for workers in case of a fire or explosion. Communication systems are also in place to warn workers of potential hazards, and specially trained emergency response teams are always on standby.

4.3 WASTE ROCK STORAGE

The WRSA are designed to contain the rock excavated from the open pits, which is predominantly granite. Several different types of granites referred to as quartz diorite, granodiorite, 2-mica granite and pegmatite have been identified in the region but the descriptors represent differences in the proportions of the major minerals. For the purpose of the waste rock management planning, these rock types can be classified as granite. Low concentrations of sulphide materials are found in all rock types on the EKATI claim block: (1) Granites and diabase have rare disseminated grains of pyrite and chalcopyrite, and (2) metasediments (biotite schist) has low concentrations of fine-grained disseminated pyrite, pyrrhotite and chalcopyrite. Both of the above rock types have low concentrations of carbonate minerals (typically calcite, but also ankerite) occurring mostly in fracture fillings. WRSA also contain and store other materials including coarse kimberlite rejects (in the Panda/Koala/Beartooth WRSA), and waste kimberlite stockpiles (in both the Panda/Koala/Beartooth and Fox WRSA) and metasediments (Misery).

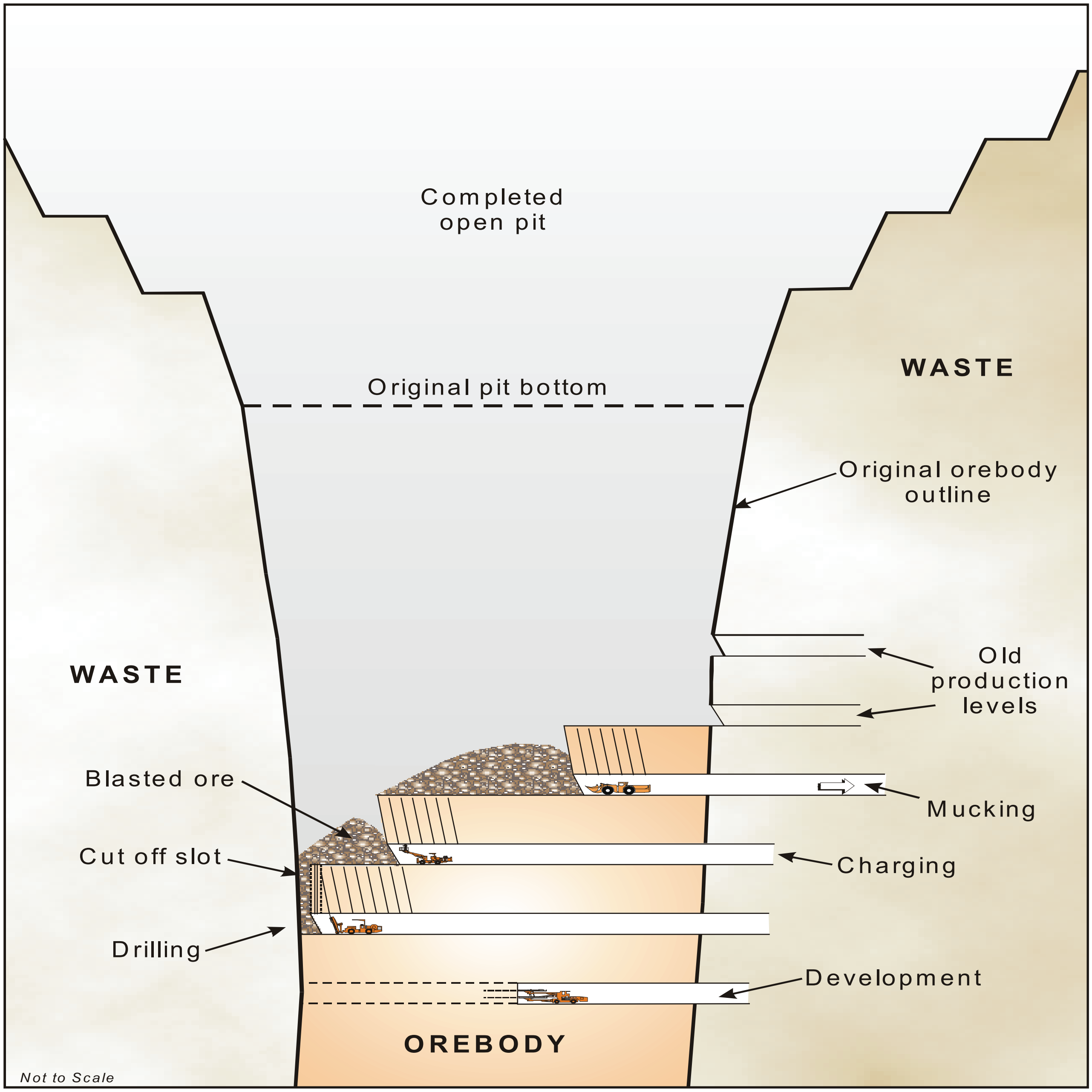

Figure 4.2-2

Example of Sublevel Retreat Underground Mining Method

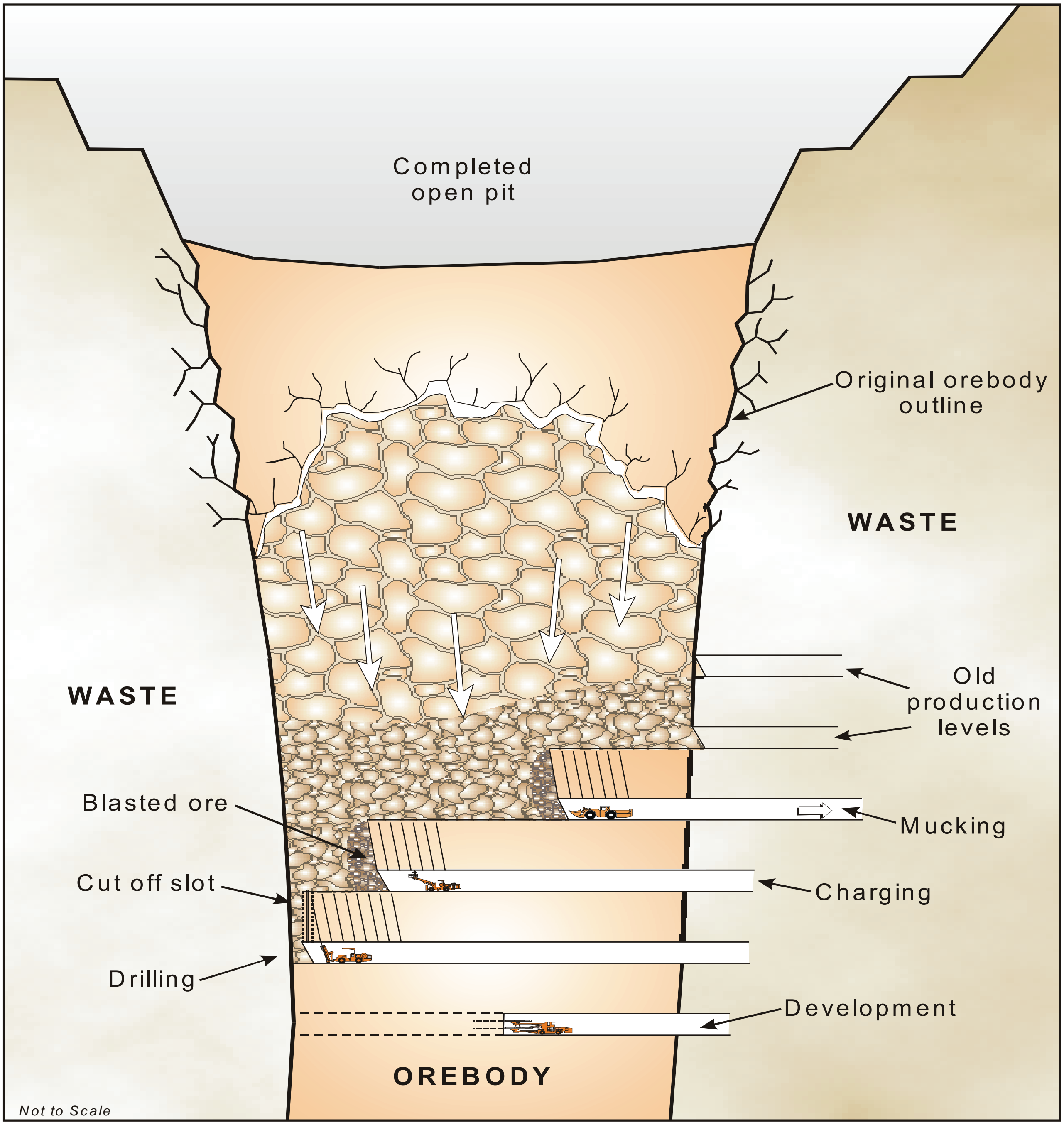

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Figure 4.2-3

Example of Sublevel Caving Underground Mining Method

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The WRSA are constructed by means of inset lifts approximately 10 to 20 m deep with natural rock face repose angles of approximately 35°. The lifts are offset in a manner such that the overall slope angle will be less than or equal to 25°. WRSA heights do not exceed 50 m above the highest topographic point over which the WRSA extends. The WRSA were all constructed and based on the original approved plans which stated they would remain as permanent structures after mining was completed.

Because EKATI lies within the zone of permafrost water from precipitation and snowmelt seeps into the waste rock piles and freezes in place. Permafrost growth through the WRSA is a key component of chemical and physical stability within the piles. The WRSA are designed to encourage permafrost movement from the underlying tundra into the rock pile. Ground temperature cables (GTC) have been installed in the WRSA to monitor the extent and rate of the permafrost growth and these have been monitored regularly (EBA 2006d). The process associated with the thermal and hydrological performance of the WRSA is shown in Figures 4.3-1 and 4.3-2.

Characteristics of the WRSA which are associated with permafrost development include the following:

- It was initially estimated that the width of the unfrozen fringe (fringe active layer) could be on the order of 150 m in late summer. Examination of the results shows that the unfrozen fringe is considerably less than 150 m wide. It is believed that the unfrozen fringe is less than 10 m wide.
- The ice-saturated core is expected to form at a rate of approximately 600 mm/year. This formation rate forms part of a hypothesis developed in the absence of site-specific data to characterize the manner in which water was expected to flow through the waste rock and the rate at which permafrost was expected to aggrade into the waste rock piles. The hypothesis was included as Appendix III-C4 in the original EKATI EIS submission.
- The growing frozen core will gradually increase the gradient and hence the seepage velocity.
- All melt water and rain infiltration into the unfrozen margin will flow through the active layer, but all infiltration into the remainder of the WRSA will freeze in situ.
- The core will remain frozen and ice saturated for the long term.

Additional cooling is also expected to occur as a result of the material placement within and around the perimeters of the WRSA. Highly porous embankment material with a narrow gradation and a relatively low amount of fines can promote enhanced cooling due to cold winter air circulation by convection currents within the open voids of the rock. This behaviour has been noted in field conditions at EKATI. The WRSA constructed from run-of-mine waste rock are similar to the embankments discussed by Goering (2002) which can promote natural convection cooling (Plate 4.3-1). Goering also discusses how natural convection cooling may occur in the embankment when the temperature difference between the embankments base and upper surface is large enough and the embankment material is of sufficient permeability. Natural convection cooling of the pore-air will continue to occur until the temperature difference between the embankment’s base and upper surface is no longer large enough to promote convection cooling.

Convection occurs in winter when cold winter air sinks into voids displacing the warm air. In summer, the thermal gradient reverses and the cooler air remains trapped in the voids. This results in a temperature difference that enhances cooling in winter and shuts down in summer. The convective component of heat transfer enhances heat removal by cold winter air and has an overall effect by the lowering of the mean annual air temperature within the rock pile. Figure 4.3-1 shows a schematic of the convective cooling concept. Additional details pertaining to the convective cooling process are available in EBA (2006b).

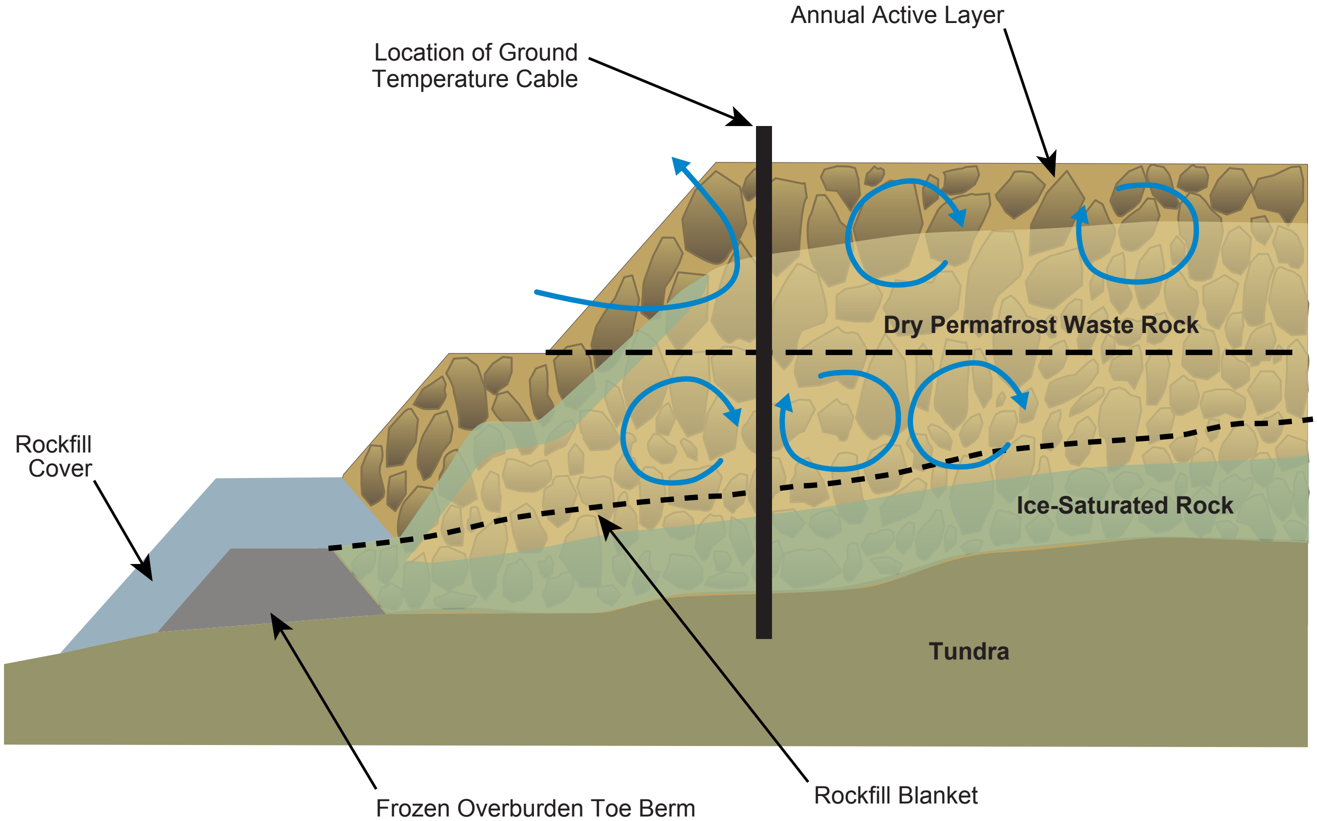


Figure 4.3-1

Convection Cooling Concept

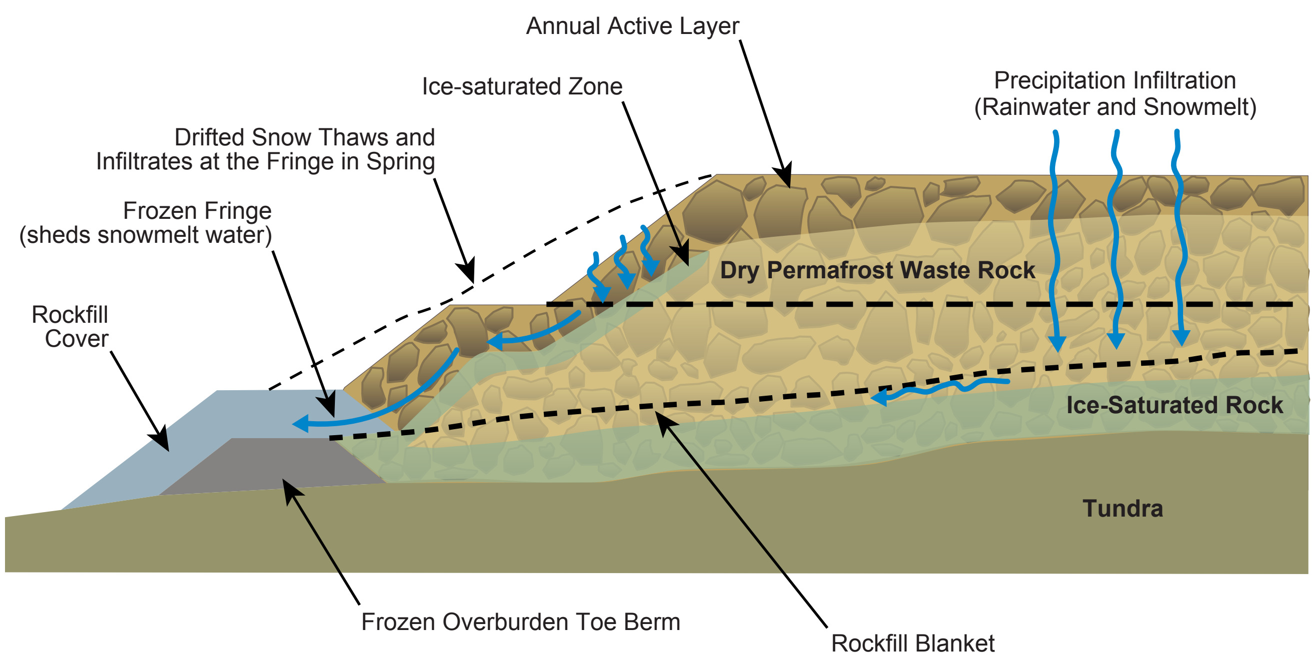
Plate 4.3-1. Typical WRSA embankment (note large fragmentation that encourages cool air flow).

Convective cooling mechanisms have been used to explain the occurrence of permafrost in waste rock embankments in northern Ontario, well south of the permafrost regions and in railway embankments in Norway (*pers. comm.*, J. Goering to K. Jones (EBA), 2001). Convective cooling processes have been observed in the WRSA at EKATI concurrent with conductive cooling of the piles.

Ground Temperature Cables have been installed in each of the materials making up the WRSA. This includes the waste rock material itself, coarse kimberlite rejects, and the fine-grained material in the toe berms around some WRSA. Although identified in Appendix 5.1-4 as further reclamation research, temperature readings in the WRSA have allowed some general trends regarding the rate of cooling and freeze back of materials in the WRSA to be made.

Cooling rate and freeze back of material is a complex problem involving many variables. In the EKATI WRSA, variable cooling rates have been observed in the constituent WRSA materials as a function of several factors including: material mineralogy, porosity/density, moisture content, and construction history. In general coarse-grained, dry materials tend to freeze back more rapidly than fine-grained materials with higher moisture contents. Deposition history also contributes to the rate of freeze back in that material placed in the summer will have higher initial temperatures than material placed in the winter and therefore require a longer period of time to cool and freeze.

Figure 4.3-2 presents a conceptual representation of water movement and ice formation in the WRSA. The movement and capture of water in the WRSA is highly dependent on the thermal conditions within the pile and these are quite variable. Generally, ice formation in the WRSA occurs when water from precipitation (rainfall or snowmelt) seeps into the waste rock materials and freezes in place before it escapes from the piles. Ice formation is thought to occur at two locations in the pile: around the pile exterior and along the base of the pile.



Conceptual Ice Formation and Hydrological Model for WRSA at EKATI

Figure 4.3-2

Generally the outside portions of the WRSA are known to be considerably colder than the interior of the piles. This is thought to be due to convective cooling that occurs to a greater extent closer to the slopes of the pile (see Figure 4.3-1). Water infiltrating into the exterior slopes of the piles from spring snow melt seeps downward until it encounters the very cold rock found around the outside of the piles. Because the rock is so cold, the water freezes very quickly, creating an ice-saturated layer around the outside slopes of the pile. This ice saturated zone, shown in Figure 4.3-2, inhibits water flow into the pile. Additional seepage infiltrates into the piles until it encounters the ice saturated layer at which point it flows along the ice saturated zone and exits the pile.

Ice development along the base results from water seepage through the top portion of the pile. Water infiltrating into the top surface of the piles seeps downward through rock, which is somewhat warmer than the rock found around the pile exteriors, and may in fact reach the bottom of the pile. The frozen toe berms decrease the hydraulic gradient in the piles and therefore slow the velocity of the seeping water to the point where it freezes before it can exit from the piles. Eventually, the waste rock near the piles becomes ice saturated, as shown in Figure 4.3-2. As additional infiltration occurs the elevation of the top of the ice saturated rock increases.

4.4 PERMAFROST ROLE IN CHEMICAL STABILITY

Permafrost, if managed carefully, has been recognized as an effective control barrier for the prevention of metal leaching (ML) and acid rock drainage (ARD) at other mine sites across northern Canada because it reduces exposure of some rock types and materials to oxidizing conditions. ARD has not been observed or measured occurring at EKATI and it is not expected because of the low reactivity of the local rock. However, to mitigate any potential ARD production, permafrost growth into the WRSA at EKATI is encouraged. This was done during the early construction phase of the WRSA by placement of a layer of granite on the tundra, across the footprint area. This provides a ‘pathway’ for permafrost growth, and enables the initial layer to freeze prior to placement of additional materials.

In addition, by slowing the movement of water through the WRSA the potential for seepage is reduced by causing water to freeze in place sooner. This was achieved by the introduction of toe berms in selected areas of the Panda/Koala/Beartooth WRSA in 1999. The toe berms impound and reduce the flow rate of water and increase its residence time in the WRSA, therefore enhancing freezing within waste rock voids. Toe berms are constructed using material of a low permeability such as glacial till that is covered with rock for protection. Toe berms are used in areas where there is a risk that any seepage flow would move towards the receiving environment rather than towards designed water collection areas. Toe berms have been constructed at specific locations on the Panda/Koala/Beartooth WRSA and the Fox WRSA, and are anticipated to be constructed around parts of the Sable WRSA. Following construction of the toe berms, a rockfill cover is placed over the toe berm at a typical height of 4 m.

4.5 KIMBERLITE PROCESSING

A single, centralized Process Plant is located within the permanent Main Camp, southwest of the Koala Pit. Ore processing was originally designed for 9,000 tons/day, which through optimization has been increased to 12,500 tons/day (based on continuous operation, 24 hours a day, 365 days a year).

Adjacent to the Process Plant is the primary crusher feeder and a coarse ore storage area.

Physical separation of diamonds from kimberlite requires grinding and washing at the Process Plant. The primary crusher reduces ore to a maximum size of 300 mm, and then a water-flushed cone crusher reduces the coarse ore to 75 mm. A high-pressure grinding roll is used to crush kimberlite to liberate diamonds and break ore down to a maximum top size of 25 mm. Flocculants and coagulants are added to aid in settling of the finer processed kimberlite fractions. Heavy medium separation using a slurry of water and ferrosilicon is used to separate a heavy mineral concentrate from the crushed ore. X-ray sorters are used to extract diamonds from the heavy medium separation concentrate because diamonds luminesce when x-rayed.

Coarse-sized processed kimberlite is trucked to the coarse ore storage area, which is located within the Long Lake drainage basin. The coarse fraction (sand size >0.65 mm) is referred to as processed coarse ore rejects, and makes up approximately 29% of the total processed ore. The fine fraction (fine sand, silt and clay <0.65 mm) is sent to the LLCF by slurry pipeline at an approximate daily volume of 13,000 m^3 (including solids and slurry). More information on the operational stream for the Process Plant is provided in the Waste Water and Processed Kimberlite Management Plan (BHP Billiton 2007d).

4.6 PROCESSED KIMBERLITE CONTAINMENT AREAS

Two Processed Kimberlite Containment Areas are located at the EKATI Mine site. The Phase 1 containment area is part of the Old Camp which was the first processing facility at EKATI. Processed kimberlite was deposited into the Phase 1 pond between 1994 and 2001. The facility is no longer in operation and is undergoing assessment for reclamation.

The LLCF comprises the basin and containment structures that are designed to contain processed kimberlite and other wastes as defined by the Water Licence and the EKATI Diamond Mine Waste Water and Processed Kimberlite Management Plan. The facility is designed to contain the projected 58 Mt of fine processed kimberlite (FPK) likely to be produced from the milling of 84 Mt of ore over a life of mine to 2020. Processed kimberlite generated during processing is separated at the Process Plant and the fine fraction is sent to the LLCF by slurry pipeline. The components at the LLCF include containment cells A, B, C, D and E; filter dikes B, C and D; the Outlet Dam; access roads and pipelines. Cells A, B and C will receive and contain the majority of processed kimberlite, with a smaller amount deposited into Cell D. The filter dikes retain processed kimberlite within upstream cells but allow process and contact water to filter through to the downstream cell. The purpose of the filter dikes is to remove suspended solids (processed kimberlite) from the water that reports to each of the lower cells. The performance of the filter is expected to change over time as the filter medium becomes clogged, in which case culverts and spillways in the dikes will be used to allow freshet flow into the lower cells. The Outlet Dam serves as the downstream water control structure. Water that meets the Water Licence criteria is pumped over the Outlet Dam into Leslie Lake.

4.7 DAMS, DIKES AND CHANNELS

There are a number of dams, dikes and channels currently in operation at EKATI as well as plans for future facilities in support of open pit development. The future Sable mine site will contain the Two Rock Dam and Dike, as part of the Two Rock Sedimentation Pond; the future Pigeon mine site will contain the Pigeon Stream Diversion; the Beartooth/Panda/Koala site complex contains the Bearclaw Diversion Dam, the Bearclaw Diversion Pipeline, Panda Diversion Dam and Panda Diversion Channel; and the Misery mine site has the Waste Rock Dam, East and West Coffer Dams, and King Pond Dam in the King Pond Settling Facility.

Dams and dikes have been constructed throughout the life of the mine to control the flow of water into operating pits and underground operations. They are also used to contain sedimentation facilities at the Misery site and at the future Sable Pit site. Dams (such as the Waste Rock Dam) are also used to control runoff from WRSA. Dikes are constructed to assist with sedimentation and act as semi-pervious filters to prevent transportation of fines downstream. Diversion channels are used to divert flow around active mining operations.

4.8 BUILDINGS AND INFRASTRUCTURE

A number of buildings and infrastructure are in place at EKATI to support mining operations. This mine area component includes not only the permanent and temporary buildings and structures EKATI but also infrastructure such as fuel storage, pipelines, pump stations, electrical systems, quarry, camp pads, laydown areas, ore storage pads, roads culverts and bridges, airport, helipad and mobile equipment. Most of the buildings and road infrastructure is centered in the Main Camp area, designed with a compact arrangement in response to the extreme cold climate, easy access and in keeping with BHP Billiton's obligations to protect the environment and keep the mine footprint as small as possible. Building infrastructure outside of the Main Camp consists of the surface facilities to support the Panda and Koala Underground operations. There is a small camp area at the Misery site, and a number of exploration camps located throughout the claim block. Most of the exploration camps have been decommissioned and reclaimed under the Land Use Permits. There are two types of roads within the mine area, access roads, and haul roads constructed from clean granite waste rock mined from open pits. A 1,950 m-long airstrip is located near the Main Camp and supports passenger and freight air traffic to and from the mine on a daily basis.

4.9 MATERIALS/WASTE MANAGEMENT

The Waste Management Plan, developed for EKATI in 2003, upholds the 4Rs of waste management: reduce, reuse, recycle and recover. It identifies procedures used to sort, handle and dispose of both inert and hazardous wastes generated at the mine site. EKATI has a landfill which only accepts inert, non-hazardous wastes such as clean wood and plastic. Waste that could attract wildlife such as food wastes, paper and oily rags are incinerated on site.

Staff of the EKATI Environment Department conducts regular monitoring of site wide waste bins and their associated disposal locations. Materials found to be improperly disposed at any location are recovered and directed to the proper disposal location.

4.10 RECLAMATION ORGANIZATION STRUCTURE

The ICRP is developed within the EKATI Environment, Community Communications and Planning Department (ECCP). Closure planning and projects use an integrated approach combining expertise from Environmental Permitting, Environmental Operations, Community (including Traditional Knowledge) and Long Range Planning.

Development and maintenance of the ICRP is a multi-disciplinary approach, which requires input from many internal and external stakeholders, including BHP Billiton's consultants. Reclamation consultants are contracted from outside the company dependent on the type of work required, and the availability of that work to be completed within BHP Billiton. Reclamation contract work in the future would include environmental monitoring and reporting, engineering design and inspection, and demolition. A more detailed assessment of closure contract work would be completed with the Final Closure Plan.

Figure 4.10-1 summarizes the management structure of BHP Billiton in regards to closure and reclamation, and Table 4.10-1 describes the responsibilities of each individual listed in Figure 4.10-1.

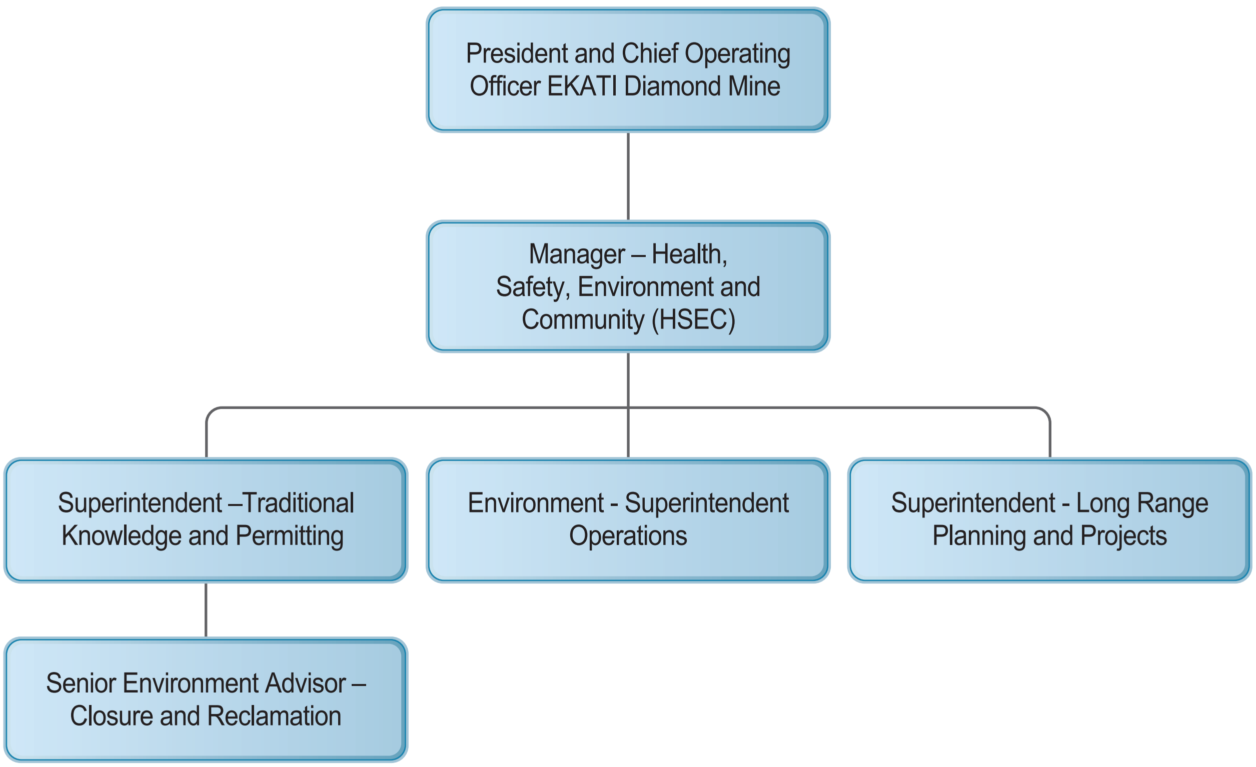


Figure 4.10-1

EKATI Organization Chart for Closure and Reclamation

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Table 4.10-1. Responsibilities of EKATI Closure and Reclamation Staff

President and Chief Operating Officer	Manages EKATI and its initiatives in Canada, and performs all duties for this position in accordance with the BHP Billiton Charter, company policies, management systems and Standard Operating Procedures. Protects all BHP Billiton assets (operations and facilities), including people, physical property, financial resources and information, within their control against loss, misuse and abuse. Responsible for share holder value and overall economical performance of the asset. Responsible for overall safe operations of a complex mining operation including open pit and underground mining, engineering and planning, maintenance and logistics. Responsible for financial control of the asset, human resources issues, strategy and development. The senior representative of BHP Billiton in Canada, responsible for liaising with both federal and territorial governments.
Manager - Health, Safety, Environment and Community (HSEC)	Manages the strategic development of EKATI's long-term planning by aligning internal and external stakeholders with environmental, regulatory and legal commitments. Oversees the day to day operations of the Environment, Community, Communications and Planning groups, as well providing leadership and direction to Community and Aboriginal Liaison staff. Works with the management team to protect all BHP Billiton Canada Inc. assets (including people, physical property, financial resources and information) within their control against loss, misuse and abuse. Ensures that all staff and operations abide by the BHP Billiton Charter including HSEC accountabilities and that all safety practices are followed, and fosters an environment of Zero Harm.
Superintendent - Traditional Knowledge and Permitting	Oversees the procurement of permits, licences, authorizations and agreements required to operate the EKATI Diamond Mine. Coordinates external communications as they pertain to the environmental performance of EKATI with regulators, Aboriginal groups and non-governmental agencies. Responsible for TK initiatives and heritage programs.
Senior Environmental Advisor - Closure and Reclamation	Coordinates the development, writing and delivery of closure and reclamation plans for EKATI. Represents BHP Billiton in regulatory and community reviews and discussion on reclamation research, planning and implementation of closure plans, and closure projects as outlined in the EKATI ICRP. Responsible for identification, budgeting, scheduling and project management on reclamation research, and in preparation for reclamation and closure of EKATI mine site components, as outlined in the ICRP. Develops and coordinates TK projects for the EKATI Mine site.

4.11 INFORMATION MANAGEMENT

Documents, reports, data, maps and engineered drawings necessary for future reclamation and closure activities have been filed at the EKATI Mine site in the Environment and Engineering Departments. The Environmental Document Management System at EKATI that is ISO 14001 compliant requires standard document management for all aspects of HSEC. BHP Billiton is currently implementing a site wide document management system which will provide the following means of information management for progressive and final reclamation:

- filing system and folders specific to reclamation documents and files;
- specified retention periods;
- lists of personnel authorized to read files;
- annual reviews of files; and
- tracking of document management and revisions.

5. Closure Requirements

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5. Closure Requirements

5.1 MINE COMPONENTS OVERVIEW

Closure and reclamation planning for EKATI is divided into the following six major mine component groups that consist of common areas of function and purpose:

- open pits;
- underground mines;
- waste rock storage areas (WRSA);
- processed kimberlite containment areas (PKCA);
- dams, dikes and channels; and
- buildings and infrastructure.

Figure 5.1-1 shows those six mine components as well as the locations of all the mines that are part of the 2005 LOM Plan. Table 5.1-1 lists the infrastructure associated with each component group. The groups are organized into areas that have been permitted but are not yet operational, and those areas that have been or are currently part of the mine operations. Detailed figures showing the locations of infrastructure of each mine component group are included in each of the appropriate sections.

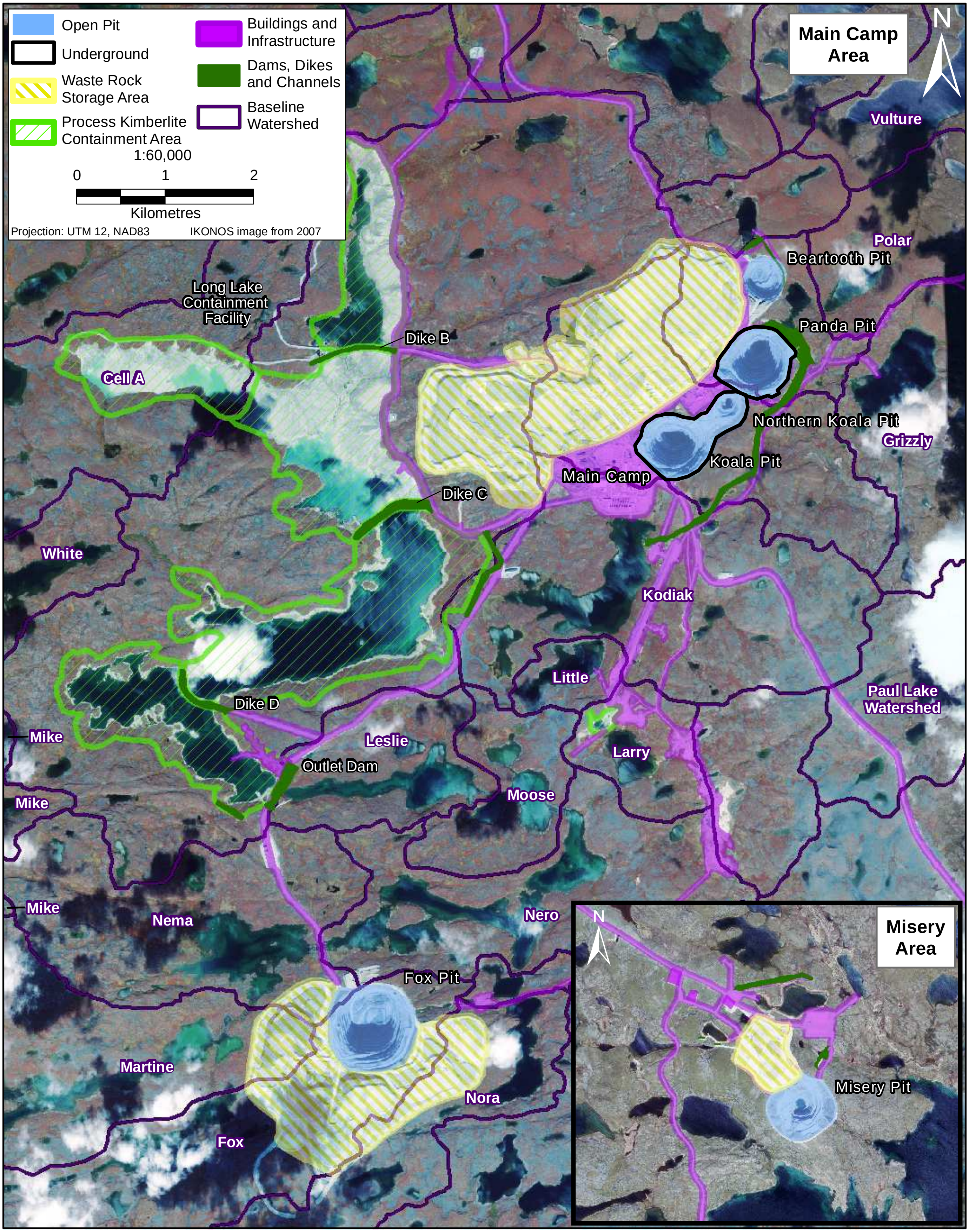
This chapter is divided into the above six mine component areas, each section beginning with a general overview and list of infrastructure included in that component. Following then is a discussion on the pre-disturbance conditions prior to development, the current development status, future projected development plans, and description of the final landscape at closure. The closure objectives are presented and followed by the reclamation activities. The reclamation activities section includes the detail on the strategies for engineering and environmental work, with Appendix 5.1-2 showing specific engineering designs. A summary of residual effects which have been assessed to remain after completion of reclamation activities are listed, followed by a list of reclamation research and engineering studies. Appendix 5.1-4 describes the reclamation research plans, and Appendix 5.1-5 describes the engineering studies. Each mine component section ends with an overview on the closure monitoring and a list of the main indicators to be monitored. Appendix 5.1-6 summarizes closure monitoring plans for all mine components.

5.2 OPEN PITS

5.2.1 Overview

There are seven kimberlite pipes in the 2005 LOM Plan. Fox and Beartooth pits are in active open pit operation, Panda and Koala open pit mines are completed and have phased into underground mines, Misery Pit is in temporary suspension of operations, and Sable and Pigeon open pits have not yet been developed. Several closure options were evaluated for the open pits as part of the ICRP development, including natural filling, pump flooding, processed kimberlite backfill and waste rock re-handling and backfill. The proposed closure method for the open pits is pump flooding.

Each of the open pits has varying levels of support infrastructure associated with this mine component group. Table 5.2-1 summarizes the open pit infrastructure (existing and future).



Current Locations of Major Mine Area Components

FIGURE 5.1-1

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Table 5.1-1. ICRP Major Mine Area Components

	Open Pits	Underground	Waste Rock Storage Areas	Processed Kimberlite Containment Areas	Dams, Dikes and Channels	Buildings and Infrastructure
Permitted	Sable Pigeon		Sable Pigeon		Two Rock Dam Two Rock Dike Two Rock Settling Facility Pigeon Stream Diversion	
Operations	Beartooth Panda Koala Koala North Fox Misery	Panda Koala North Koala	Panda/Koala/Beartooth Fox Misery Landfills and Waste Disposal sites	Phase 1 (Old Camp) LLCF	Bearclaw Dam Panda Diversion Dam (including new spillway) Panda Diversion Channel Outlet Dam King Pond Dam Waste Rock Dam King Pond Settling Facility East and West Coffer Dams	All roads Bridges and Culverts Buildings (including Main Camp and Underground Surface facilities) Mobile Equipment Airport Quarry sites (Borrow pits) Petroleum and Chemical Storage Facilities Contaminated Sites Laydown and Camp Pads Ore Storage sites Satellite Facilities and Exploration Camps

Permitted = permitted under current water licences but not constructed.

Table 5.2-1. Infrastructure Associated with Open Pits

Open Pit	Infrastructure
Sable	Open pit
	Pit berm
	Dewatering system
	Sable outflow channel
Pigeon	Open pit
	Pit berm
	Dewatering system
	Pigeon outflow channel
	Pit diversion berm
Beartooth	Open pit
	Pit berm
	Beartooth outflow channel
	Dewatering system
	Bearclaw outflow channel
Panda	Open pit
	Pit berm
	Dewatering system
	Sumps (within pit perimeter)
	Underground vent raises located within pit perimeter
	Panda Spillway
	Panda-Koala surface channel

Open Pit	Infrastructure
Koala	Koala North open pit
	Koala open pit
	Pit berm
	Dewatering system
	Koala outflow channel
	Underground vent raises located within pit perimeter
	Sumps (within pit perimeter)
Fox	Open pit
	Pit berm
	Dewatering system
	Fox outflow channel
Misery	Open pit
	Pit berm
	Dewatering system
	Misery outflow channel

5.2.2 Pre-Disturbance Conditions

Table 5.2-2 summarizes hydrologic conditions for lakes prior to pit development, and Section 5.2.2.6 summarizes pre-disturbance aquatic communities for lakes.

5.2.2.1 Sable Pit

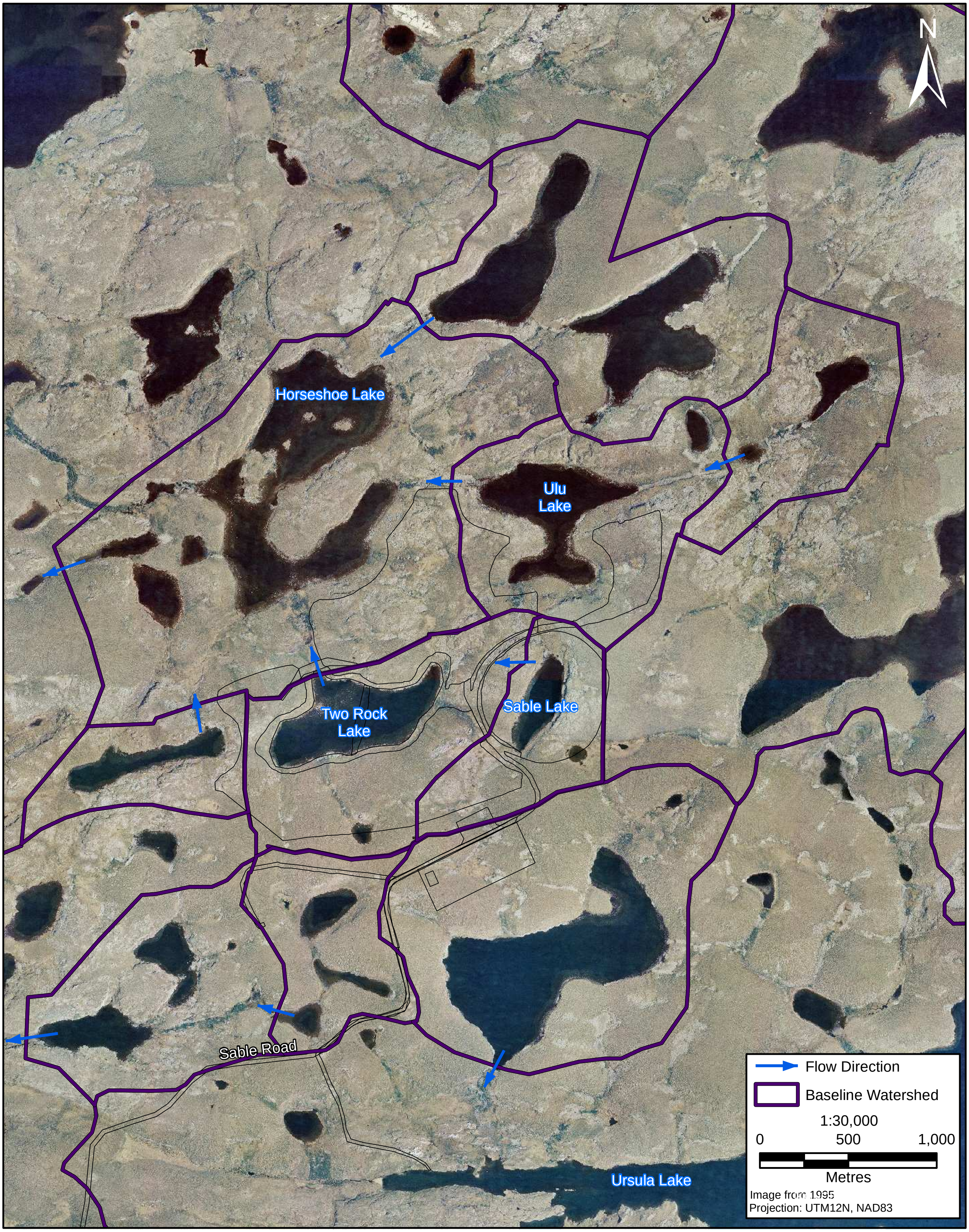
The Sable Pit has not yet been developed, but is included in the LOM Plan with infrastructure development expected to start in 2010 and ore production first scheduled in 2013. It will be developed by means of open pit mining methods already in use at EKATI. It will be an extension of existing operations at EKATI and hence will use the existing processing facilities for diamond recovery.

Sable pipe is located beneath Sable Lake, approximately 17 km north of Main Camp. Sable Lake is a headwater lake with a small catchment area and no significant inflow. It is part of the Horseshoe Watershed which lies within the overall Exeter Lake catchment, and it is also close to the Ursula Lake catchment. Figure 5.2-1 shows the pre-disturbance conditions of Sable Pit.

Table 5.2-2. Pre-Disturbance Hydrologic Conditions

Lake	Lake Area (ha)	Mean Lake Depth (m)	Max Lake Depth (m)	Lake Volume (m^3)	Watershed Area (km^2)	Mean Measured Discharge (at watershed main outflow) (m^3/sec)	Runoff Coefficient (at main watershed outflow)	Mean Calculated Discharge (based on watershed area) (m^3/sec)	Comments
Sable	8.9	4.8	18	560,173	0.66 (Sable) 86.9 (Logan)	1.15 (Logan)	0.43 (Logan)	1.10 (Logan) 0.008 (Sable)	Headwater lake. Inflow from two ephemeral streams. Discharge north to Two Rock Lake through a boulder garden.
Pigeon	1.1	1.0	< 2	N/A	10.3 (Above Pigeon Pond) 11.8 (Fay)	0.129 (Pigeon-Fay)	0.35 (Fay)	0.15 (Fay Bay) 0.13 (Above Pigeon Pond)	Inflow from Pigeon Stream. Discharge to Pigeon Stream with outlet to Fay Bay.
Beartooth	4.8	2.9	13	151,587	0.95 (Beartooth)	2.40 (Slipper)	0.45 (Slipper)	0.012 (Beartooth)	Inflow from Bearclaw Lake. Ephemeral stream from Beartooth to Panda Lake.
Panda	35	3.8	19	1,312,921	21.3 Lower PDC 185 Slipper	2.40 (Slipper)	0.45 (Slipper)	0.27 (Lower PDC) 2.34 (Slipper)	Inflow from Polar Stream and Bearclaw Stream. Discharge to Koala Lake.
Koala	38	5.9	20	2,254,152	28 (Koala) 185 (Slipper)	2.40 (Slipper)	0.45 (Slipper)	0.35 (Koala)	Inflow from Panda Lake. Discharge to Kodiak Lake.
Fox	43.6	6.9	29	3,030,154	185 (Slipper)	2.40 (Slipper)	0.45 (Slipper)	N/A	Headwater lake. Discharge to Fox 2 Lake to the south.
Misery	13.6	7.5	28	1,023,560	1.16	N/A	N/A	N/A	Headwater lake. Discharge to Lac de Gras.

N/A = not available.
Lake names in brackets represent the lake outflow for which corresponding values were calculated. See Section 5.2.2.8 for explanatory comments.



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Pre-Disturbance Conditions of Sable Pit (1995)

FIGURE 5.2-1

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Rolling ground moraine up to 15 m thick underlies terrain south, east and northeast of Sable Lake. Outcrop bedrock forms a small cliff at the shoreline along the east shore of the lake. Individual and concentrated boulders are found on the ground surface at some locations. Patterned ground such as non-sorted and sorted circles, stone polygons and rings typical of permafrost environments are well defined on the elevated flat and gently sloping windblown surfaces.

5.2.2.2 Pigeon Pit

Pigeon Pit has not yet been developed, but is included in the LOM Plan with infrastructure development starting in approximately 2011 and ore production in 2013. As with Sable Pit, Pigeon Pit will be developed by means of open pit mining methods already in use at EKATI. Since it is an extension of existing operations at EKATI it will use the existing processing facilities for diamond recovery. Figure 5.2-2 shows the pre-disturbance conditions and development status for the Pigeon area.

Pigeon Pipe is situated 5 km northwest of the existing Main Camp and lies beneath an overburden cover, and a small pond (<2 m deep) located 250 m west of the pipe centre. The upstream catchment area of Pigeon Pond includes several small and medium sized lakes. Pigeon Pond is located within the Exeter drainage, and drains through Pigeon Stream into Fay Lake, and Upper Exeter Lake.

The terrain west of Pigeon Pond consists of flat, low-lying wetland underlain by organic peat and silt deposits. Small ice-wedge polygons are evident north of the pond along the east side of the Pigeon Stream. A few boulders occur at surface in the low-lying area, in close proximity to both the stream and the pond. Northwest of the pond, beyond the wetland area, the surface rises slightly, reflecting the underlying bedrock topography. The area is covered with a thin till veneer with well defined stony earth circles on its surface. An isolated kame consisting of partially water-sorted and crudely stratified sand and gravel lies approximately 500 m north of Pigeon Pond. The kame is shaped like an equilateral triangle with an approximate surface area of 11,000 m^2. South and east of Pigeon Pond the terrain consists of rolling ground moraine covered with glacial till up to 15 m thick. Concentrations of boulders on the surface of the moraine at some locations suggest that the boulder content within the rill is variable. The exposed boulder fields are the result of melt water running off the glacial ice mass, causing erosion of finer material, possibly combined with some frost jacking.

5.2.2.3 Panda/Koala/Beartooth Pits

The Panda, Koala and Beartooth Open Pits are located in close proximity to each other. Figure 5.2-3 shows the pre-disturbance conditions and development status of the area.

The pre-disturbance topography of the Beartooth Lake area is characterized by rolling hills that reflect the morphology of the bedrock surface. West and south of Beartooth Lake the bedrock appears to have been washed of most of its surficial cover by melt water flowing away from the glacial ice. A few thin patches of glaciofluvial sediments overlie the uneven bedrock surface at isolated locations. Northeast of Beartooth Lake the bedrock is overlain by a till blanket up to 5 m thick. The surficial features throughout the area consist of well-defined, non-vegetated circular soil patches known as frost boils and stony earth circles. A few small boulder accumulations and individual boulders and bedrock blocks are disseminated across the ground surface. These features are the result of cumulative upward displacement caused by frost jacking.

Beartooth is located within the drainage flow between Bearclaw Lake to the northwest and Upper Panda Lake to the southeast. A small stream used to flow through a vegetated area from Bearclaw Lake, north of Beartooth Lake, into Beartooth Lake and a stream flowed from Beartooth Lake to Panda Lake via a boulder field and terrestrial grasses (BHP and Dia Met 2000).

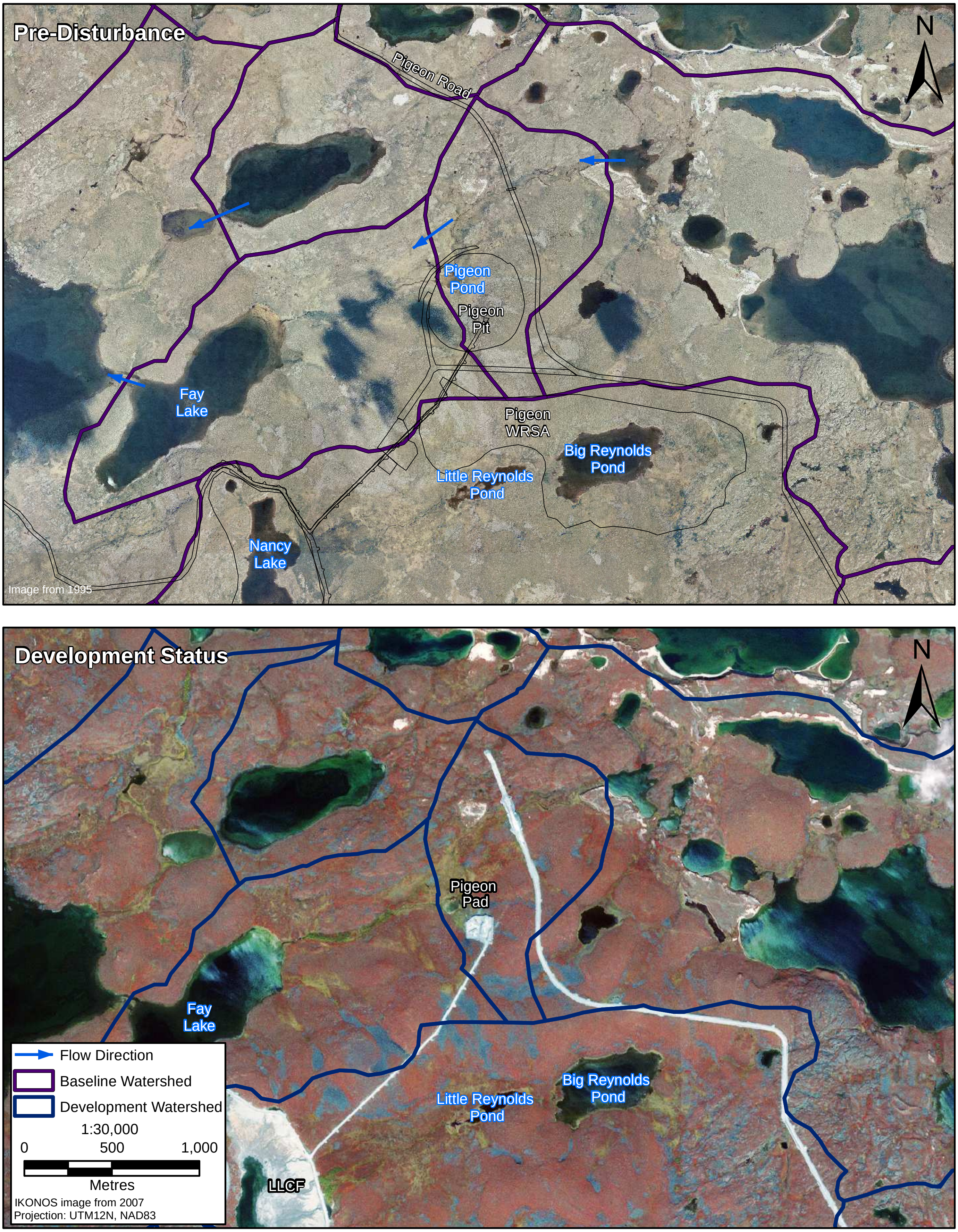

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FIGURE 5.2-2

Pre-Disturbance Conditions and Development Status of Pigeon Pit (1995 and 2007)

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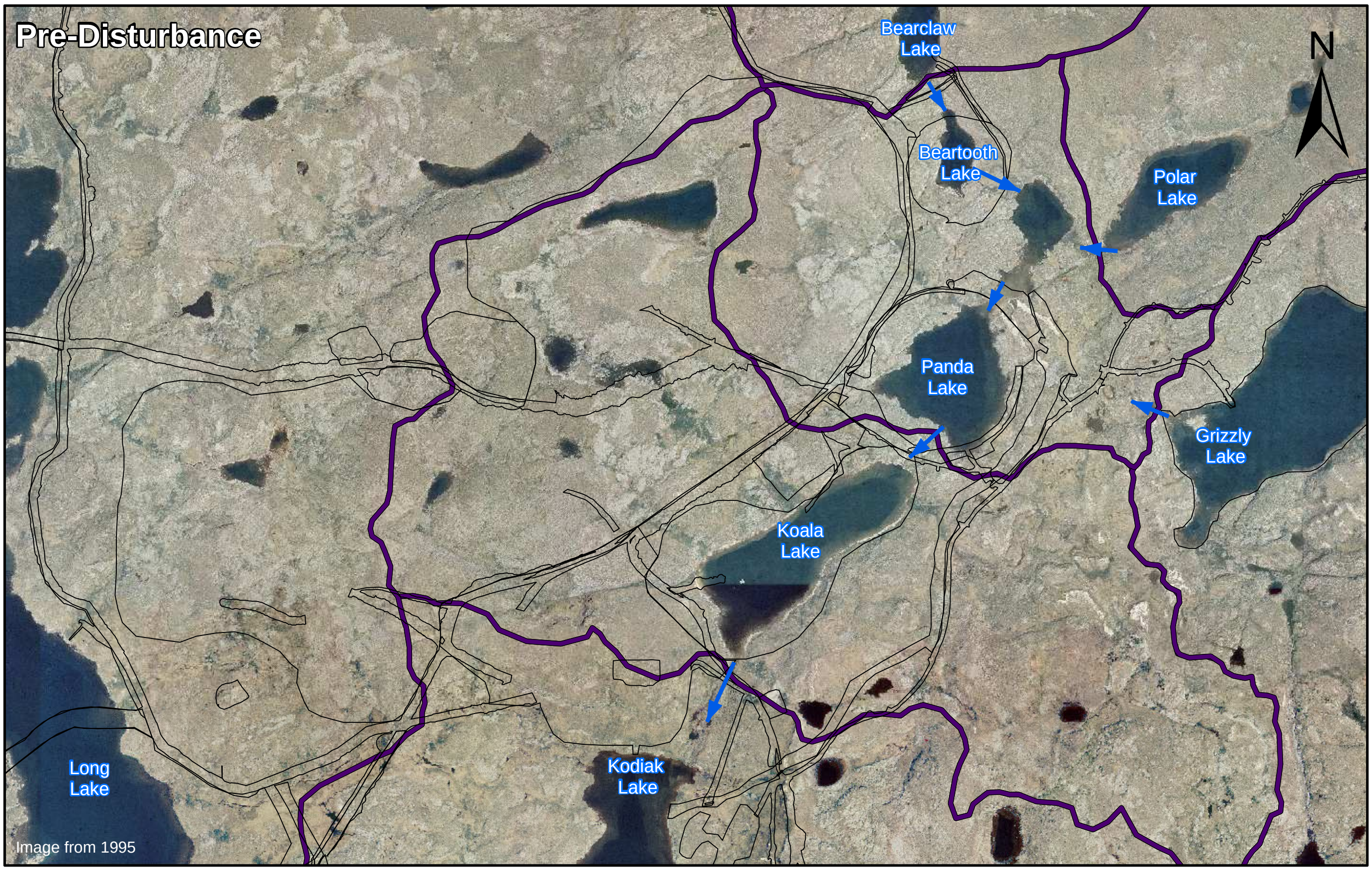

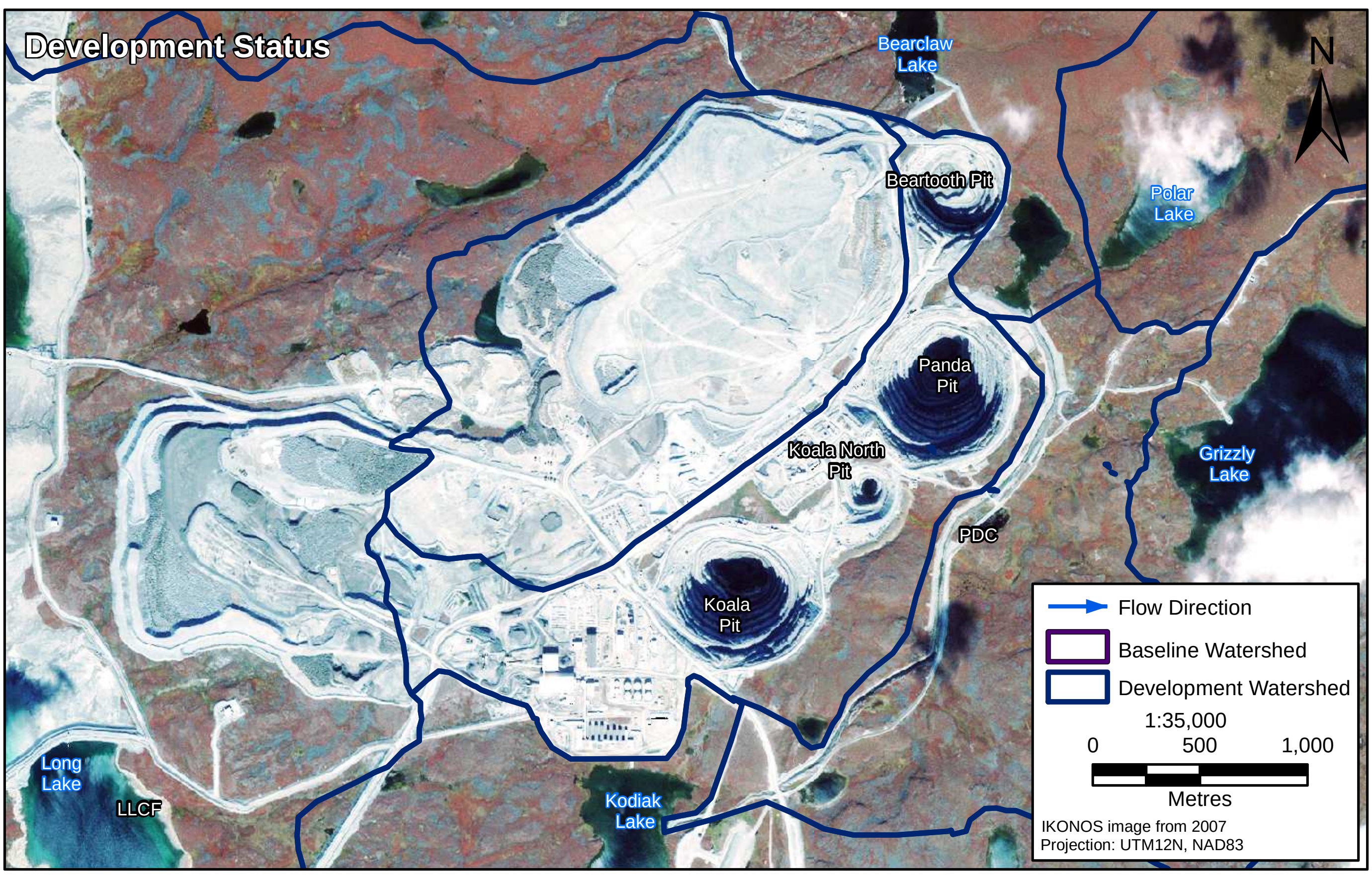

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Pre-Disturbance Conditions and Development Status of Panda, Koala and Beartooth Pits (1995 and 2007)

FIGURE 5.2-3

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Although fish are present in Bearclaw Lake, and were present in Beartooth Lake, it is likely there was no fish migration between Bearclaw Lake and Beartooth and between Beartooth and Panda Lake given the limited water depths and discharge in these streams (BHP and Dia Met 2000).

At Panda Lake, the pre-disturbance topography and deposits are predominantly glaciofluvial and comprise sand and gravel eskers. Two small eskers to the southwest have cobbles and boulders on the surface. Patches of outwash and boulders cover the till veneer to the north and south of the lake. These patches continue to the southwest of Koala Lake. A concentration of boulders on the south side of Koala Lake has resulted from the removal of fine material by glaciofluvial outwash processes. A northeast trending esker is situated to the southwest of Koala Lake, indicating a slight variation in the late glacial flow.

The dominant surficial cover in the Panda and Koala areas is till veneer less than 2 m thick. The till is generally a compact, unsorted mineral soil consisting of a silty-sand matrix with pebbles, cobbles and boulders.

Prior to pit development Panda and Upper Panda Lake were connected as a single lake. Inflow came from Beartooth Lake to the northwest and Polar Lake to the northeast. A short stream connected Panda Lake to Koala Lake. Discharge from Koala Lake flowed through a braided stream to Kodiak Lake in the south.

5.2.2.4 Fox Pit

The original Fox Lake is located in the Koala Watershed and was part of an original string of lakes Fox 1 (location of the Fox open pit), Fox 2 and Fox 3, with drainage basin flow from Fox 1 through to Fox 3. The surficial materials of the area include a lodgement till veneer containing pebbles, cobbles and boulders. The extensive boulder field south of Fox Lake is believed to be a lag deposit from glacial retreat, a product of melt water erosion. Figure 5.2-4 shows the pre-disturbance conditions and development status of the Fox Lake area.

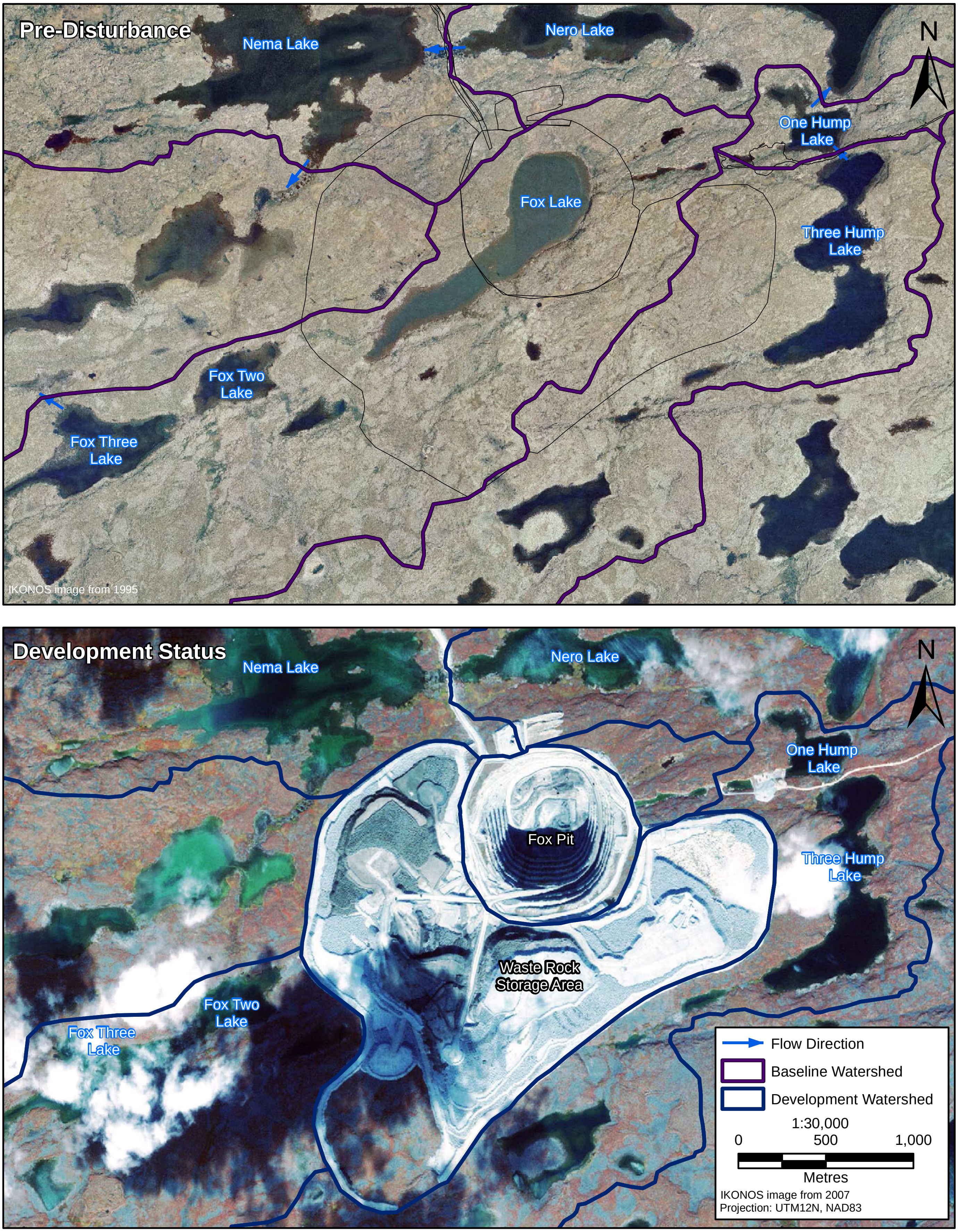
5.2.2.5 Misery Pit

The pre-disturbance conditions and topography of the Misery Lake area is characterized by low to moderate relief with rolling hills and low-lying muskeg areas. Topographic variations correspond to the change in lithology from strongly resistant granitic rocks expressed by positive relief to less resistant schist (metasediments) and low-relief. Moraine, kames and eskers are common in the Misery Lake area. The original Misery Lake is located in the Pointe de Misère area in an isolated minor catchment with an areas of 1.16 km^2) draining into Lac de Gras. Figure 5.2-5 shows the pre-disturbance conditions and development status of the Misery Lake area.

5.2.2.6 Pre-Disturbance Aquatic Communities

The lake waters above the pre-development pits at EKATI are generally very clear and soft (*i.e.*, water hardness is <60 mg/L). These lakes are inhabited by aquatic organisms which include primary producers such as periphyton (algae attached to underwater surfaces such as rocks) and phytoplankton (microscopic plants floating in the water column), secondary producers such as zooplankton (small, weakly-swimming animals that feed on phytoplankton), benthos (organisms living in or on bottom sediments in lakes and streams), and fish.

The pre-development lakes in the area are oligotrophic. In other words, they contain low concentrations of nutrients and support low levels of phytoplankton biomass. Phytoplankton and periphyton assemblages in the area are mainly comprised of algae and diatoms. Zooplankton assemblages are largely comprised of copepods, rotifers, and occasionally cladocerans (water fleas). Benthos assemblages are largely comprised of dipteran insect larvae.



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Pre-Disturbance Conditions and Development Status of Fox Pit (1995 and 2007)

FIGURE 5.2-4

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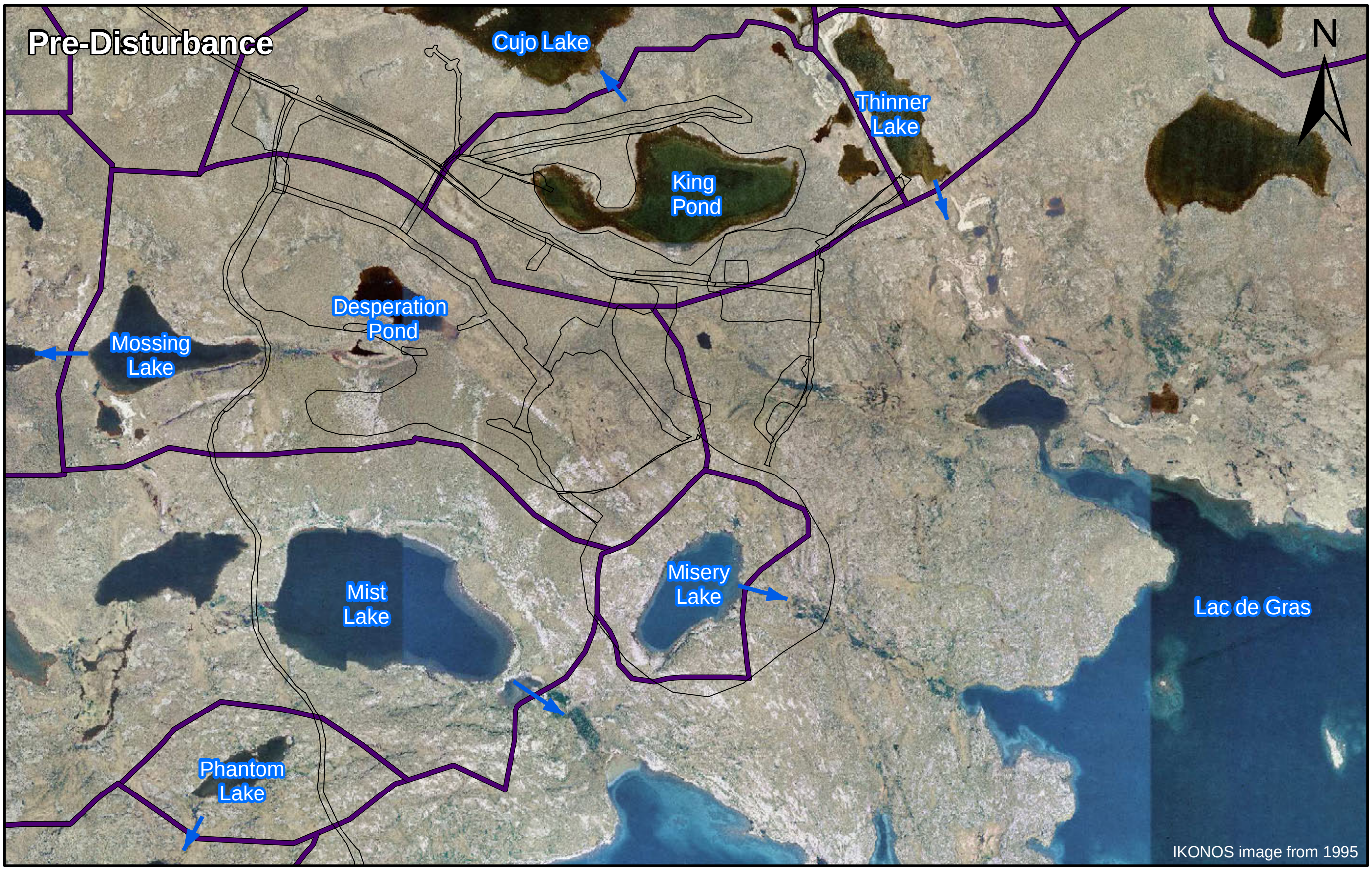

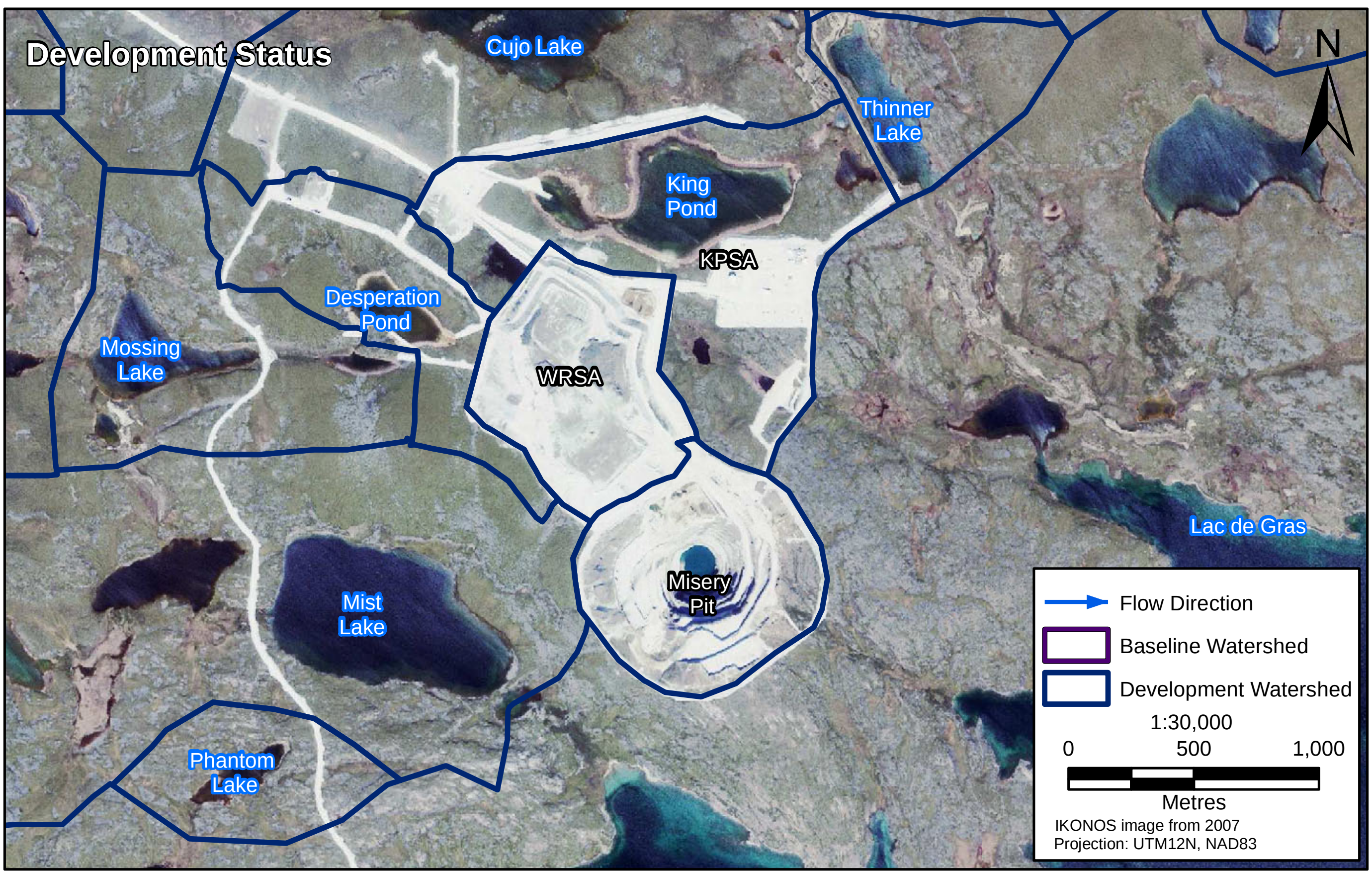

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Pre-Disturbance Conditions and Development Status of Misery Pit (1995 and 2007)

FIGURE 5.2-5

Rescan™

The five dominant fish species in the majority of pre-development lakes are lake trout, round whitefish, Arctic grayling, burbot and slimy sculpin. Lake trout are the largest and most abundant species in the majority of lakes and are at the top of the Arctic aquatic food web. They are long-lived (commonly more than 30 years old), large, predatory fish found in most lakes. Round whitefish are also very common and are an important food source for lake trout. They are also long-lived (up to 26 years old) but do not reach the same size as trout, averaging less than 0.5 kg in weight. Round whitefish consume a variety of organisms including bottom dwelling invertebrates, insects, small clams and other fish. Trout and whitefish spawn in lakes during fall, preferably over gravel substrates at least 2 m below the water surface.

Arctic grayling are a common, primarily stream-dwelling fish. They are small (<0.5 kg), and generally live less than 15 years. Grayling primarily consume insects. They spawn in early spring, moving out of lakes where they over-winter to take advantage of runoff flows in streams.

5.2.2.7 Fish Habitat Loss Authorization

Fish habitat lost through the removal of lakes at EKATI from mining operations including Sable, Two Rock, Beartooth, Panda, Koala, Long, Fox, and Misery Lakes has been approved and compensated for through *Fisheries Act Authorizations* issued by DFO. Specific details on the Authorizations for Harmful Alteration, Disruption or Destruction of fish habitat are found in *Fisheries Act Authorizations* SCA96021, SC99037, SC01111 and SC01168.

5.2.2.8 Site Hydrology

The surface hydrology at EKATI is complex due primarily to the low relief of the terrain, and the resulting diffuse drainage patterns. Lakes are typically connected by boulder-filled streams that meander in braided channels following weak hydraulic gradients. The majority of the EKATI mine development is concentrated in the Koala Watershed, with other important watersheds located to the north (Exeter Watershed for Sable and Pigeon developments and King-Cujo Watershed for Misery).

The proposed Sable development will be located in the Horseshoe Watershed, a sub-basin of the Exeter Watershed. The proposed Pigeon development will be located in the Upper Exeter Watershed, also a sub-basin of the Exeter Watershed. The Koala Watershed contains the Beartooth, Panda, Koala, and Fox pits, and Long Lake Containment Facility. The Misery pit is located in an isolated minor catchment draining into Lac de Gras, and the King Pond Settling Facility is located in the King-Cujo Watershed (Figure 3.6-2).

Table 5.2-2 lists the pre-disturbance hydrologic conditions (lake dimensions, discharge and watershed areas). The majority of this information was taken from the 1995 EIS (BHP and Dia Met 1995) and the Environmental Assessment for Sable, Pigeon and Beartooth pipes (BHP and Dia Met 2000). Mean measured discharge (at watershed main outflow) was based on stream flow measurement data from the 1995 EIS as well on data collected subsequently from baseline studies. For example, Long Lake and Slipper were taken from the 1995 EIS, because this represented pre-development. Data for Cujo Lake was from 1999 and 2000 (pre-development of Misery) and data for Horseshoe, Logan and Pigeon are from more recent baseline studies (BHP and Dia Met 2000; Rescan 2000, 2003, 2005a, 2006d, 2007d).

The collection of site data to estimate runoff from land is an important aspect of hydrologic work done at EKATI. Runoff coefficients are calculated by dividing the annual runoff total (stream flow measurements) by the annual precipitation total. The runoff coefficient is a dimensionless factor that describes the fraction of total precipitation falling on a watershed that is converted to stream runoff. It has a value less than 1 and accounts for all losses of water within the watershed, including evapotranspiration, soil storage and any losses to groundwater. Table 5.2-2 shows that the runoff coefficients estimated in the 1995 EIS and 2000 Environmental Assessment ranged from 0.35 to 0.45.

From an analysis of the 1997 to 2005 EKATI dataset, an average runoff coefficient of 0.5 was calculated. However, observed mean annual runoff coefficients can range from 0.30 to 0.63 and for the full data set values can range from 0.17 to 0.87. Average discharge (based on watershed area) was estimated for each baseline watershed based on an average annual precipitation of 333 mm and the average runoff coefficient. The average annual precipitation estimate is the most up-to-date, based on analysis of 11 years of data from the Koala meteorology station, as well as data from the Lupin Mine. Note that the 1995 EIS used an average annual runoff of 180 mm based on regional data, however, the more recent analysis uses 166 mm which is based on analysis of on-site data. Average discharge was calculated by multiplying the watershed area of a given watershed by the annual runoff depth, and dividing by the length of the open water season (which was assumed to be from May 15 to October 15 or 152 days).

5.2.3 Development Status

5.2.3.1 Sable Pit

No development has occurred at Sable pipe.

5.2.3.2 Pigeon Pit

An exploration pad and access road was been constructed to the Pigeon pit site as part of early exploratory kimberlite sampling, apart from which no mining development has occurred at Pigeon pipe (Figure 5.2-2).

5.2.3.3 Beartooth Pit

Development of Beartooth Pit commenced in 2003 and the first ore production was recorded in 2005. The pit will remain part of operations until 2020 to be used as a mine water retention pond. Approval for the use of Beartooth for mine water storage was given by the WLWB in June 2009. Construction of Beartooth Pit required draining Beartooth Lake, which involved the construction of the Bearclaw Dam to capture southern drainage from Bearclaw Lake. The flow through Beartooth Lake was diverted using a pipeline which directs surface drainage from Bearclaw Lake around the Beartooth Pit and into Upper Panda Lake. Water pumping from Bearclaw to Upper Panda Lakes maintains the natural hydrological regime.

Figures 5.2-3 and 5.2-6 show the current status of development of the Beartooth Pit. This is the expected final footprint at closure.

5.2.3.4 Panda Pit

Panda was the first pipe to be developed at EKATI. Open pit mining commenced in 1997 and was completed in 2003 when the development of the Panda Underground mine began that year. Underground operations reached full production in 2006 and are expected to continue until 2010.

For the construction of Panda Pit it was necessary to dam Upper Panda Lake in order to drain the portion of Panda Lake which overlay the Panda Pipe. Panda Diversion Dam ensures water does not enter the pit from the north and the water is diverted around the mine operations by the Panda Diversion Channel.

Figures 5.2-3 and 5.2-7 show the current status of development of Panda Pit. This is the expected final footprint and underground development will not increase the future surface area of Panda Pit.

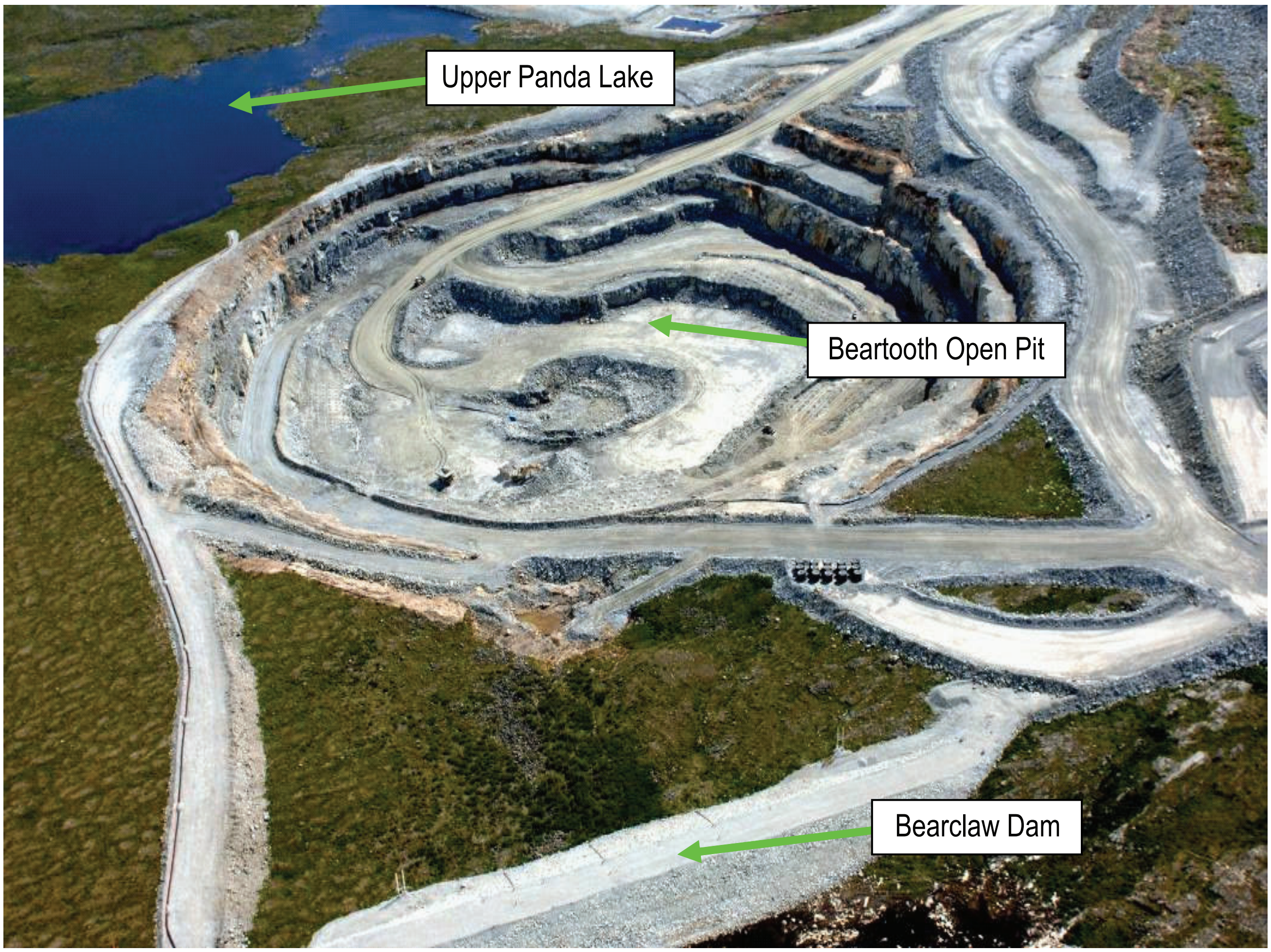

Figure 5.2-6

Development Status of Beartooth Pit (2006)

Figure 5.2-7

Development Status of Panda Pit (2006)

5.2.3.5 Koala and Koala North Pits

Construction of Koala Pit commenced in 2000 after the Koala Lake was drained, and the first ore production was recorded in 2003. Koala Pit ceased production in 2005. Underground operations reached full production in 2007 and are expected to continue until 2020.

Koala North Pit was developed as a trial underground mine to test mining techniques in kimberlite in the Arctic conditions at EKATI. The surface expression was the pit that was developed to remove lake sediments and overburden to prevent mud rushes and other safety concerns in the trial underground mine.

Figures 5.2-3 and 5.2-7 show the current development status of the Koala and Koala North pits.

5.2.3.6 Fox Pit

Fox pipe is located 8 km southwest of the main EKATI camp and is connected to the camp by an all-weather road. Construction and stripping of the Fox Pit commenced in 2001 with the first ore production being recorded in 2005. The bulk of the waste and barren kimberlite has been stripped off and ore production is scheduled to continue until 2014. Fox Pit currently provides the majority of feed to the Process Plant. Ore is trucked to the Process Plant feed stockpiles and occasionally to ore stockpiles for temporary (less than 6 months) storage at the Main Camp. All waste rock and barren kimberlite is stored in the Fox WRSA.

Figures 5.2-4 and 5.2-8 show the current development status of the Fox Pit at closure based on the 2005 LOM Plan.

5.2.3.7 Misery Pit

Misery pipe is located 27 km south-east of the main EKATI camp and is connected to it by an all-weather road. Construction and stripping of Misery pipe commenced in 1999 with ore production first being recorded in 2001. In 2005, Misery Pit was put into temporary suspension of operations although haulage of stockpiled ore continued through 2007. Figures 5.2-5 and 5.2-9 show the current development status of Misery Pit.

Mining at Misery Pit was by conventional open pit techniques similar to the other EKATI open pits. During the period of suspended operations, temporary closure measures to protect the environment and safety of mine personal are in place as outlined in detail in Chapter 6 and summarized below:

- Access to the Misery Pit and WRSA has been restricted to authorized personnel only.
- Mechanical and hydraulic systems for unused equipment have been left in a no-load condition.
- Environmental monitoring programs continue as per water licence requirements and conditions.
- Waste and unused materials have been made secured or removed to the Main Camp.
- A berm was placed around the pit perimeter to deter wildlife access to the open pit.

5.2.4 Projected Development

5.2.4.1 Sable Pit

Construction and dewatering of Sable Pit is expected to commence in 2010, and production is planned to begin in 2013 to be followed by approximately 5 years of operations. The design of the pit has been developed at a pre-feasibility level and further work is scheduled both from the perspective of kimberlite sampling and engineering design. Formal approval of the project by BHP Billiton has yet to occur. There is currently no infrastructure or all-weather road access, therefore an exploration drill program carried out in 2006 was supported by helicopter.

Figure 5.2-8

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Development Status of Fox Pit (2006)

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Figure 5.2-9

Development Status of Misery Pit (2006)

Figure 5.2-10 shows the projected development of Sable Pit at the end of its mine life in 2018.

5.2.4.2 Pigeon Pit

Construction of the Pigeon Pit is currently planned to begin in 2011, with ore production commencing in 2013.

Additional drilling of Pigeon pipe was carried out in 2006 to provide samples for kimberlite and geochemical evaluation. Further drilling during 2006 collected additional pipe wall intersection points. This data is important for pit design purposes in order to establish the pipe boundary. It is not expected that the Pigeon Pit will be extended at depth because a grade boundary has been encountered at depth.

Figure 5.2-11 shows the projected development status of Pigeon Pit at the end of its mine life in 2017.

5.2.4.3 Beartooth Pit

Ore production in Beartooth will continue into 2009, at which time the exhausted pit will be used as a mine water retention pond until the end of mining operations in 2020. These activities will not increase the current surface footprint shown in Figures 5.2-3 and 5.2-6.

5.2.4.4 Panda Pit

There are no plans to resume any open pit mining in the Panda Pit in the future, and the current surface expression of the Panda Pit is not expected to increase from that shown in Figures 5.2-3 and 5.2-7. Panda will continue as an underground operation until 2010.

5.2.4.5 Koala and Koala North Pits

There are no plans to resume any open pit mining in the Koala and Koala North Pit, and the current surface expression of the Koala and Koala North Pits is not expected to increase from that shown in Figures 5.2-3 and 5.2-7. Koala and Koala North will continue as underground operations until 2020 and 2011, respectively.

5.2.4.6 Fox Pit

Drilling carried out in 2005 indicates that significant additional kimberlite resources remain below the bottom of the existing pit design. Evaluation of this additional material is currently in progress. The marginal nature of the resource indicates a high level of risk associated with this expansion. At this time concepts for a potential pushback or a potential underground operation are being developed. These concepts are not part of the LOM Plan and do not increase the footprint of the Fox Pit shown in Figures 5.2-4 and 5.2-8. Currently the Fox Pit is expected to complete operations in 2014.

5.2.4.7 Misery Pit

Future operations at Misery are now in the planning stage. A 4 year-long pushback of the Misery Pit walls to allow deeper mining is tentatively planned to commence in 2012. Stripping is expected to commence in 2012, and ore production is expected to be completed in 2018. A pushback is permitted under the water licences and would increase the current surface expression of the Misery Pit. Figure 5.2-12 shows the expected extent of the pit limits of the Misery Pit at closure in 2018, should the pushback occur.

A review of Misery Underground operations is also planned which could potentially replace the pushback and surface mining.

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FIGURE 5.2-10

Projected Development of Sable Pit

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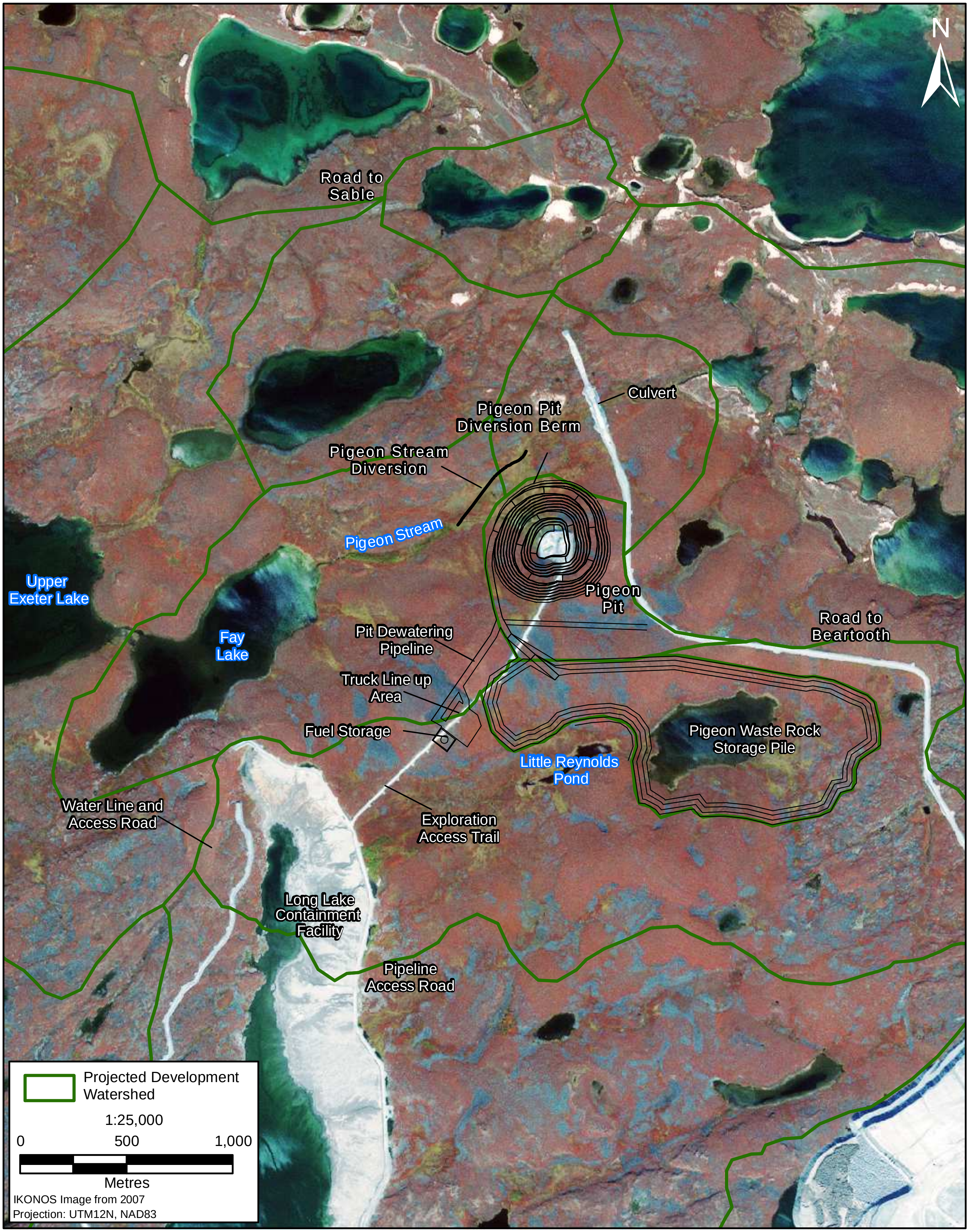

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FIGURE 5.2-11

Projected Development of Pigeon Pit

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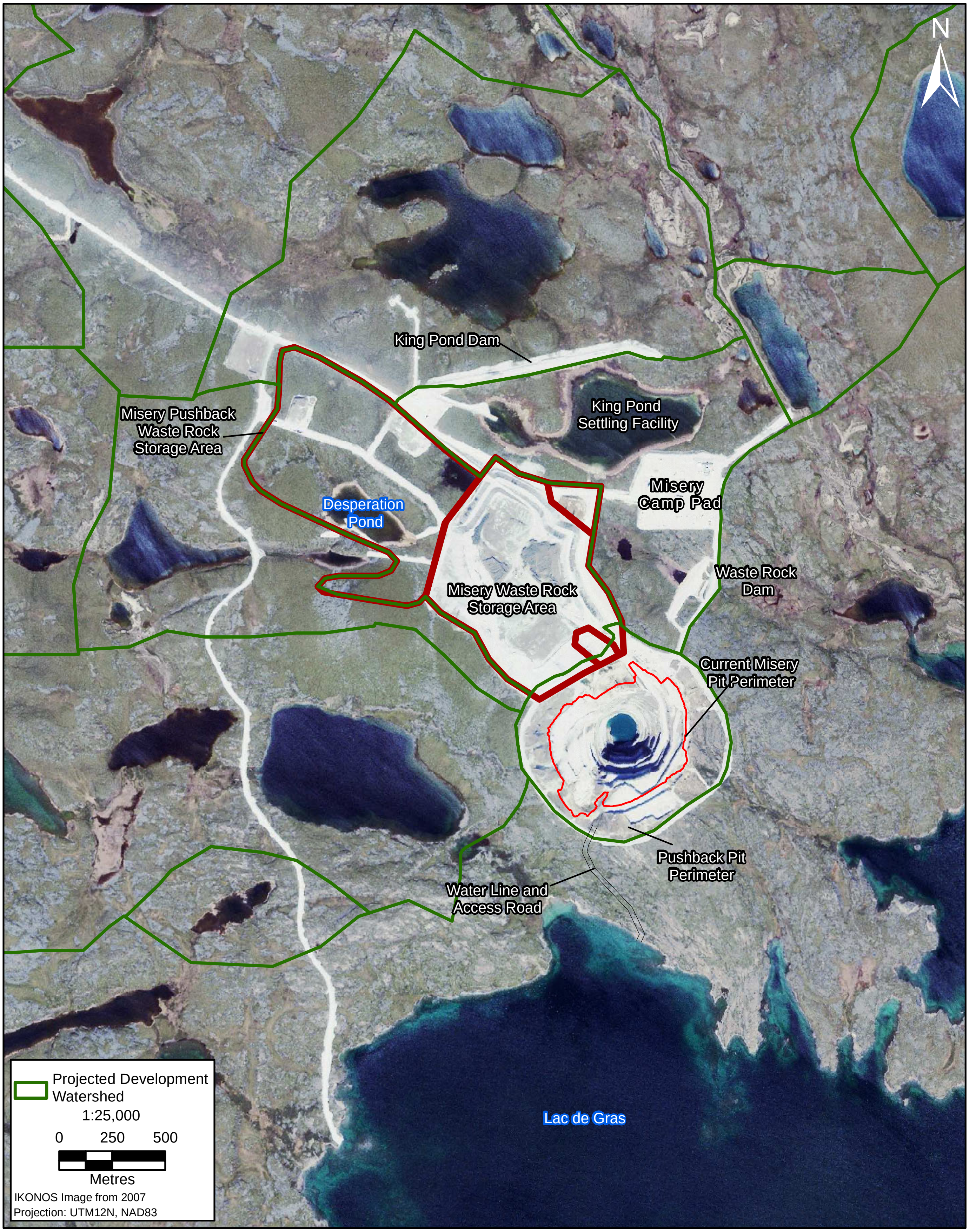

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Projected Development of Misery Pit

FIGURE 5.2-12

Rescan™

Table 5.2-3 shows the current and future pit dimensions, areas and volumes for each of the seven open pits in the 2005 LOM Plan. As a comparison, the projected status and dimensions of the open pits is included to compare the expected changes in the current open pits over the life of the mine.

5.2.5 Final Landscape at Closure

5.2.5.1 Overview

The closure plan for all the open pits at EKATI is to pump flood with water from selected source lakes on the Claim Block. As each pit or connecting underground operation ceases the pits will be flooded to create post closure pit lakes.

These pit lakes will differ from natural lakes in the EKATI Claim Block because they will be deep relative to their surface area and because they may become meromictic (no complete mixing and formation of stratified layers) due to reduced mixing potential. It is important to know whether or not a pit lake will be meromictic because this can determine the fate of dissolved materials entering the lake and therefore, its water quality. In some instances, meromictic conditions are desirable – under meromictic conditions, bottom dwelling contaminants can become isolated from the lake surface and can be stored without posing risk to the surrounding environment. In general, meromixis should not be taken to imply complete isolation of deep water. There may be a small degree of transfer between surface and deep water each year, driven for example, by plunging saline boundary flows and much more slowly by diffusion. Alternatively, some mixing may occur every few years as a result, for example, of deep water cooling. Neither should the absence of meromixis be taken to indicate complete mixing. Pressure effects may reduce mixing in deep (>150 m) lakes.

Predictions of water quality for individual pits cannot be fully developed until current pit lake research studies are complete, but preliminary studies indicate that pit lake water quality will be dependent on a number of factors, including loadings in the fresh water introduced during pit filling, surface runoff, pit wall geochemistry and processes such as meromixis, turbulence and salt exclusion from winter ice cover. These factors are discussed in Tasks 1 and 2 of the pit lakes research (BHP Billiton 2005a, 2005b), and in more depth in Chapter 7. Once pits fill with water, lake productivity is expected to be low because only limited littoral development will be possible on the steep pit slopes, and the large depths of the pit lakes will result in lost nutrients from the water column. The majority of pit lakes at EKATI will have depths over 260 m and approximate average surface areas of 60 ha, resulting in high depth to surface ratios, which decreases the potential for wind mixing. It is expected that meromictic conditions may develop within the final pit lakes should stratification evolve between water densities, chemistry and/or temperature differences, or if climatic conditions prevent seasonal turnover.

Fish barriers may be used as a temporary measure in case of water quality concerns in the pit lakes during flooding. The barriers would be removed by BHP Billiton following a process by which the Board will solicit comment from DFO and other parties once BHP Billiton has submitted to the Board that it believes conditions are safe for fish passage. The final decision on whether to remove any fish barriers will rest solely with the Board. The development of a temporary fish barrier design has been included in the tasks of Engineering Study # 4 (Appendix 5.1-5).

Table 5.2-3. Current and Projected Development of Final Open Pits

Open Pit	Current Diameter (m)	Maximum Expected Diameters (m)	Current Depth (m)	Maximum Expected Depth (m)[1]	Current Open Pit Surface Area (m^2)	Maximum Open Pit Expected Surface Area (m^2)	Pit Surface Elevation (masl)	Current Volume Open Pit (m^3)	Expected Volume Open Pit (m^3)
Sable	-	600	-	234	-	400,000	505	-	33,800,000
Pigeon	-	400	-	179	-	100,000	465	-	6,500,000
Beartooth	420	420	150	200	200,000	200,000	457	7,900,000	13,400,000
Panda	720	720	320	535	300,000	300,000	464	38,000,000	40,900,000
Koala North	270	270	51	270	50,000	50,000	453	1,100,000	2,100,000
Koala	700	700	225	630	300,000	300,000	460	30,100,000	44,500,000
Fox	900	900	200	310	600,000	600,000	450	57,800,000	70,300,000
Misery	500	620	175	275	200,000	300,000	450	14,800,000	26,000,000

masl = metres above sea level

1. The expected maximum depth of Panda, Koala and Koala North is to the bottom of the underground mines.

The stability of pit walls after flooding will be dependent on the rock type, number of fracture joints, permafrost and climate. Pit walls at EKATI are composed of strong granite with minor joint fractures. When the open pits are filled with water, the new pit lakes will have some degree of thermal storage capacity. The heat stored over the summer months is expected to slowly thaw out a portion of the pit walls and pit floor. This is called a talik zone and is recognized beneath the deeper natural lakes. The thickness of a talik zone is proportionate to the size of the water body and the amount of warmth it is exposed to in the summer. Talik geometries are based on known mechanisms of heat transfer. Discussion pertaining to heat transfer is available in Andersland and Ladanyi (2004). Nixon (1998) also discusses talik formation. Previous investigations at EKATI and thermal analyses have also indicated the tendency for taliks to form to a greater extent under water bodies as opposed to laterally.

Fractured bench crests and smaller wedges in the pit walls that are currently frozen in place could possibly fall when thawed out. The granite host rocks are structurally strong, and no structures have been identified that could impact long term stability of pit lakes. It is not expected that the talik zone will move far enough into the pit walls to cause any large scale failures, but close to the pit crest there is the potential for some small or medium sized sloughing.

Freeze-thaw action is expected to be the main driver of instabilities in pit walls. Once the pit is filled with water there will no longer be the freeze-thaw cycles that occur throughout the year, and a reduction in the weathering effects and spalling (i.e., sloughing and erosion).

The final landscape of the pit lake shoreline following completion of reclamation activities will be a constructed environment that may naturally evolve over time into an aquatic ecosystem that may support fish and that may be naturally self-sustaining. Littoral zones around portions of the lake perimeters and connector channels to the natural environment (see also Section 5.2.5.2) will be designed with the intention of facilitating the establishment of a self-sustaining aquatic ecosystem. Design considerations for the littoral zones will include substrate, with the outer rim of the littoral areas protected by rock shoal berms to reduce scouring of substrate into the deep basin by winter ice cap, and providing areas that may develop into spawning and rearing habitat for fish. Aquatic plants and riparian vegetation may be used to stabilize fines in areas of potential erosion near the water's edge and upper banks. Some pit lakes will have steep highwalls remaining above the water surface which may provide raptor nesting locations, while other areas of the lake edge will have shallower slopes that will allow wildlife access and egress. Figure 5.2-13 illustrates the conceptual design considerations for pit lake perimeter areas, including littoral zones, and Table 5.2-4 identifies the physical and biological functions that each might facilitate. A design report for pit lake littoral zones and connector channels will be provided to the Board for its approval prior to construction.

Barriers will be placed around the open pits during the flooding period to deter wildlife and human access. BHP Billiton has proposed rock berms as a deterrent method. However, other options will be considered. Barriers may remain in place in areas of potential pit wall instability after pits are flooded. If berms are selected it is expected that these barriers will be breached in areas for wildlife access (in stable areas) and to facilitate channel overland flow.

Research and engineering studies are being used to assess in more detail the final landscape of the pit lake perimeters, with respect to slope angles, beach areas, riparian areas and remaining high walls. The listed research and engineering plans are located in Section 5.2.10 to 5.2.11, and detailed research and engineering studies are located in Appendix 5.1-5.

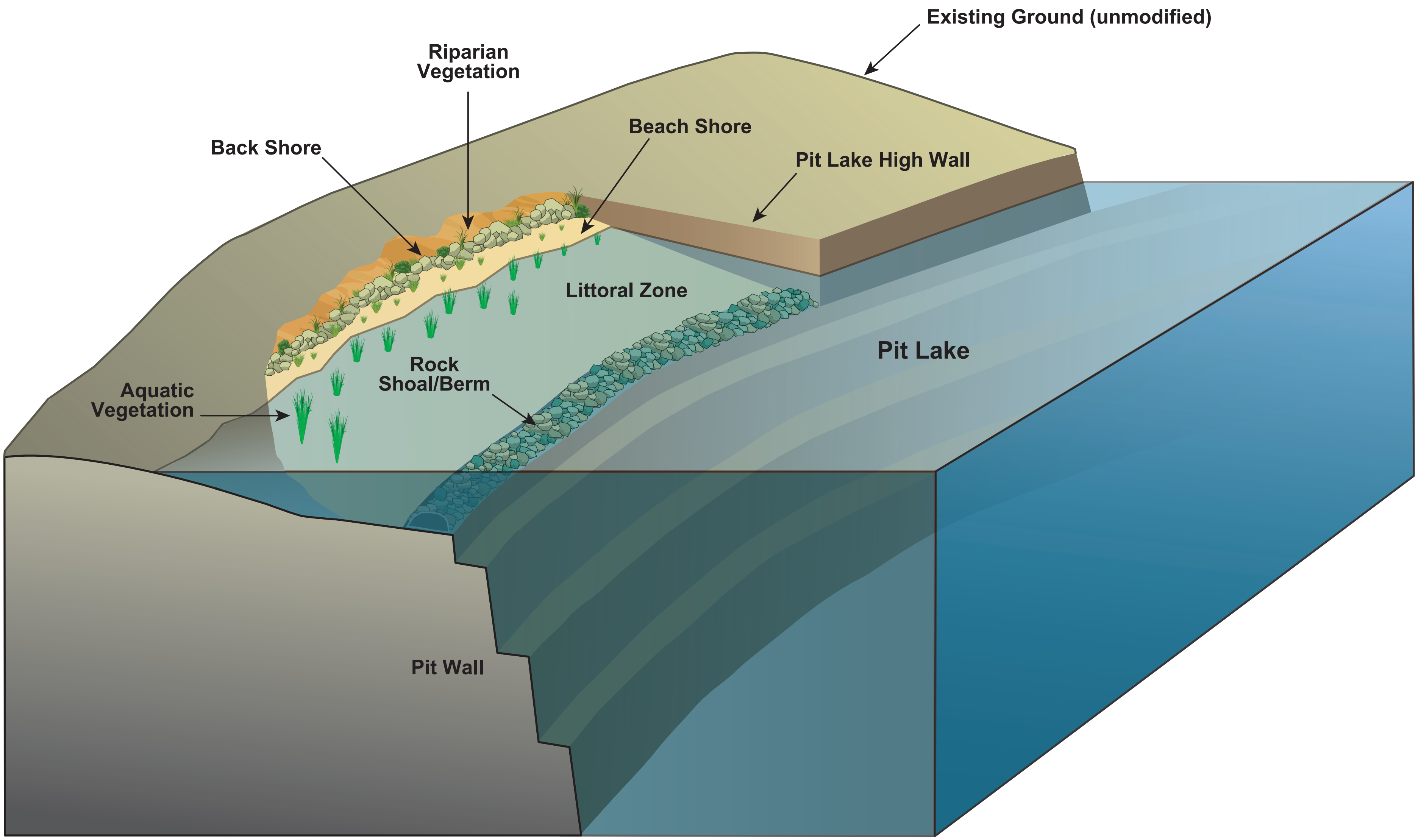

Figure 5.2-13

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Conceptual Pit Lake Littoral Zone

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Table 5.2-4. Pit Lake Perimeters Aquatic Ecosystem Facilitation Work

Pit Lake Perimeter Area	Concept Design Work	Facilitated Function (Physical)	Facilitated Function (Biological)
Pit Lake Highwall	Highwall area remaining, following mining operations	N/A	Nesting areas for Raptors
Back Shore/Beach Shore	Sloping and stabilizing work Rock armouring and riparian vegetation where necessary	Prevents erosion	Safe access/egress areas for people and wildlife
Littoral zone	Sloping and excavation work to create sloping beach and submerged zone. Substrate placement for aquatic plants and spawning areas for fish	Light penetration through water column to substrate. Aquatic vegetation growth reduces scouring and erosion of fines.	May facilitate food source chain from phytoplankton to zooplankton May facilitate habitat for benthic invertebrates May facilitate spawning substrates for fish.
Rock Shoal / Berm	Rock berm placement of clean granite (mixture of boulder sizes)	Increase substrate stability, increase substrate complexity	Substrate may facilitate spawning for adult lake trout and round whitefish, cover for juveniles
Riparian vegetation	Plant native grasses and shrub live cuttings	Increase shoreline stability, reduced surface erosion	Reduced turbidity
Aquatic vegetation	Plant native aquatic grasses and sedges	Increase substrate stability	Aquatic vegetation may facilitate establishment of habitat for primary and secondary producers, cover for juveniles

5.2.5.2 Surface Drainage

<u>General</u>

Once the open pits are filled with water from pump flooding it is expected that discharge from the pit lakes will occur. This will require re-connection of the pit lake with the local hydrological system to allow drainage. Final pit lake elevations, expected seasonal lake level fluctuations and pit perimeter topographic characteristics have been included as part of the engineering study plan on pit lakes perimeter and connector channel design (Appendix 5.1-5, Engineering Study #2). Discharge volumes and other channel flow characteristics such as channel slope and bank width will be provided in future updates of the ICRP, once preliminary pit lake and connecting channels designs have been assessed. Where necessary new connector channels will be constructed, however existing flow channels that were in place prior to pit development would be used where possible. Channel banks will be stabilized, if needed, through rock armouring and/or plant establishment to prevent erosion. The design for the pit lakes littoral zones will acknowledge that fish access into and out of the pit lakes through connector channels may be intermittent and may not be possible every year in some instances, being dependent on natural flow conditions in the small catchment areas around the pit lakes. The pit lakes closure objective of ‘safe for fish passage’ means that fish should not have any more risk of physical injury than they would typically experience elsewhere in their natural range under similar circumstances, with similar natural flow conditions.

Sable Outflow Channel

An outflow channel will be constructed between Sable Pit Lake and Two Rock Lake. The pre-development flow from Sable Lake was north into Ulu Lake; however, at closure this drainage path will be covered with the Sable WRSA. Sable Pit lake flow will be connected with Two Rock Lake only when the pit lake water quality meets water licence criteria.

Pigeon Outflow Channel

Pigeon Stream will flow through the Pigeon Stream Diversion during mining operations and that diversion will remain open after closure. The pre-development inflow from Pigeon Stream above the diversion will not be reconnected at closure. Instead, the berm on the southern end of Pigeon Pit Lake will be breached and outflow from Pigeon Pit Lake will be connected to lower Pigeon Stream whence it will flow into Fay Lake and Upper Exeter Lake. Flow from Pigeon Pit Lake will be connected to the external drainage only when pit lake water quality meets water licence criteria.

Beartooth Inflow and Outflow Channels

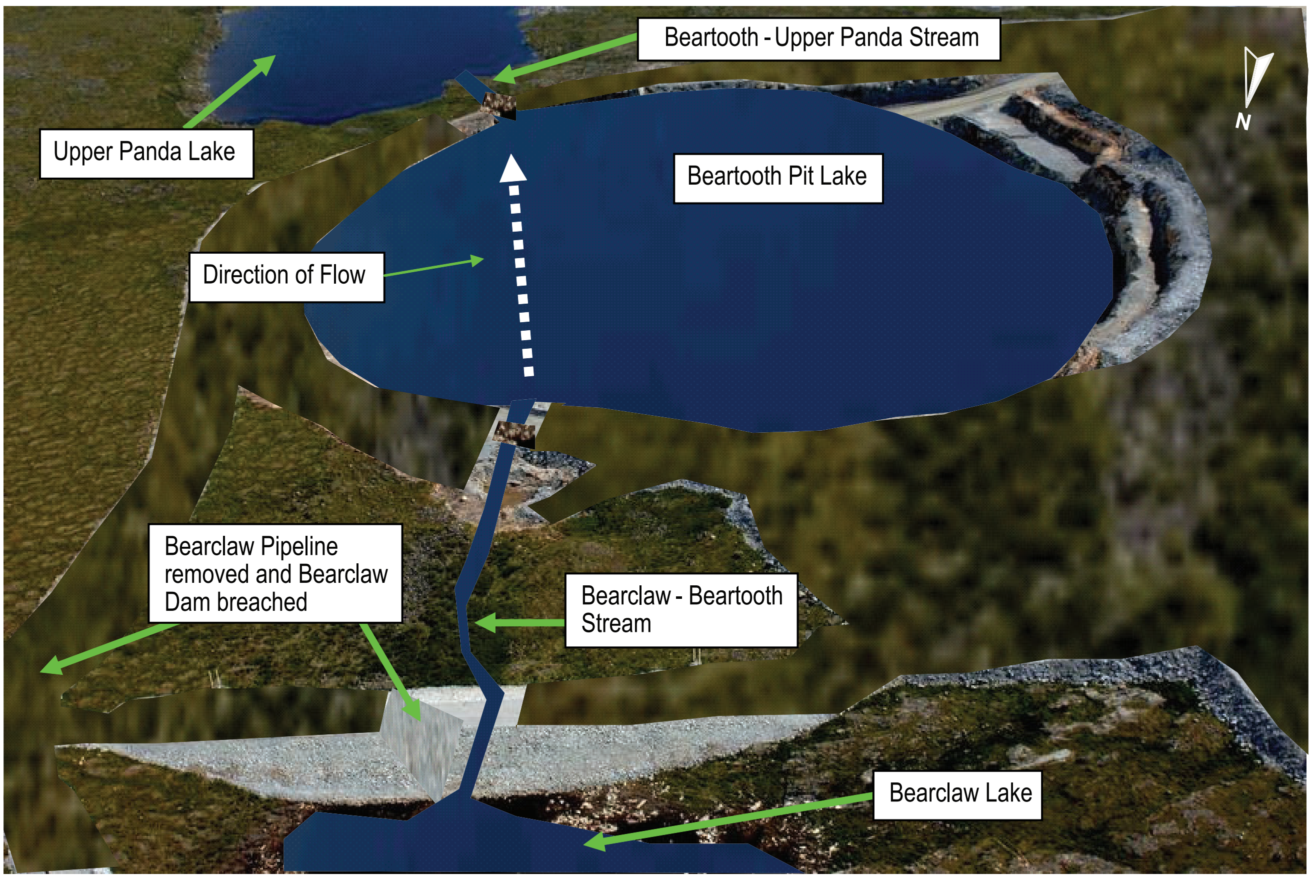
At closure, once Beartooth Pit Lake has been pumped full and pit lake water quality meets water licence criteria, the Bearclaw pipeline will be de-commissioned and flow will be re-directed through the Beartooth Pit Lake. Flow will be re-established from Bearclaw Lake through Beartooth Pit Lake by breaching the Bearclaw Dam and re-constructing an inflow stream. The outflow into Upper Panda Lake will also be re-established. Figure 5.2-14 shows an overview of Beartooth Pit Lake and its surface drainage pattern.

Panda/Koala/Kodiak Channels

At closure, the surface drainage patterns in the Panda and Koala Pit lakes area will be dictated by leaving the Panda Diversion Channel open. This will continue the diversion of the majority of flow from Upper Panda Lake around Panda and Koala Pit lakes to Kodiak Lake. Modifications to the channel have been designed which are intended to stabilize the channel walls in areas where they are currently very steep. This, together with removal of culverts at closure, is expected to reduce snow drifting and the potential for spring blockage of the channel. A spillway will be constructed around the Panda Dam that will allow safe passage of flood flows. This is a precautionary measure to protect against general flooding of the area in a flood event or if the Panda Diversion Channel is temporarily blocked with snow during freshet. Appendix 5.1-2 shows figures of the diversion channel and planned spillway and diversion channel stabilization work.

A channel between Panda Pit Lake and Koala Pit Lake (which will include a flooded Koala North Pit) will be constructed to reconnect surface drainage. The channel between Koala Pit Lake and Kodiak Lake will also be reconstructed. Flow from Koala Pit Lake into Kodiak Lake will be reconnected when the Panda and Koala pit lakes meet water quality licence criteria. Figures 5.2-15 and 5.2-16 show the flow path of Beartooth, Panda and Koala pit lakes at closure, including a cross-section of these pit lakes with final elevations.

Two flooding scenarios have been proposed for filling Panda and Koala Pits. The first scenario is the placement of plugs in the underground connections between Panda and Koala Underground mines that allows the two pits to be flooded independently and to different water elevations. The second scenario is flooding these pits without underground plugs. For this ICRP both scenarios have been included in the scheduling of pit flooding, in Figure 5.2-19.



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Final Landscape of Beartooth Pit Lake

Figure 5.2-14

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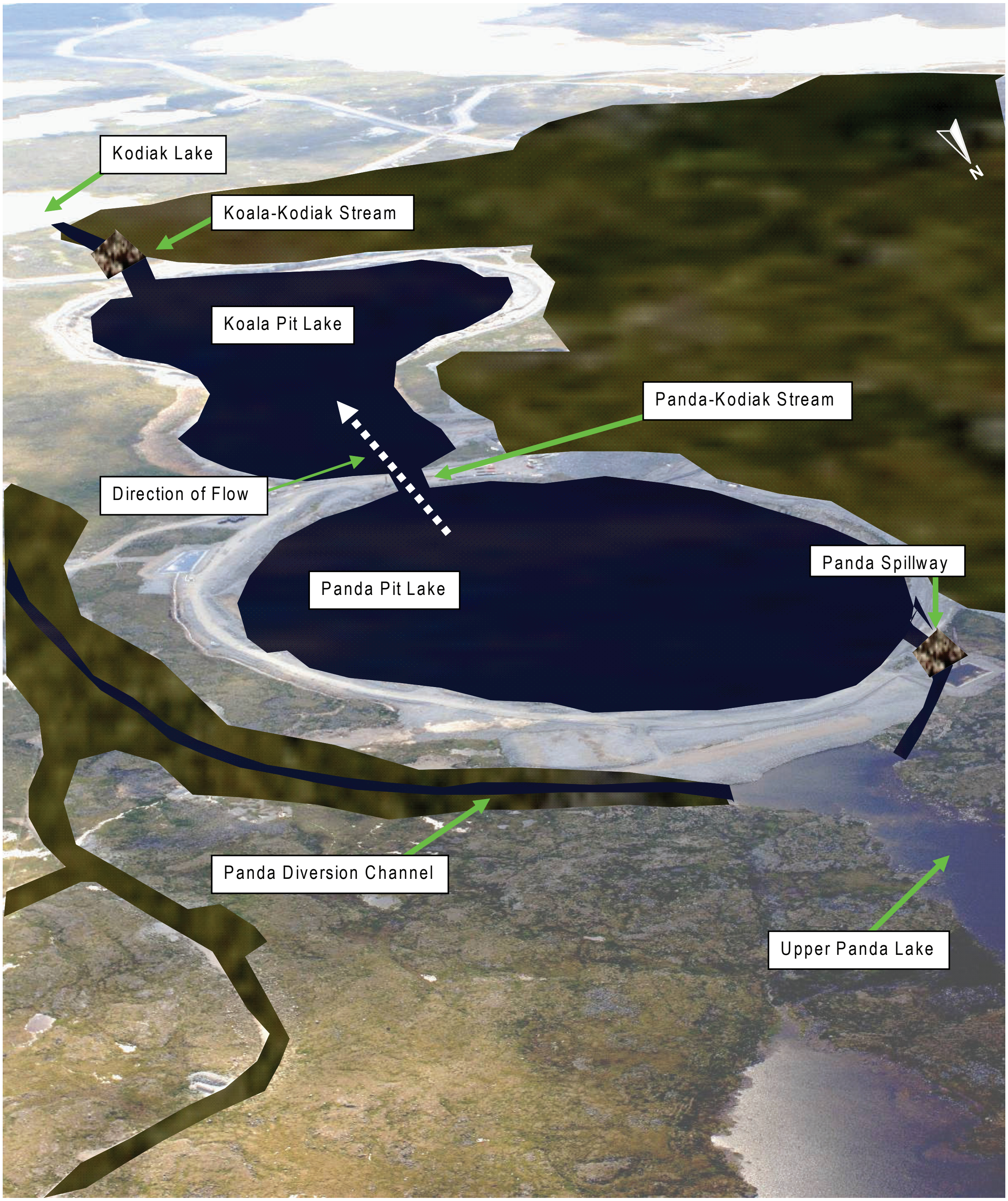

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Final Landscape of Panda and Koala Pit Lakes

Figure 5.2-15

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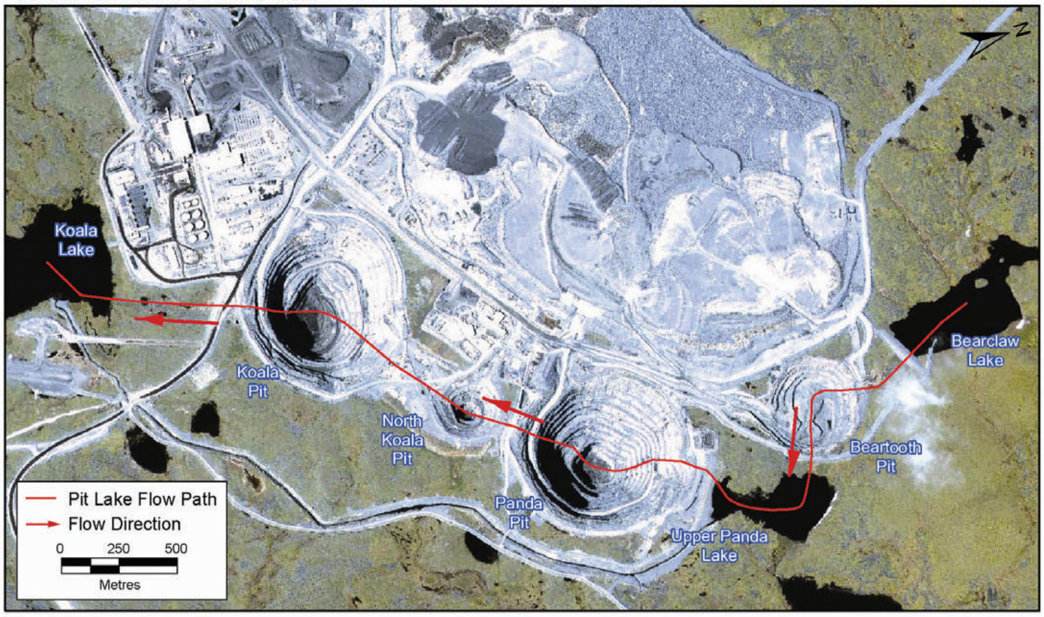
Aerial View of Flow Path



Cross-Section View of Flow Path

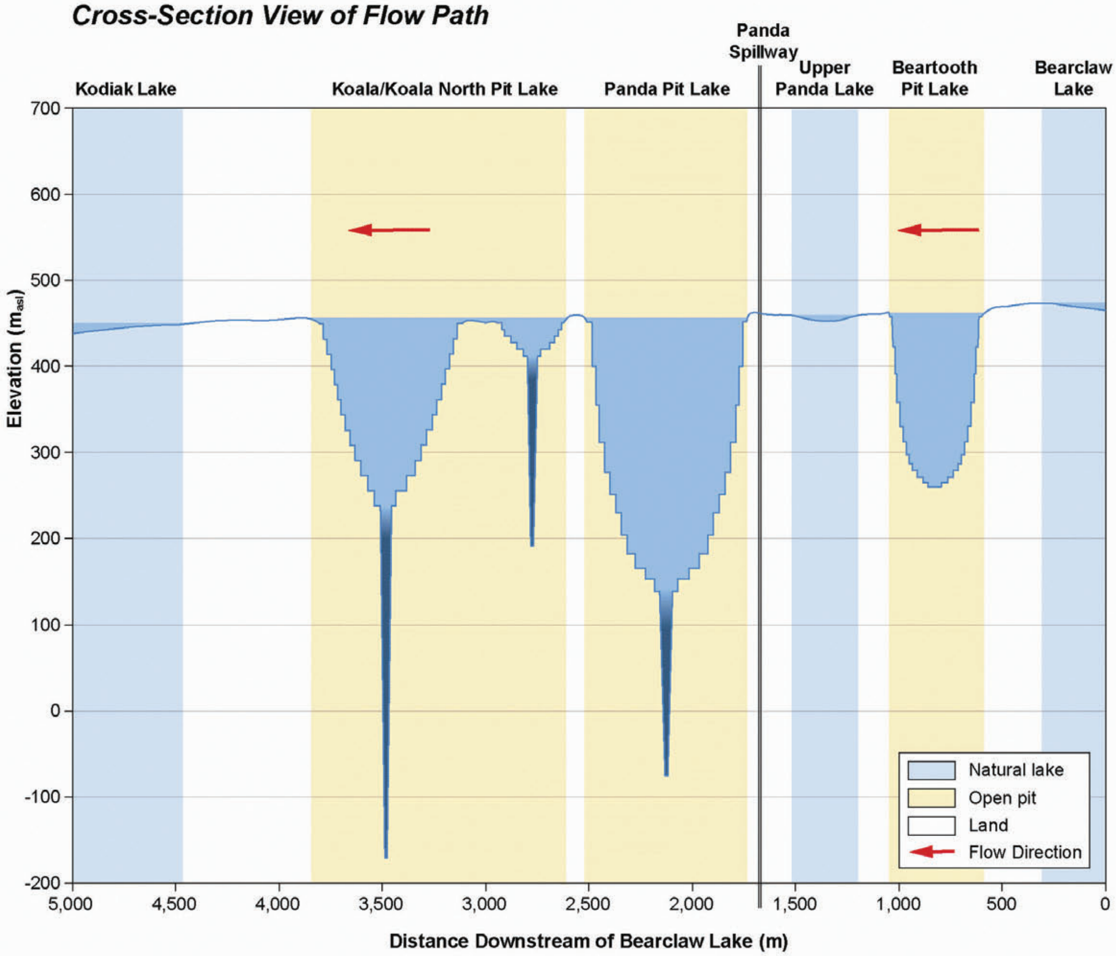


Figure 5.2-16

Flow Path of Beartooth, Panda and Koala Pit Lakes at Closure

Fox Outflow Channel

After the Fox Pit has been filled with water, discharge will be directed northeast to One Hump Lake. Flow from Fox Pit Lake will be reconnected when the Fox Pit lake water meets water licence criteria. Figure 5.2-17 shows an overview of Fox Pit Lake and surface drainage patterns.

Misery Outflow Channel

Once Misery Pit is filled with water, and when that lake's water quality meets water licence criteria, the outflow from Misery Pit Lake will discharge into Lac de Gras. An outflow channel will be constructed to direct drainage from Misery Pit Lake to Lac de Gras. Figure 5.2-18 shows the drainage pattern for Misery Pit Lake.

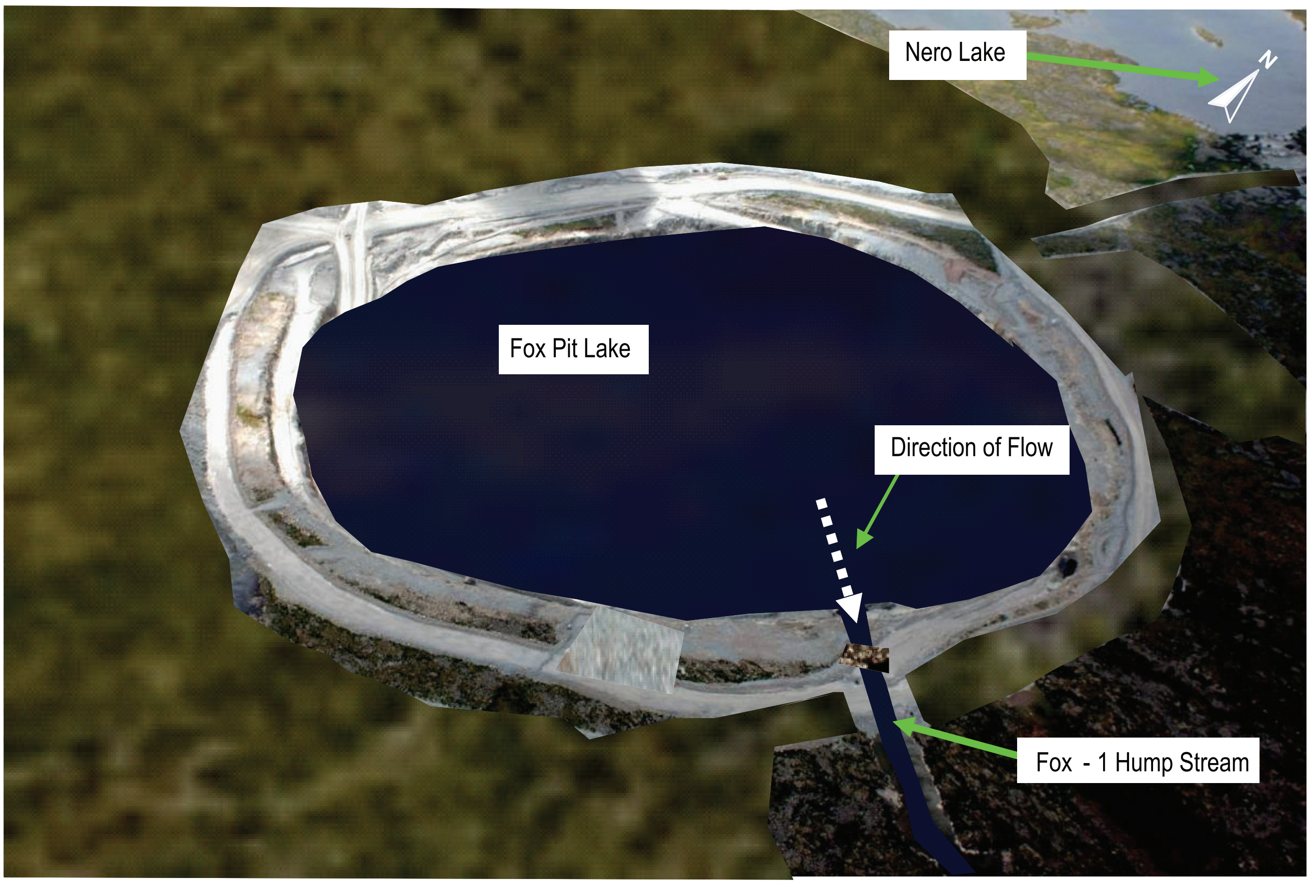
5.2.6 Designing for Closure

Designing for closure means incorporating mine closure and reclamation plan requirements prior to the development of a mine area component. This concept requires looking into the future to identify closure issues that can be addressed during the development and operational period. An example of designing for closure for open pits is the salvage of lake sediments/glacial till exposed after dewatering the pre-disturbance lakes are excavated and storing these materials for use in reclamation and re-vegetation during closure.

5.2.7 Closure Objectives and Criteria

Section 1.4 described the Reclamation Goal, Closure Objectives and Closure Criteria, and Appendix 5.1-1 shows a comprehensive list of closure objectives and criteria for the Open Pit mines component, with Actions/Measurements and linkages to reclamation research, engineering studies, and closure monitoring. The Closure Objectives that were developed for the open pits are:

- fugitive dust levels meet Canadian Ambient Air Quality Objectives;
- pit wall slopes are stabilized;
- removal/remediation of hydrocarbon contamination;
- native vegetation used for rehabilitation work;
- sites rehabilitated with plant cover have sufficient plant cover to stabilize land surfaces;
- remaining operational, engineered structures meet appropriate design levels;
- no significant impacts to source lake aquatic habitats;
- surface drainage patterns at pit lakes are established to ensure runoff is channelled through the watershed;
- any permanent lake stratification caused by meromixis remains stable;
- pit lake water meets water licence criteria;
- facilitate the establishment of a self-sustaining aquatic ecosystem in the pit lakes;
- pit lakes are safe for fish passage;
- allow emergency access and egress from flooded pits;
- wildlife are using the EKATI Claim Block;
- minimize access to open pits to protect humans;



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Final Landscape of Fox Pit Lake

Figure 5.2-17

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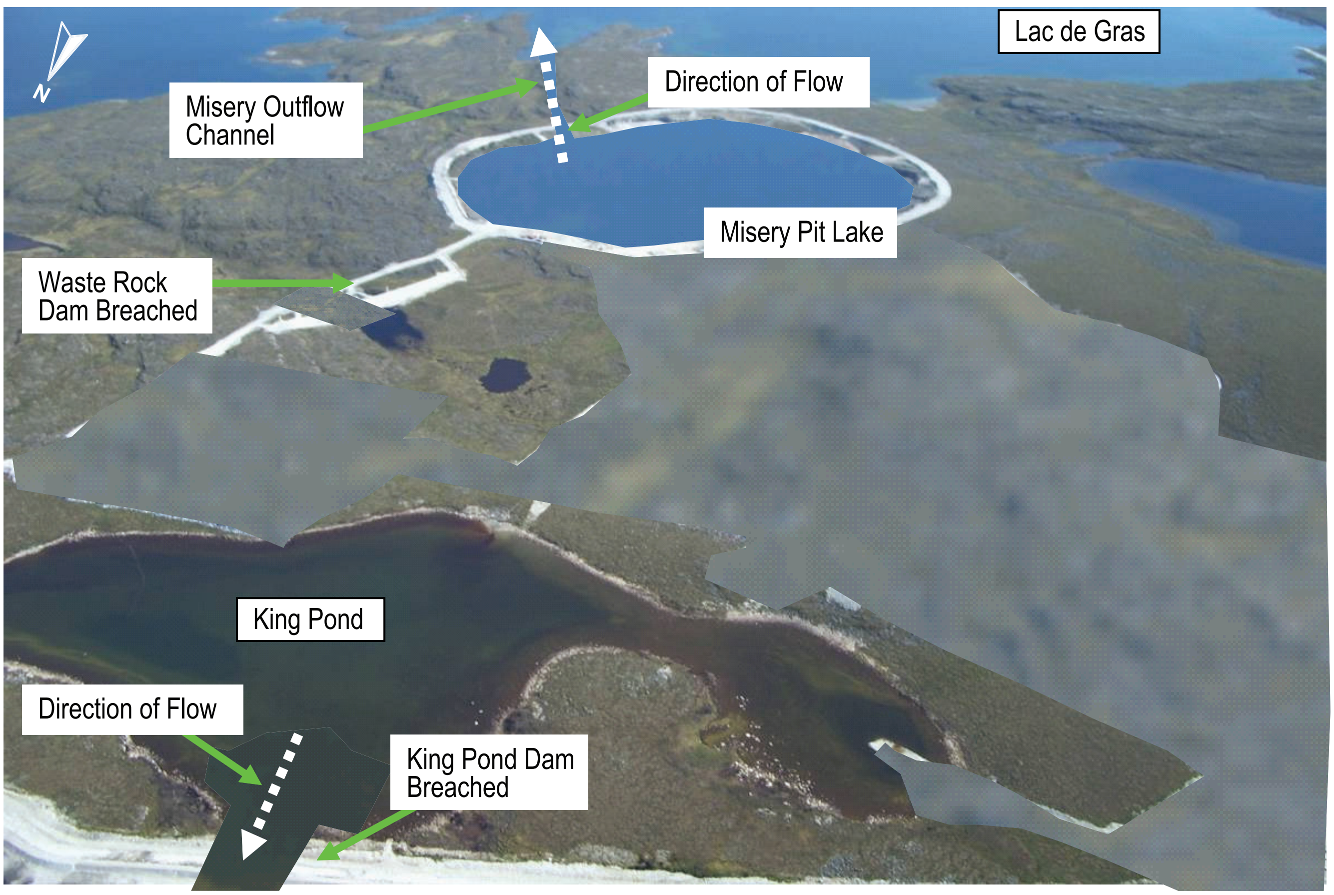


Final Landscape of Misery Pit Lake

- appropriate safety control measures in place for reclamation activities associated with reclaiming open pits;
- open pit mine component is left in a healthy state that supports continuation of human land use activities;
- community land use expectations and TK have been considered in the closure planning;
- archaeological sites are protected;
- transition plan in place;
- compliance with legal, regulatory, and corporate obligations;
- appropriate documentation is in place for open pits closure operations; and
- business procedures and policies in place for reclamation project development.

5.2.8 Reclamation Activities

The open pits at EKATI will be flooded when each of the pits is no longer required for mining operations. A number of closure options were discussed with communities and regulatory agencies as part of the ICRP development and selection process for open pit reclamation. The reclamation options were open pit backfilling with processed kimberlite or waste rock, and natural filling. Open pit backfilling may be viable where an open pit(s) is available for closure during the mining operations phase, and should the open pit/s be within reasonable proximity to the Process Plant operations (for processed kimberlite backfill), or to an open pit which has concurrent active mining (for waste rock backfill). At this time there are no viable opportunities for processed kimberlite or waste rock backfill. However, BHP Billiton recognizes the potential benefits from processed kimberlite backfill, such as reduced processed kimberlite volume in the LLCF, and better water quality management opportunities. Appendices 5.1-4 and 5.1-5 describes reclamation and engineering studies, respectively, on the method of processed kimberlite backfill into open pits and the potential impacts on LLCF water balance.

Natural pit filling has also been considered as a closure option for the open pits. However, based on community and regulatory consultation and feedback, the estimated fill times is excessively long and would introduce a higher degree of uncertainty in the assessment of long-term water quality of the pit lakes. Table 5.2-5 compares the estimated fill times for both natural and pump flooding.

Table 5.2-5. Comparison of Natural Fill and Pump Flood Time Estimates

Pit	Pit Filling Time (years)		Average Pumping Rate (m^3/s)
	Natural Filling	Active Filling	
Sable	~500	14	0.2
Pigeon	120	1	0.4
Beartooth	40	2	0.4
Panda	70	17	0.4
Koala North	20	17	0.4
Koala	135	17	0.4
Fox	~500	13	0.4
Misery	~500	5	0.4

5.2.8.1 Open Pit Reclamation Strategy

Reclamation of the open pits at EKATI includes facilitating the establishment of a self-sustaining aquatic ecosystem in the pit lakes. This means constructing an environment in the pit lakes that may naturally evolve over time into an aquatic ecosystem that may support fish and that may be naturally self-sustaining.

BHP Billiton will prepare a design report for the Board's approval that describes the works to be constructed in pit lake littoral zones and connector channels. The final design of the pit lakes littoral zones and connector channels (also see Section 5.2.5.2) will be on a pit-by-pit basis, working within the unique physical and environmental constraints of each pit lake, and will also take into consideration the level of facilitation effort appropriate to those pit lakes where the likelihood of success is reduced by physical or biological impediments. Littoral zones can not be constructed in areas that would interfere with nearby infrastructure such as WRSA or unstable ground. The final extent, configuration and design of the littoral zones and connector channels will be achieved through good engineering practices and best efforts in design, meaning that BHP Billiton will make the good faith efforts that a reasonable and well-informed person would believe to be sufficient to achieve the best design considering the information available at the time of the design. The design report will be developed as part of an Engineering Study which will address uncertainties associated with the pit perimeter areas such as beach shores and riparian zones, access and egress areas for people and wildlife, connector channel design, and the stability of remaining highwalls (Engineering Studies # 1 and 2, Appendix 5.1-5). Approval of the final design for littoral zones and connector channels will represent the WLWB's complete review of the work that is required to achieve the facilitation objective. Specifically, the concepts of 'facilitating', 'establishment', 'self-sustaining' and 'aquatic ecosystem' will be fully resolved with approval of the final design. The facilitation objective and the 'built as designed' criteria will be fully achieved when BHP Billiton has constructed according to the approved final design using good engineering practice. BHP Billiton is not responsible for monitoring or proving the establishment of a self-sustaining aquatic ecosystem.

A spillway will be constructed adjacent to the Panda Diversion Dam to provide a safety release for water in the event of blockage of the Panda Diversion Channel by snow and ice. The Panda Spillway will be installed around the west abutment of the Panda Diversion Dam and will discharge directly into Panda Pit Lake.

The spillway invert has been designed to be approximately 2.3 m above the Panda Diversion Channel invert such that all flow would be directed into the channel once it opens. The spillway is expected to function only during those years when the channel is slow to clear. The inlet to the spillway would have a concrete weir structure and the excavation upstream of the weir would extend into the lake sufficiently far to provide a permanent water depth of 2 m against the weir. The ice ahead of the weir would be floating at breakup (not frozen to the bottom due to the 2 m depth) and could rise in response to water accumulation under the ice at freshet, breaking the bond with the spillway and allowing the water to spill from below the ice. The normal summertime operation of the Panda Diversion Channel would not be affected by the presence of the spillway. The inlet would have a concrete weir structure and excavation work upstream of the weir in Upper Panda Lake will provide a permanent water depth of 2 m against the weir. This will ensure that ice will not freeze to the bottom of the lake but will float and should rise in response to water accumulation under the ice at freshet. This will break the bond between the ice and the spillway and allow water to spill from below the ice. Figures 5.1-2c and 5.1-2d of Appendix 5.1-2 show cross-sectional drawings of the proposed Panda Spillway. Modifications to the spillway are practical to allow controlled flow from Upper Panda Lake at freshet into Panda Pit. This may enhance filling Panda Pit by diverting freshet water at breakup that is not needed to sustain acceptable flows downstream of the Panda Diversion Channel.

Spillway construction must be deferred until flooding of Panda Pit is allowable, from a safety perspective. The work will be completed as soon as practical following the completion of all work at Panda and Koala. This approach will provide time for performance observations, as practical, to observe the behaviour of the channel with natural snow infilling at breakup to optimize its performance.

The Sable, Pigeon, Beartooth, Panda, Koala (Koala North will be within the Koala pit lake), Fox, and Misery pits will be reclaimed by active pump flooding from nearby source lakes (Ursula Lake, Upper Exeter Lake, Lac de Gras). Table 5.2-5 shows the estimated time to fill each open pit. (EBA 2006c) provides a conceptual level study of the logistics and strategy to flood the exhausted open pits at EKATI. The pump flooding strategies discussed herein are based on the 2005 LOM Plan. Sections 5.2.8.2 through 5.2.8.8 discuss the physical reclamation or engineering works and the necessary environmental works for each of the individual open pits.

5.2.8.2 Source Lake Description

Three lakes were identified as potential water sources for active pit filling dependant upon further study for suitability: Ursula Lake, Upper Exeter Lake and Lac de Gras (Figure 3.6-2).

Ursula Lake is located south of the proposed Sable Pit. It is approximately 23.0 km^2 in surface area and is recharged by a catchment basin with an area of 94.6 km^2 and a maximum relief of approximately 32 m. Waterbodies account for approximately 40% of the surface area of the catchment basin. The lake discharges to a channel on its southeast side, which flows through a series of lakes and channels and ultimately into Lac de Gras. A stream gauge was installed at Ursula Outflow in 2001 and 4 years of flow data have been collected as a baseline for studies of water extraction.

Upper Exeter Lake is located west of the proposed Pigeon Pit. The surface area of the lake is approximately 27.3 km^2, and the lake is recharged by a catchment basin with an area of 228.4 km^2 and a maximum relief of approximately 36 m. Waterbodies account for approximately 27% of the surface area of the catchment basin. Upper Exeter Outflow discharges directly to Exeter Lake. The water balance was completed using a runoff coefficient of 0.5.

Lac de Gras is a large lake located south of the EKATI Mine site, at the headwaters of the Coppermine River basin. The lake surface area is approximately 572 km^2 (DMMI 1998) and the lake is recharged by a catchment surface area of 3,890 km^2. A preliminary assessment of the Lac de Gras catchment basin indicates an average annual recharge of 505,000,000 m^3.

Evaluation of other sources of water for pit flooding will be carried out by BHP Billiton and if feasible will be included in future updates of the ICRP.

5.2.8.3 Pumping Rate and Filling Times

<u>General</u>

As part of the conceptual level pumping study, a number of assumptions were made concerning pumping rates. First, water will be extracted from source lakes only during the open water season (June 1 to October 30) to draw water solely from the summer recharge volume and to eliminate the requirement for heated water lines during winter. Second, all calculations concerning the impacts of pumping were for average hydrological conditions.

The drawdowns from source lakes were calculated using values for precipitation and evaporation derived from on-site data, and with observed data from hydrometric stations that were operated at the outflows of Upper Exeter and Ursula lakes. Ursula Lake outflow was gauged and data collected from 2001 to 2006.

Ursula Lake level data was collected from 2001 to 2003. Upper Exeter Lake outflow was gauged and data collected from 2001 to 2003. Upper Exeter Lake level data was collected from 2002 to 2006.

It was estimated that an annual water volume of up to 10,000,000 m^3 (at a pumping rate of 0.8 m^3/s) could be extracted from the Lac de Gras without impacting lake levels or the hydrological regime (Table 5.2-6). This extraction rate would result in a 2% reduction in the water discharged from Lac de Gras and ultimately a 0.1% reduction in the volume of outflow at the mouth of the Coppermine River. Pumping rates are based on average years, but because variation in precipitation from year to year is expected the rates may need to be adjusted for drier or wetter years. The rates are believed to be a good representation of the long-term expectation for acceptable water extraction flow. Flow reduction or interruptions to pumping are expected to mitigate negative effects of drawdown, and more detailed estimates of pumping versus high/low precipitation years will be provided in the final design and permitting stages of closure planning.

Table 5.2-6. Summary of Source Lake Water Extraction

Source Lake	Catchment (km^2)	Allowable Annual Extraction Volume (m^3)	Average Pumping Rate (m^3/sec)	Reduction in Annual Flow at Catchment Outlet (%)
Ursula Lake	95	2,500,000	0.2	21
Upper Exeter Lake	230	5,000,000	0.4	18
Lac de Gras	4,000	10,000,000	0.4	Negligible

Filling of the EKATI pits has been scheduled not to interfere with pit filling activities at the Diavik mine site which occur in 2017 and between 2024 and 2026 as outlined in Diavik Diamond Mine's Environmental Effects Report (DDMI 1998).

Sable Pit

A pumping rate of 0.2 m^3/s from Ursula Lake to Sable Pit is expected to result in a reduction of 21.5% in Ursula Outflow volume (Table 5.2-6). At this pumping rate, a minimum flow rate of 0.4 m^3/s would be maintained in Ursula Outflow from June to September. Pumping will cease in mid-October to avoid pumping more water than natural discharge rates.

The filling time of Sable Pit is estimated to be 14 years (Table 5.2-7). A 4,000 m-long pipeline would be constructed from Ursula Lake along the Sable Pit access road as shown in Figure 5.1-2g of Appendix 5.1-2. A 1,000 m-long road would be required to access Ursula Lake.

Pigeon Pit

A pumping rate of 0.4 m^3/s from Upper Exeter Lake is expected to result in a reduction in lake surface elevation of 0.03 m and a reduction in Upper Exeter Outflow volume of 18.1% (Table 5.2-6). At this pumping rate, a minimum flow rate of 0.4 m^3/s will be maintained in Upper Exeter Outflow from June to September. These calculations are for average hydrological conditions.

The filling time for Pigeon Pit is estimated to be 1 year (Table 5.2-7). A pipeline, approximately 3,700 m long would be constructed from Upper Exeter Lake to the Pigeon Pit as shown in Figure 5.1-2h of Appendix 5.1-2. An access road, approximately 1,600 m long, would be required to access Upper Exeter Lake.

Table 5.2-7. Open Pit Pump Flood Summary

Open Pit	Start Pump Flooding	Primary Source Lake	Average Pumping Rate (m^3/s)	Pit Volume at Completion (m^3)	Estimated Time to Pump Fill (years)(4)
Sable	2019	Ursula Lake	0.2	33,750,000	14
Pigeon	2018	Upper Exeter	0.4	6,500,000	1
Beartooth	2031	Lac de Gras	0.4	13,400,000	2
Panda	2033	Lac de Gras	0.4	41,300,000(1)	17
Koala North	2033	Lac de Gras	0.4	2,100,000(2)	17
Koala	2033	Lac de Gras	0.4	44,500,000(3)	17
Fox	2015	Lac de Gras	0.4	70,300,000	15(5)
Misery	2019	Lac de Gras	0.4	26,000,000	5

Note: pumping occurs only during open water season.
(1) Includes 1.8 Mm^3 from Panda Underground.
(2) Includes 0.65 Mm^3 from Koala North Underground.
(3) Includes 5.3 Mm^3 from Koala Underground.
(4) Panda, Koala North and Koala are filled concurrently from Lac de Gras over a 17 year period.
(5) Filling will be suspended for 2 years to allow for Diavik pit flooding in 2025 and 2026.

Beartooth Pit

The filling time for Beartooth Pit is estimated to be 2 years at a pumping rate of 0.4 m^3/s (Table 5.2-7). A 13,700 m-long pipeline to flood Beartooth Pit would be constructed along the Misery Road from the Paul Lake Bridge.

Panda, Koala North and Koala pits

The filling time for the combined Panda, Koala and Koala North pits is estimated to be 17 years based on a pumping rate of 0.4 m^3/s (Table 5.2-7). Two filling scenarios are being considered for flooding Panda and Koala pits. Scenario 1 assumes that engineered plugs will be constructed in underground workings, to allow the Panda and Koala pits to be filled simultaneously. Scenario 2 assumes no plug construction in the underground mines and pit flooding will bring the water level in Panda and Koala pit lakes to nearly identical elevations, with hydraulic connection between the pits. Maintaining the hydraulic connection between pits means that the maximum pit lake water elevation is determined by the pit with the lowest ground surface elevation. This specifically impacts Panda Pit where the final pit lake elevation will be in the order of 453 masl, as compared to the pre-development lake elevation of 461 masl.

The reasoning behind the use of two scenarios is because there remains uncertainty around the likelihood of no future failure of one or more underground plugs (which would bring both pit lake levels to the same elevation), and what the potential effects of this would be on the hydrologic regime within the local watershed. The use of underground low plugs will be addressed by BHP Billiton through risk assessment. Neither of the two scenarios affects Panda and Koala cumulative pit lake flooding times and pump rates. Individual flooding times for each in Scenario 1, are 8 years for Panda and 9 years for Koala (including Koala North).

The closure concept for the Koala pits is to flood the Koala North pit to a static level of 453 m. At this elevation water would spill over the crest of the pit and flood the area between Koala North and Koala pits. The pipeline to flood Panda, Koala North and Koala pits would be the same pipeline used to flood Beartooth pit.

Fox Pit

The Fox Pit is estimated to take 15 years to fill, based on a pumping rate of 0.4 m^3/s (Table 5.2-7). The actual fill time for Fox is 13 years however; a 2 year suspension of filling is included to account for potential cumulative impacts from Diavik pit filling from 2025 to 2026. Water for Fox Pit would be pumped through a 12,000 m-long pipeline from Lac de Gras at the Paul Lake Bridge. A 5.5 km-long access road would need to be constructed from Misery Road across to the Fox Portal Road at the south end of the Airport Esker. Figure 5.1-2i of Appendix 5.1-2 shows an outline of the pipeline route.

Misery Pit

The filling time for Misery Pit is estimated to be 5 years, based on a pumping rate of 0.4 m^3/s (Table 5.2-7). Water would be pumped through a 680 m-long pipeline from Lac de Gras. A 560 m-long access road would be required to extend the pipeline to Lac de Gras. The pipeline route from Lac de Gras to Misery Pit is shown in Figure 5.1-2j in Appendix 5.1-2.

5.2.8.4 Effects on Source Lakes

The potential impacts of the pumping rates shown in Table 5.2-6 and 5.2-7 were studied to determine if they would have a significant negative impact on surface elevations of source lakes and downstream lakes and on outlet stream flows. The study concluded that pumping from Ursula and Upper Exeter Lakes would not negatively impact fish habitat. The drawdown of Lac de Gras was assessed as negligible and was not further evaluated.

The pumping rates in Table 5.2-7 are believed to be a good representation of the long-term expectation for acceptable water extraction flow. Further information on the assessment of water withdrawal and potential effects on source lake aquatic habitats is provided in Sections 7.4.4 through 7.4.7. Because these are conceptual level estimates for water extraction, continued baseline monitoring prior to pumping will assist in providing a better understanding of natural variability within littoral zones, as well as monitoring of lake surface elevations during pumping will further refine the volumes which can be extracted to ensure there are no significant effects on aquatic resources. Appendix 5.1-4 includes a study for water extraction from source lakes.

At the time of pit filling pumping rates will require adjustment in response to downstream stream flows, in response to expected variation in precipitation from year to year. Flow reduction or interruptions to pumping are expected to mitigate unacceptable effects of drawdown, and more detailed estimates of pumping versus high/low precipitation years will be provided in the final design and permitting stages of closure planning.

Stream flows from source lakes will be reduced as a result of water extraction, but downstream flow will be maintained through freshet and to the end of September. In October, pumping rates generally exceed natural discharge rates for Ursula and Upper Exeter lakes; therefore, downstream flow during pumping will end sooner than would occur naturally. This reduction in flow duration is estimated to be in the order of 15 days, based on data from the Ursula Lake stream gauge.

Section 7.4 describes a preliminary assessment of aquatic effects on source lakes from pump flooding.

5.2.8.5 Source Lake Recovery Timing

After pumping ceases, the lakes will require time to recover to their natural elevations. Table 5.2-8 summarizes the rebound time estimates for Upper Exeter and Ursula Lakes. Ursula Lake is estimated to take nearly 3 years to recover, while Upper Exeter Lake is predicted to recover within 1 year of the end of pumping.

Table 5.2-8. Recovery Times for Proposed Pump Rates

Source Lake	Proposed Pumping Rate (m^3/s)	Estimated Pumping Duration (days)	Estimated Recovery Time (days)
Ursula Lake	0.2	900	1,000
Upper Exeter Lake	0.4	450	300

5.2.8.6 Regulatory Requirements for Pit Flooding

BHP Billiton recognizes that to remove any water from lakes on the EKATI Claim Block for pump flooding open pits will require additional water licensing. Applications for such licences will be submitted before pump flooding of the pits is scheduled to occur. Based on current licence durations, if EKATI applied for a licence to pump water for this ICRP then no pumping would have taken place before the requirement for renewal would have fallen due. In addition, further research work is underway, as detailed in Appendices 5.1-4 and 5.1-5, which will provide the detailed scientific and engineering analyses required for such an application.

Under Section 30 of the *Fisheries Act*, every intake constructed for conducting water from any Canadian waterbody that supports fish must have a fish screen (DFO 1995). In line with current site operating practices, the DFO guideline will be followed when installing the end-of-pipe fish screens.

5.2.8.7 Engineering Requirements

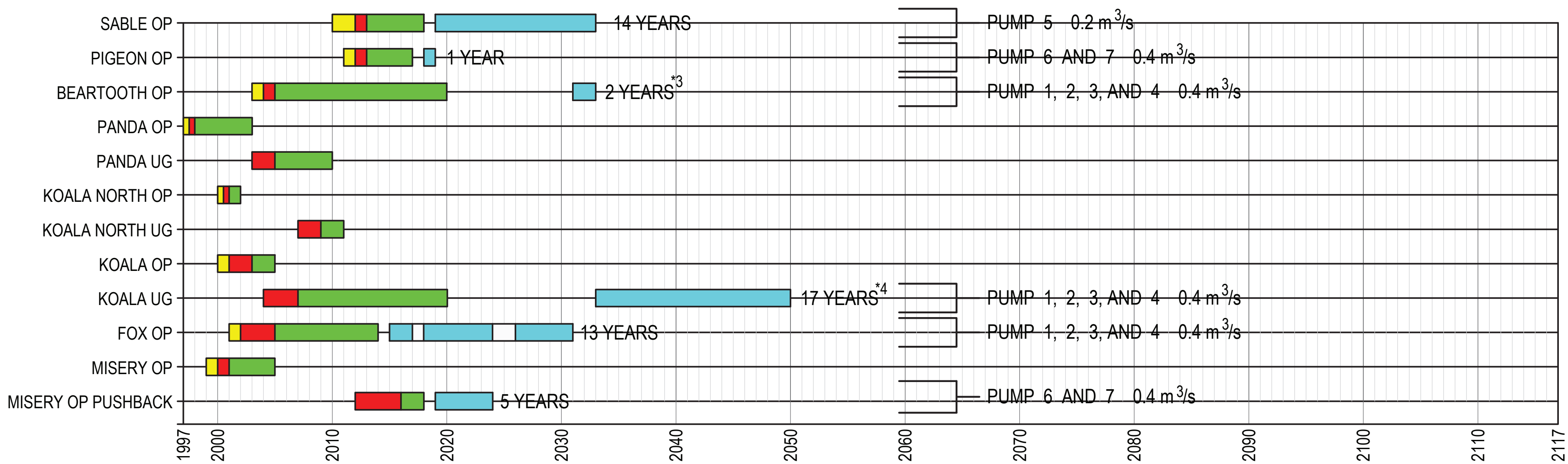
The pit filling schedule assumes that pit filling will commence within the same year that mining operations are completed for each pit. As part of BHP Billiton's progressive reclamation, water licensing for source lake withdrawal and pit flooding infrastructure will be in place when operations cease for the respective pits. The timing of pit flooding is staged to optimize and reduce the number of pumping systems required.

A total of seven diesel pumps will be required to meet the flooding schedules. Figure 5.2-19 shows the pumping sequence, and Table 5.2-9 shows their characteristics.

Pumps 1 through 4 would be used to fill Beartooth, Panda, Koala North, Koala and Fox pits. Water lines would extend from the Paul Lake Bridge to each of the pit lakes. The water lines would be relocated as required to service a particular pit. Booster pumps would be required in the line to compensate for elevation changes and friction losses along the pipe length. Pump 5 would be located at Sable Pit where it would be required for an extended period due to the lower allowable extraction volume from Ursula Lake. Pumps 6 and 7 would be used to fill Pigeon and Misery pits. The pumps would be relocated as pits became available for filling.

Once finished, it may be feasible to relocate the pumps to Lac de Gras at the Paul Lake Bridge to accelerate filling of the Fox, Beartooth, Panda and Koala pits. This would require supply and installation of additional water lines and assessment of the potential effects to Lac de Gras of increased water withdrawal. This option has not been included for the purpose of this study.

The pumping system has been designed assuming the use of Godwin HL250M Dri-Prime pumps. These are high head pumps capable of pumping the distances and elevation changes required from source lakes. EKATI has already purchased several of these pumps for other applications. Appendix 5.1-2 includes conceptual drawings for the engineering requirements associated with pump flooding the open pits.



Legend:

- Infrastructure
- Mine Development
- Mine Production
- Pit Flooding
- Diavik Diamond Mine Pit Flooding

Notes:

1. *The filling sequence represents both scenarios for flooding Panda and Koala pits with underground plugs (Scenario 1) and without plugs (Scenario 2)*
2. *Schedule assumes PDC remains open.*

*3. *Beartooth Pit filling time assumes no mine water in pit*

*4. *Filling time shown for Koala underground represents cumulative filling time for Panda and Koala pits, including both underground and surface operations*

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Implementation Schedule Active Pit Filling

Figure 5.2-19

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Table 5.2-9. Proposed Pumping System

Pit	Pump Number	Filling Schedule		Proposed Pumping Rate per Pump (m^3/sec)	Number of Water Lines	Line Length (m)	Source Lake
		Start Year	End Year				
Sable	5	2019	2033	0.2	1	4,000	Ursula Lake
Pigeon	6 ,7	2018	2019	0.4	2	3,700	Upper Exeter Lake
Beartooth	1, 2, 3, 4	2031	2033	0.4	2	13,700	Lac de Gras
Panda	1, 2, 3, 4	2033	2050	0.4	2	13,300	Lac de Gras
Koala North	1, 2, 3, 4	2033	2050	0.4	2	12,900	Lac de Gras
Koala	1, 2, 3, 4	2033	2050	0.4	2	11,400	Lac de Gras
Fox	1, 2, 3, 4	2015	2031	0.4	2	12,000	Lac de Gras
Misery	6, 7	2019	2024	0.4	2	680	Lac de Gras

Line diameter is based on single pump configuration. If pumps are set up in parallel, then larger lines are required. Panda, Koala, Koala North are flooded as one unit at a rate of 0.4 m^3/sec.

5.2.8.8 *Pipeline Route Construction*

Road construction is required to provide access to Ursula and Upper Exeter lakes and to Lac de Gras. Road construction quantity estimates are based on an assumed 8 m crest width road top, approximately 1 m above the original ground. It is assumed that construction of the roads, and pipeline infrastructure will be in place prior to or at the time of completion of mining.

Appendix 5.1-2 shows conceptual drawings for the engineering requirements associated with pump flooding the open pits, and Tables 5.2-10 to 5.2-16 summarize the engineering and environmental works required for closure for each pit.

Table 5.2-10. Sable Open Pit Reclamation Activities

Description	Open Pit Mine
Reclamation Method	Pump Flooding
Start Reclamation Activities	2019
End Reclamation Activities	2033
Monitoring Period	2033-2043
Engineering Works: • Construct berm around perimeter of open pit to prevent wildlife access during pit flooding and access to potential unstable pit perimeter areas. Berm dimensions will be determined through research studies. • Construct littoral zones along portions of the pit lake perimeter as outlined in the final design report. • Remove access haul road entrance into Sable open pit to prevent human entrance into pit. • Construct roadway for pipeline and access to pump from Ursula Lake to Sable Pit. • Construct water pumping system and pipeline from Ursula Lake to Sable Pit. • Construct outflow channel from rim of Sable Pit to entrance of Two Rock Pond. • Pump water from Ursula Lake to Sable Pit for estimated period of 14 years until pit is flooded. • Once Sable Pit is filled with water, then remove pumping and piping systems. • Reclaim pipeline roadway in same manner as mine site roads.	
Environmental Works: • Clean up and dispose of any debris or garbage. • Remove any remaining infrastructure or equipment within the open pit. • Plant riparian vegetation and aquatic plants along some beach areas and littoral zones. • Conduct post-reclamation water quality monitoring.	

5.2.9 Residual Effects

An assessment has been conducted on potential negative residual effects which may remain in the open pits mine component after reclamation work has been completed. No minor or higher residual effects were identified. Results from the environmental assessment which include the predicted potential negative effects during the reclamation period, the contingencies in place to control effects and the predicted residual effects after reclamation work is completed are included in Table 7.3-1. Post-reclamation residual effects for the open pit mine component that were evaluated as negligible were:

- nutrient sink in pit lakes;
- underground mines impact pit lake water quality;
- inadequate outflow from Sable, Fox and Misery pits once pits are flooded, causing downstream effects on fish habitat;
- remaining highwalls leads to wildlife falling into pit lakes may cause injury or fatality; and
- migratory birds land on pit lake and are effected by poor pit lake water quality.

Table 5.2-11. Pigeon Open Pit Reclamation Activities

Description	Open Pit Mine
Reclamation Method	Pump Flooding
Start Reclamation Activities	2018
End Reclamation Activities	2019
Monitoring Period	2019-2029

Engineering Works:

- Construct berm around perimeter of open pit to prevent wildlife access during pit flooding and access to potential unstable pit perimeter areas. Berm dimensions will be determined through research studies.
- Construct littoral zones along portions of the pit lake perimeter as outlined in the final design report.
- Remove access haul road entrance into Pigeon open pit to prevent human entrance into pit.
- Construct roadway for pipeline and access to pump from Upper Exeter Lake to Pigeon Pit.
- Construct water pumping system and pipeline from Upper Exeter Lake to Pigeon Pit.
- Construct surface flow channel from rim of Pigeon Pit to Pigeon Stream.
- Pump water from Upper Exeter Lake to Pigeon Pit for estimated period of 1 year until pit is flooded.
- Once Pigeon Pit is filled with water, then remove pumping and piping systems.
- Reclaim pipeline roadway in the same manner as mine site roads.

Environmental Works:

- Clean up and dispose of any debris and garbage.
- Remove any remaining infrastructure or equipment within the open pit.
- Plant riparian vegetation and aquatic plants along some beach areas and littoral zones.
- Conduct post-reclamation water quality monitoring.

Table 5.2-12. Beartooth Open Pit Reclamation Activities

Description	Open Pit Mine
Reclamation Method	Pump Flooding
Start Reclamation Activities	2020
End Reclamation Activities	2033
Monitoring Period	2033-2043

Engineering Works:

- Construct berm around perimeter of open pit to prevent wildlife access during pit flooding and access to potential unstable pit perimeter areas. Berm dimensions will be determined through research studies.
- Construct littoral zones along portions of the pit lake perimeter as outlined in the final design report.
- Remove access haul road entrance into Beartooth open pit to prevent human entrance into pit.
- Construct water pumping system and pipeline from Lac de Gras (at Paul Lake Bridge) to Beartooth Pit.
- Pump water from Lac de Gras to Beartooth Pit for estimated period of 2 years until pit is flooded.
- Construct surface flow channel from rim of Beartooth Pit to entrance of Upper Panda Lake.
- Breach Bearclaw Dam and establish flow between Bearclaw Lake and Beartooth Pit Lake.
- Remove pumping and piping systems.

Environmental Works:

- Clean up and dispose of any debris and garbage.
- Remove any remaining infrastructure or equipment within the open pit.
- Plant riparian vegetation and aquatic plants along some beach areas and littoral zones.
- Conduct post-reclamation water quality monitoring.

Table 5.2-13. Panda Open Pit Reclamation Activities

Description	Open Pit Mine
Reclamation Method	Pump flooding
Start Reclamation Activities	2020
End Reclamation Activities	2050
Monitoring Period	2050-2060

Engineering Works:

- Construct berm around perimeter of open pit to prevent wildlife access during pit flooding and access to potential unstable pit perimeter areas. Berm dimensions will be determined through research studies.
- Construct littoral zones along portions of the pit perimeter as outlined in the final design report.
- Remove access haul road entrance into Panda open pit to prevent human entrance into pit.
- Construct water pumping system and pipeline from Lac de Gras to Panda Pit.
- Construct outflow channel from rim of Panda Pit to entrance of Koala Pit.
- Pump water from Lac de Gras (Paul Lake Bridge) to Panda and Koala pits for estimated period of 17 years until pits are flooded.
- Construct spillway around Panda Diversion Dam to allow spring freshet to overflow into Panda Pit, when necessary.
- Once Panda Pit is filled with water, then remove pumping and piping systems.
- Reclaim pipeline roadway in same manner as mine site roads.

Environmental Works:

- Clean up and dispose of any debris and garbage.
- Remove any remaining infrastructure or equipment within the open pit
- Plant riparian vegetation and aquatic plants along some beach areas and littoral zones.
- Conduct post-reclamation water quality monitoring.

Table 5.2-14. Koala Open Pit Reclamation Activities

Description	Open Pit Mine
Reclamation Method	Pump Flooding
Start Reclamation Activities	2020
End Reclamation Activities	2050
Monitoring Period	2050-2060

Engineering Works:

- Construct berm around perimeter of open pit to prevent wildlife access during pit flooding and access to potential unstable pit perimeter areas. Berm dimensions will be determined through research studies.
- Construct littoral zones along portions of the pit perimeter as outlined in the final design report.
- Remove access haul road entrance into Koala open pit to prevent human entrance into pit.
- Construct water pumping system and pipeline from Lac de Gras to Koala Pit.
- Pump water from Lac de Gras (Paul Lake Bridge) to Panda and Koala pits for estimated period of 17 years until pits are flooded.
- Construct outflow channel from rim of Koala Pit to entrance of Kodiak Lake.
- Once Koala open pit is filled with water, then remove pumping and piping systems.

Environmental Works:

- Clean up and dispose of any debris and garbage.
- Remove any remaining infrastructure or equipment within the open pit.
- Plant riparian vegetation and aquatic plants along some beach areas and littoral zones.
- Conduct post-reclamation water quality monitoring.

Table 5.2-15. Fox Open Pit Reclamation Activities

Description	Open Pit Mine
Reclamation Method	Pump Flooding
Start Reclamation Activities	2015
End Reclamation Activities	2031
Monitoring Period	2031-2041

Engineering Works:

- Construct berm around perimeter of open pit to prevent wildlife access during pit flooding and access to potential unstable pit perimeter areas. Berm dimensions will be determined through research studies.
- Construct littoral zones along portions of the pit perimeter as outlined in the final design report.
- Remove access to haul road entrance into Fox Pit to prevent human entrance into pit.
- Construct roadway for pipeline from Misery Road to Fox Portal Road.
- Construct water pumping system and pipeline from Lac de Gras (Paul Lake Bridge) to Fox Pit.
- Construct outflow channel from rim of Fox Pit to 1 Hump Lake.
- Pump water from Lac de Gras to Fox Pit for an estimated period of 15 years until pit is flooded.
- Once Fox Pit is filled with water, then remove pumping and piping systems.
- Reclaim pipeline roadway in the same manner as mine site roads.

Environmental Works:

- Clean up and dispose of any debris and garbage.
- Remove any remaining infrastructure or equipment within the open pit.
- Plant riparian vegetation and aquatic plants along some beach areas and littoral zones.
- Conduct post-reclamation water quality monitoring.

Table 5.2-16. Misery Open Pit Reclamation Activities

Description	Open Pit Mine
Reclamation Method	Pump Flooding
Start Reclamation Activities	2019
End Reclamation Activities	2024
Monitoring Period	2024-2034

Engineering Works:

- Construct berm around perimeter of open pit to prevent wildlife access during pit flooding and access to potential unstable pit perimeter areas. Berm dimensions will be determined through research studies.
- Construct littoral zones along portions of the pit perimeter as outlined in the final design report.
- Remove access haul road entrance into Misery open pit to prevent human entrance into pit.
- Construct roadway for pipeline and access to pump from Misery Pit to Lac de Gras.
- Construct water pumping system and pipeline from Lac de Gras to Misery Pit.
- Construct outflow channel from rim of Misery Pit to entrance of Lac de Gras.
- Pump water from Lac de Gras to Misery Pit for an estimated period of 5 years until pit is flooded.
- Once Misery Pit is filled with water, then remove pumping and piping systems.
- Reclaim pipeline roadway in same manner as the mine site roads.

Environmental Works:

- Clean up and dispose of any debris and garbage.
- Plant riparian vegetation and aquatic plants along some beach areas and littoral zones.
- Remove any remaining infrastructure or equipment within the open pit.
- Conduct post reclamation water quality monitoring.

Appendix 5.1-3 shows the results of a risk assessment on the preferred closure option for the open pits at EKATI.

Research studies to address how negative residual effects in the Open Pits mine component can be removed have been included in the Reclamation Research Plan (Appendix 5.1-4), and the contingencies in place during the reclamation period to ensure that residual effects are not increased, have been included in the Environmental Assessment Summary (Table 7.3-1).

5.2.10 Reclamation Research

Reclamation research for Open Pits addresses uncertainties in pit lake water quality, effects on source lakes from water withdrawal, people and wildlife safety and vegetative cover. Research studies are in place to ensure that people and wildlife safety around open pits during and after pit flooding is addressed during pit filling, and in the final landscape design which will allow wildlife safe use of pit lake edges after pit flooding. Research plans are also in place to determine the volumes of water which can be withdrawn from source lakes without negatively impacting aquatic habitats in those lakes. Also, pit lake water quality research will assist in the establishment of water quality criteria for pit lakes and expected conditions in pit lakes in the case of meromixis. The uncertainty of sustainable plant communities and vegetation covers to stabilize land and water interface zones is also included. TK ideas that will assist reclamation of open pits will also be incorporated into the reclamation research plans. Appendix 5.1-4 provides the reclamation research objectives and work scope, along with a schedule for completion of the research work.

Identified reclamation research studies for the Open Pit mine component include:

- pit safety
- water withdrawal from source lakes;
- pit lake water quality;
- incorporation of TK into reclamation planning;
- establishment of plant communities;
- vegetation cover and surface stability; and
- wildlife closure objectives and criteria.

5.2.11 Engineering Questions

Identified engineering questions for the Open Pit mine component include:

- final pit perimeter stability;
- pit lake perimeters and connector channel design;
- pit flooding infrastructure;
- temporary fish barriers for pit lakes; and
- processed kimberlite backfill into open pits.

Appendix 5.1-5 summarizes the engineering studies identified for the Open Pit mines.

5.2.12 Post-Closure Monitoring

The post-closure monitoring program for the Open Pits mine component proposes to use a combination of the current monitoring programs at EKATI adapted to suit specific closure needs, including to a large degree the AEMP. Appendix 5.1-6 provides details of the proposed closure monitoring program, including monitoring schedules, QA/QC protocols for monitoring and discussion on adaptive management. Pit lake water quality monitoring will commence in the pit lakes as soon as it is safe to do so. The commencement of formal water quality monitoring towards successful completion of closure objectives will coincide with completion of flooding and initial verification of acceptable water quality. Since no pits are currently in reclamation or monitoring the initial monitoring schedule for all pits is commencement of formal monitoring the year pit flooding is completed.

The indicators selected for monitoring of the Open Pits mine component to establish when closure objectives have been met are list below:

- fugitive dust (monitored under general site Air Quality Management);
- slope stability;
- percent vegetation cover;
- lake levels and stream discharge;
- stream flow;
- water quality;
- wildlife habitat movement, safety, abundance, mortalities, incidents, breeding, distribution, density, and diversity (monitored under general site Wildlife Effects Monitoring Program);
- safe working procedures/practices;
- incorporation of TK into closure;
- archaeological sites; and
- operations, procedures and reporting.

5.3 UNDERGROUND MINES

5.3.1 Overview

There are two underground mines currently in operation at EKATI, namely the Panda and Koala Underground mines. The Koala North Underground mine is expected to re-start production around 2009. Table 5.3-1 shows the infrastructure associated with the Panda, Koala North and Koala Underground Mines, and Section 5.7 describes the surface infrastructure that supports the underground operations.

5.3.2 Pre-Disturbance Conditions

Pre-disturbance conditions of the underground components include both the subsurface geology of the underground mine areas as well as the surface areas that currently contain underground mine support facilities.

The host rock in the underground mines is granitic to dioritic plutonic rock and the ore body is the kimberlite pipe.

Table 5.3-1. EKATI Underground Mines and Associated Infrastructure

Underground Mine	Infrastructure	Underground Mine	Infrastructure
Panda	Panda Conveyor Portal	Koala	Refuge Stations (3)
	Panda Conveyor System		Equipment Service Bay
	Panda Sizer (Includes Conveyor Control Room)		Fuelling Bay
			Explosives Magazine (3)
	Primary Dewatering System		Electrical distribution system
	Refuge Stations (5)		Rock Breaker
	Explosives Magazine (3)		Conveyor system
	Washbay		Conveyor Control Room
	Equipment Service Bay (2)		Sizer
	Fuelling Bay		Dewatering System
	Electrical distribution system		Fresh Air Raises (2)
	Rock Breaker		Return Air Raise (1)
	Fresh Air Raises (2)		Man-way Raise (1)
	Return Air Raise (2)		Koala Ore pass
	Man-way Raise (1)		Equipment Service Bay (1)
Koala North	Koala North Portal		Koala Adit
	Refuge Stations		
	Explosive Magazine (1)		
	Electrical distribution system		
	Fresh Air Raises (2)		
	Man-way Raise (1)		
	Return Air Raise (1)		
	Inter-level Ore passes (8)		

A pre-disturbance condition of the underground locations is the presence of very ancient groundwater trapped in fractures in the bedrock below the permafrost layer at depths greater than 300 m. It is called “connate” water, which means it was trapped in pores in the rock at the time the rock was formed. This fossil water can be highly saline and its salinity increases with depth. This water is only encountered in the underground operations that go below the permafrost.

The surface facilities to support the underground mines are located immediately northwest of the Koala North Pit on the shores of the old Koala lakebed. The pre-disturbance condition of this area is predominantly glaciofluvial and comprises sand and gravel eskers. The dominant surficial cover of the Panda and Koala areas is a till veneer less than 2 m thick. The till is generally a compact, unsorted mineral soil consisting of a silty-sand matrix with pebbles, cobbles and boulders (Figure 5.2-3).

5.3.3 Development Status

5.3.3.1 Panda Underground

The Panda Underground is located directly beneath the old Panda Pit, which ceased production in 2003 (Figure 5.3-1). Panda Underground came into production in 2005 and is expected to continue producing kimberlite ore through to 2010. It is currently producing an average of 3,200 tonnes per day of kimberlite ore using sub-level retreat techniques. Further drilling will be carried out beneath the base of the Panda Underground, but any additional material is expected to be small and will have minimal impact on future LOM Plans.

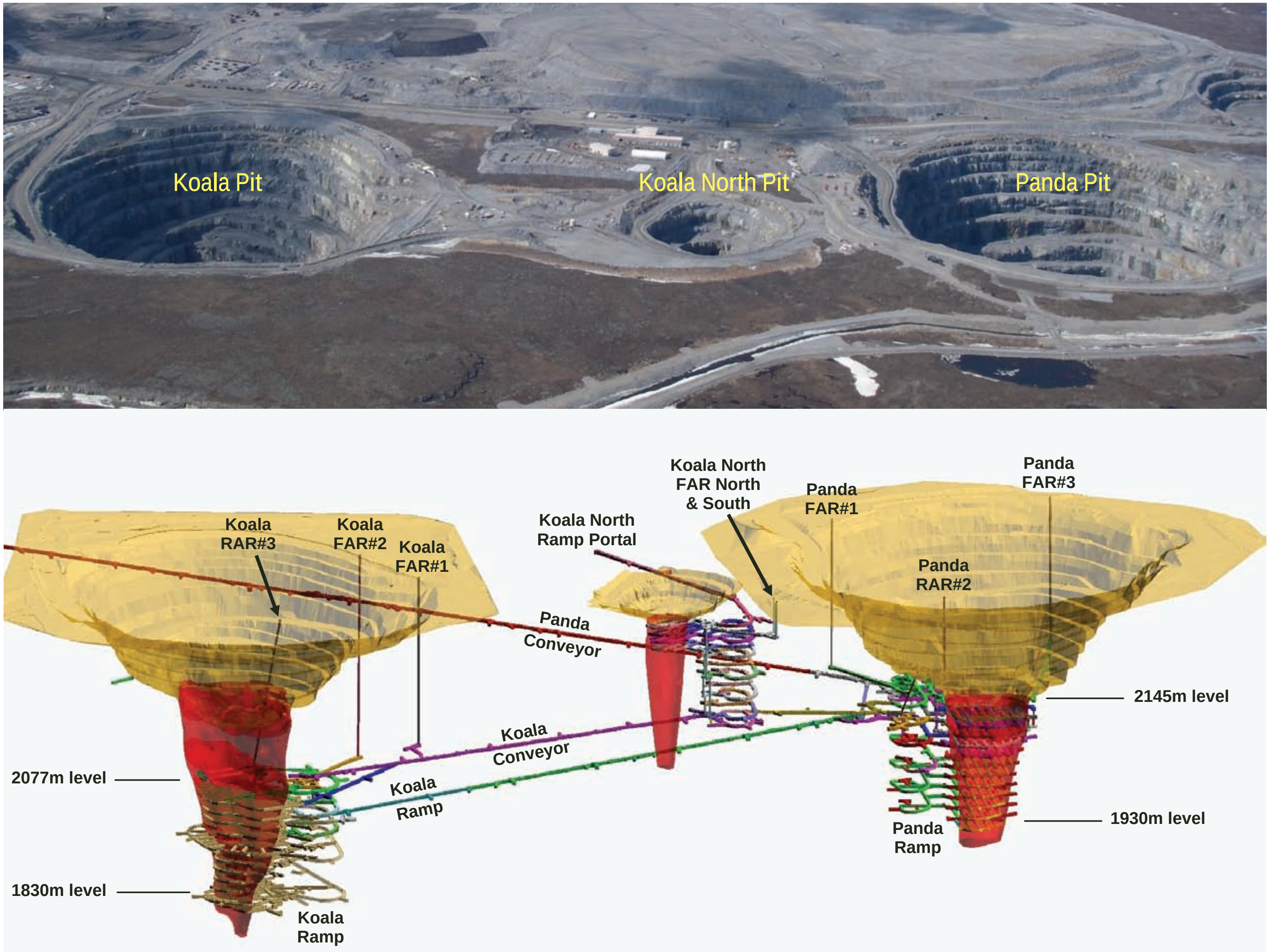


Figure 5.3-1

Projected Development of Panda and Koala Underground Mines (side view)

5.3.3.2 Koala Underground

Koala Pit ceased production in 2005 at a low-grade, sub-economic band of kimberlite. In 2006, BHP Billiton completed a feasibility study on the extraction of deeper higher value ore using underground techniques. Based on that study, BHP Billiton approved Koala Underground operations. The Koala Underground began full production in late 2007 using sub-level caving techniques. Average daily production is approximately 3,300 tonnes per day of kimberlite ore. In the 2005 LOM Plan, Koala Underground will be in production until 2020, although the final 2 years of the mine after the last open pit closes do not meet the need for a full Process Plant. Drilling at depth will be carried out at the Koala Underground at some point in the future. At this time, it is not expected to add significantly to the future LOM Plan.

5.3.3.3 Koala North Underground

The Koala North Underground began production in November 2002. It was developed as a test mine to determine what types of equipment, materials and processes worked best in Arctic permafrost underground conditions. During production it produced an average of 1,450 tonnes per day of kimberlite ore. Operations of Koala North Underground were suspended in November 2004 and are scheduled to resume in 2009 for another 2 years. This will exhaust the known resources in the Koala North pipe. The delay is due to the need for additional delineation drilling, however this is not expected to have any significant impact on the 2005 LOM Plan.

5.3.3.4 Access and Development

Access to the three underground mines is via the Koala North Portal located adjacent to the Koala North Open pit (Figure 5.7-2). Panda Underground is also connected to the surface by a 2.4 km-long tunnel called the Panda Conveyor Ramp that opens to the north of the Process Plant.

Additional conveyor systems that connect the crushing system to the Panda Conveyor, and a 1.0 km-long conveyor ramp linking Koala Underground to the Panda Conveyor Ramp were constructed in 2006 and 2007. This is used to bring kimberlite ore to surface. Koala North Underground has two 3 m-wide fresh-air raises that extend to surface. The Koala and Panda underground mines each have two 4 m-wide fresh air raises plus one return air raise that extend from surface to underground. The fresh air raises are fitted with large ventilation fans.

5.3.4 Projected Development

The Koala Underground is projected to continue operations until the end of the EKATI mine life in 2020. The Panda Underground is projected to continue operations until 2010. The Koala North Underground is expected to come back into production in 2009 and continue operations until 2011.

At the end of the underground mine life, approximate design elevations for the lowest levels of operation in each of the undergrounds are 115 m below sea level for Panda Underground, 163 m above sea level in Koala North Underground, and 191 m below sea level in Koala Underground. Table 5.3-2 shows the expected waste and ore that will be removed from each of the three undergrounds.

Two tunnels will connect Panda Underground with Koala North Underground, and one shaft is planned for connection between Koala Underground and Koala North Underground. Figures 5.3-1 and 5.3-2 show the expected development of the underground operations at the end of the current mine plan.

Table 5.3-2. Projected Development of Underground Mines

Underground	Projected Ore (tonnes)	Projected Waste (tonnes)
Panda	5,716,000	417,000
Koala North	1,847,000	528,000
Koala	14,576,000	586,000

5.3.5 Final Landscape at Closure

5.3.5.1 Overview

The final landscape for the underground operations will be below the pit lakes described in Section 5.2. Surface installations, such as ventilation fans will be removed and engineered plugs will be installed in surface raises. Portals will be sealed to prevent human or wildlife access. The installation of the plugs and seals will meet BHP Billiton's HSEC requirements, as well as the Northwest Territory *Mine Health and Safety Act*.

5.3.5.2 Evaluation of Potential Subsidence

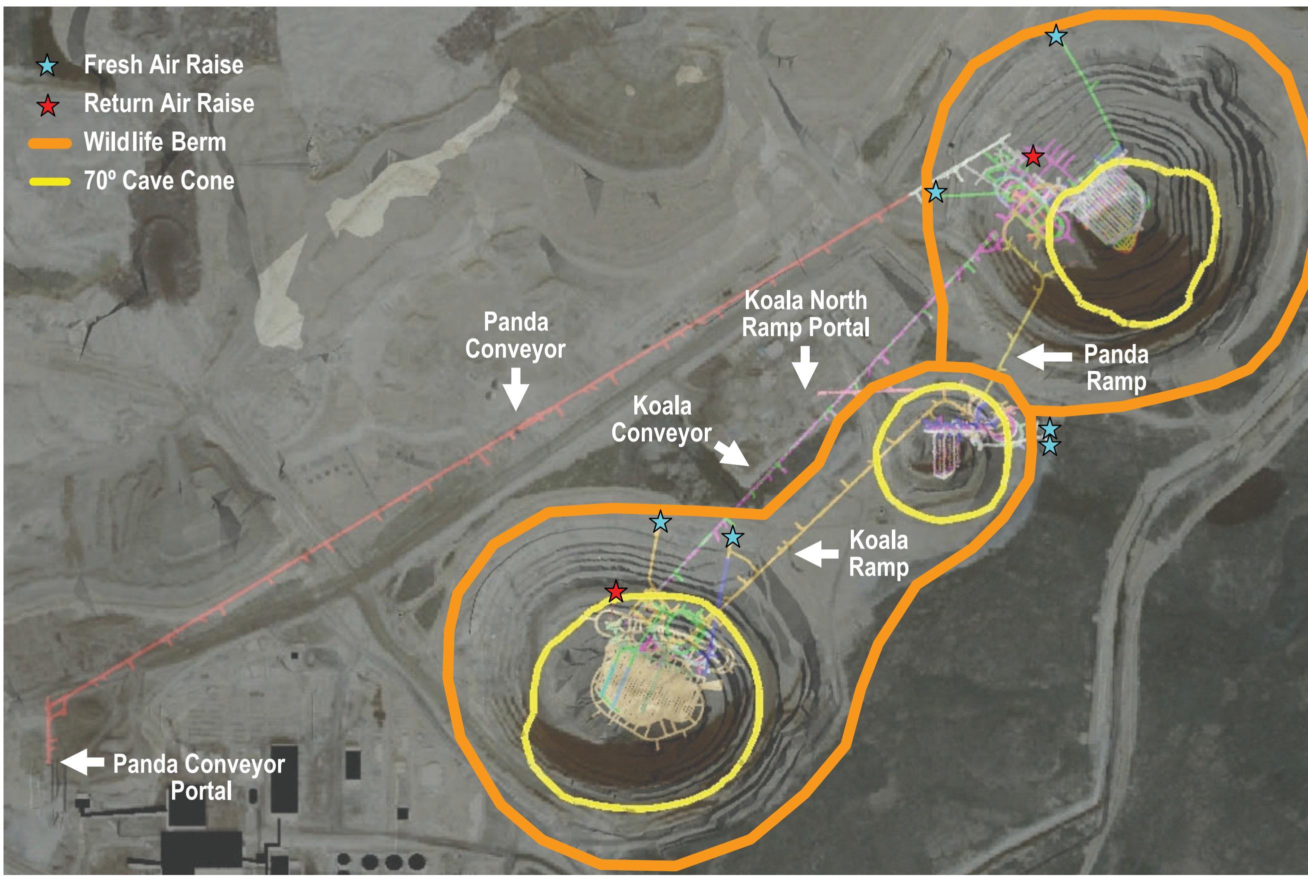
An evaluation of the local geology (competent granite) expected at final mining depth was carried out to assess the potential extent of long term subsidence and underground structural stability. The evaluation involved identifying an angle of subsidence within the underground mines which was then extrapolated upwards from the bottom of each underground mine as a cone. This was calculated for each pipe and then extrapolated to the surface.

Figure 5.3-2 shows the extrapolated cave cone in yellow. In all cases the potential area of long-term subsidence lies within the open pit or, in the case of Koala North, at the rim of the pit (and within the perimeter of the final pit lakes). Indications are that there are no significant structures which would be expected to result in major wall failure in the underground mines. However, some subsidence related to localized instabilities in the remaining pit walls of the underground operations may occur, but as noted these will occur in local areas within the pit lake. The Engineering Studies Plan (Appendix 5.1-5) includes a study in more detail in the Open Pits mine component section on pit wall stabilities.

5.3.5.3 Groundwater Quality and Quantity

In March 2008, a numerical modelling assessment was undertaken on the impact of mine water from the underground operations on the water quality of the LLCF (Rescan 2008a, 2008b). The assessment was based on data from field sampling programs that included assessments of water volumes and contaminant loadings originating from the underground developments (Rescan 2006a). In addition, available historical data related to underground development and water quality was analyzed to identify patterns and trends in loadings in water quality parameters from underground mines.

The historical flow records show a trend of increasing flows of mine water from the underground operations with large temporary inflows of connate water. The temporary inflows were caused by intersection of fracture zones with high hydraulic conductivity and inflowing surface water. The average total flow rate of mine water from the underground operations was estimated to be 976 m^3/d (Rescan 2006a).



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Projected Development of Panda and Koala Underground Mines (top view)

Figure 5.3-2

Rescan Engineers & Scientists

Predictions of future water flows from underground operations have considerable uncertainty because of the difficulty in predicting local hydrological conductivities of the host rock and kimberlite that will be intercepted by future development. Estimates made by Klohn Crippen in 2003 for the ultimate steady state flow rate of mine water were 10 L/s from Panda Underground and 3 L/s from Koala Underground. However, updated estimates predicted a substantially higher flow rate from Koala Underground. A future total steady state flow rate of 20 L/s from underground operations is considered to be a reasonable estimate of long-term flows.

Analysis of the main underground sump and drill-hole water chemistry confirmed previous general findings that the connate water is saline with increasing dissolved solids content with depth. Current average concentrations of chloride, calcium, sodium and potassium are 5,714, 1,912, 1,000 and 52 mg/L, respectively. Current trends indicate that the salinity of mine water from underground operations will increase in the future as the depth of the underground operations increases. For example, drill results from the Westbay well installed in 2001 in Panda Pit show that concentrations of chloride increase by about 15% from the depth of the Panda underground to that of the Koala underground development depths (Rescan 2006a). The data provided are based on reporting in 2006 and 2008 and is used to predict long term water flows and water quality, with particular focus on how underground water quality will affect pit lake water quality at mine closure. Reclamation research studies are in place to continue assessment of ground water flows and water quality contributions and how they influence pit lake water quality at closure (Appendix 5.1-4).

5.3.5.4 Designing for Closure

Designing for closure means incorporating mine closure and reclamation plan requirements prior to the development of a mine area component. This concept requires looking into the future to identify closure issues that can be addressed during the development and operational periods. Examples of designing for closure for the underground operations include:

- Geotechnical design considerations during development that consider the potential for surface subsidence after the underground has been closed. This includes the selection of the mining method used for all of the underground operations.
- Incorporation of surface facilities near existing infrastructure to minimize additional surface disturbance and to reduce the facilities requiring dismantling at closure.
- Use of a common portal for access and ore transport to minimize the number of openings to surface that have to be closed in the future.

5.3.6 Closure Objectives and Criteria

Section 1.4 describes the Reclamation Goal, Closure Objectives and Closure Criteria. Closure objectives have been developed for the underground mines and are listed below. Appendix 5.1-1B provides a comprehensive list of closure objectives and criteria for underground mines, with actions/measurements and linkages to reclamation research, engineering studies and closure monitoring.

The Underground Mine Component Closure Objectives that were developed for the site are:

- hazardous materials are removed from the underground mine and sent to appropriate facilities;
- groundwater contribution from underground does not significantly impact discharge water quality of pit lakes;
- eliminate access to underground workings;

- appropriate safety control measures in place for reclamation activities associated with reclaiming underground mines;
- compliance with legal, regulatory, and corporate obligations;
- appropriate documentation is in place for underground closure obligations; and
- identification of equipment and materials to be removed from the underground mine.

5.3.7 Reclamation Activities

Reclamation activities and engineering work for the underground mines follow the *Mine Site Reclamation Guidelines for the Northwest Territories* issued in January 2007. From a closure perspective, the EKATI Underground mines pose no unique structural considerations.

Tables 5.3-3 to 5.3-5 summarize the engineering and environmental works required for closure of the underground mines.

At closure, all mobile equipment and vehicles that can be salvaged and sold from the underground mines will be removed. Pipes, cables, electrical gear and fixed equipment that have remaining salvage value will be removed but all other equipment will be left in place (*e.g.,* mobile equipment, rock breaker and conveyor system that have been cleaned of fuels and lubricants). Oxygen bottles and chemical cleaners and all materials with potential for chemical degradation that are located in the maintenance shops (*e.g.,* petroleum products, batteries) will be removed from the underground. Material and equipment that is not considered as salvageable and/or will not negatively impact water quality will remain in the underground, rather than be hauled to surface and buried in a landfill. Explosives supplies are only maintained in 1 to 2 day quantities underground, so there will be limited amounts on-site when underground mining is complete. Any inventory of explosives remaining underground will be removed and disposed of safely.

Table 5.3-3. Panda Underground Mine Reclamation Activities

Description	Underground mine
Reclamation Method	Seal Fresh Air Raises
Start Reclamation Activities	2011
End Reclamation Activities	2020
Monitoring Period	2020-2030
Engineering Works: • Remove all remaining equipment with salvage value or with risk of contamination. • Install engineered plugs between Panda and Koala underground mines (if this scenario is selected for final closure). • Install safety seals over (2) fresh air raises as per GNWT Mine Health and Safety regulation to ensure safety during the period of pit filling until the collars are submerged (the return air raise is well within the pit and does not require a safety seal in this manner, Figure 5.3-2). Access and conveyor portals are considered under Koala underground closure activities. • Contour local surface drainage and flow away from safety seals. **Environmental Works:** • Remove hazardous materials from underground workings including fuels, oils, glycol, batteries and explosives. • Remove all remaining equipment with salvage value. • Conduct post-closure monitoring.	

Table 5.3-4. Koala North Underground Mine Reclamation Activities

Description	Underground Mine
Reclamation Method	Seal Fresh Air Raises
Start Reclamation Activities	2021
End Reclamation Activities	2020
Monitoring Period	2020-2030
Engineering Works: • Remove all remaining equipment with salvage value or risk of contamination. • Install safety seals over (2) fresh air raises as per GNWT Mine Health and Safety regulation. Access and conveyor portals are considered under Koala underground closure activities. • Contour local surface drainage and flow away from safety seals. **Environmental Works:** • Remove hazardous materials from underground workings including fuels, oils, glycol, batteries and explosives. • Remove all remaining equipment with salvage value. • Conduct post-closure monitoring.	

Table 5.3-5. Koala Underground Mines Reclamation Activities

Description	Underground Mine
Reclamation Method	Seal Fresh Air Raises and Portals
Start Reclamation Activities	2020
End Reclamation Activities	2020
Monitoring Period	2020-2030
Engineering Works: • Remove all remaining equipment with salvage value. • Install safety seals over (2) fresh air raises as per GNWT Mine Health and Safety regulation to ensure safety during the period of pit filling until the collars are submerged (the return air raise is well within the pit and does not require a safety seal in this manner, Figure 5.3-2). • Seal mine conveyor and portals and mine access portal as per GNWT Mine Health and Safety regulation. • Decommission primary crusher and conveyor systems. • Contour local surface drainage and flow away from safety seals. **Environmental Works:** • Remove hazardous materials from underground workings including fuels, oils, glycol, batteries and explosives. • Remove all remaining equipment with salvage value. • Conduct post-closure monitoring.	

All portals into the underground mines and fresh air raises will be sealed as per the Northwest Territories *Mine Health and Safety Act*. That act states that entrances to underground mines that are dangerous by reason of their depth or otherwise should be suitably protected against inadvertent access [Section 17.03 (1)]. The Panda and Koala return air raises are located well within the open pits where they will be inaccessible during pit flooding and ultimately well submerged under pit lake water for closure. Backfilling and/or capping of the seals will be designed to conform to the surrounding area.

As an example, the Fox portal entrance used during the exploration phase to access the Fox pipe has been plugged with waste rock excavated from the decline. The profile at the entrance conforms to the natural terrain within the area. Since Koala Underground mine will be the last underground mine to be close, closure activities associated with portals has been included for that mine (Table 5.3-5).

5.3.8 Residual Effects

An assessment of potential negative residual effects which may remain in the underground mine component after reclamation work has been completed. No minor or higher residual effects were identified. Results from the environmental assessment which include the predicted potential negative effects during the reclamation period, the contingencies in place to control effects and the predicted residual effects after reclamation work is completed are included in Table 7.3-1. Appendix 5.1-4 shows research studies to address how residual effects in the Underground Mines component can be removed.

Post-reclamation effects that were evaluated as negligible were:

- underground mines impact water quality; and
- failure of underground access seals.

Appendix 5.1-3 shows the results of a risk assessment on the preferred closure option for the underground mine component.

5.3.9 Reclamation Research

Reclamation research for Underground Mines addresses uncertainties in the effect underground mines may have on pit lake water quality. Research plans are in place to look specifically at the potential and extent of underground mine water contribution to pit lakes, and to model and study the general water quality of pit lakes (including those with underground mines) as part of the Open Pits reclamation research.

Identified reclamation research studies for the Underground mine component include underground water quality and quantity.

Appendix 5.1-4 provides the reclamation research objectives, work scope and a schedule for completion of research studies.

5.3.10 Post-Closure Monitoring

The post-closure monitoring program for the Underground mines component is focused on ground stability after portals and raises have been sealed to prevent human and wildlife access to flooded underground mines.

The indicators selected for monitoring of the Underground mines component to establish when closure objectives have been met are list below:

- slopes, drainages, surface stability or adit/raises plugs and seals;
- safe working procedures/practices; and
- operations, procedures and reporting.

Appendix 5.1-6 provides details of the proposed closure monitoring program, including monitoring schedules, QA/AC protocols for monitoring and discussion on adaptive management.

5.4 WASTE ROCK STORAGE AREAS

5.4.1 Overview

There are currently three separate WRSA at EKATI: Panda/Koala/Beartooth, Fox and Misery. Separate WRSA are planned for the Sable and Pigeon pits. The WRSA are designed to contain the rock excavated from the open pits. The WRSA also contain and store other materials including coarse rejects, topsoil, and kimberlite stockpiles.

Table 5.4-1 summarizes the infrastructure associated with the WRSA, and Table 5.4-2 lists the WRSA operations design criteria. Although the table includes design criteria for operations many of the criteria will be carried into closure of the WRSA.

Table 5.4-1. EKATI WRSA and Associated Infrastructure

WRSA	Infrastructure	WRSA	Infrastructure
Sable	Waste rock storage areas (3)	Panda/Koala/ Beartooth	Waste rock storage area
	Access ramps		Access ramps
	Thermistors		Landfill
	Topsoil storage area		Landfarm
Pigeon	Waste rock storage area		Coarse Rejects Storage Area (CRSA)
	Access ramps		Contaminated Snow Containment Facility (CSCF)
	Thermistors		Zone S
	Topsoil storage area		Crusher area
Fox	Waste rock storage area		Panda lake sediment pile
	Access ramps		Koala North lake sediment pile
	Thermistors		Emergency response training site
	Topsoil storage area		Thermistors
Misery	Waste rock storage area		Topsoil storage area
	Access ramps		Equipment parking areas
	Landfill		
	Thermistors		
	Topsoil storage area		

Table 5.4-2. WRSA Operations Design Criteria

Design Parameter	Panda/Koala/Beartooth	Misery	Fox
Ramp Gradient (%)	10	10	8
Road Width (m)	32	30	35
Distance from high water marks (m)	100	100	100
Distance from pit walls (m)	50	50	50
Distance from lease boundaries (m)	N/A	50	50
Angle of repose (degrees)	35	35	37
Dump lift heights (m)	10-20	Variable	15
Dump lift heights maximum (m)	20	15	15
Maximum overall height above nearest topographic point (m)	50	50	50
Overall slope angle (degrees)	23	25	25
Minimum dumping width (m)	60	60	60
Other waste (landfill waste) (t/m^3)	2.73	2.69	N/A
Sediment in-situ density (t/m^3)	2.27	2.27	2.27

(continued)

Table 5.4-2. WRSA Operations Design Criteria (completed)

Design Parameter	Panda/Koala/Beartooth	Misery	Fox
Waste kimberlite in-situ density (t/m^3)	N/A	N/A	1.72
Waste swell factor (%)	50	50	35
Waste compaction factor (%)	30	30	30

N/A = not applicable.

5.4.2 Pre-Disturbance Conditions

5.4.2.1 Sable WRSA

The Sable WRSA is in the 2005 LOM Plan but will not be developed until approximately 2010. The pre-disturbance conditions of the Sable WRSA can be described as rolling ground moraine up to 15 m thick that underlies terrain south, east and northeast of Sable Lake. Individual and concentrated boulders are found on the ground surface at some locations. The vegetation and wildlife conditions prior to disturbance of the Sable WRSA area are typical of the EKATI project area. Figure 5.4-1 shows the pre-disturbance conditions of the Sable WRSA.

5.4.2.2 Pigeon WRSA

The Pigeon WRSA is in the 2005 LOM Plan but is not expected to be developed until approximately 2011. The Pigeon area is covered with a thin till veneer with well defined stony earth circles on its surface. An isolated kame consisting of partially water-sorted and crudely stratified sand and gravel lies north of the kimberlite pipe and approximately 500 m north of Pigeon Pond. South and east of Pigeon Pond the terrain consists of rolling ground moraine covered with glacial till up to 15 m thick. The planned location of the WRSA will be within the Long Lake drainage basin, and all seepage and runoff from the pile will drain toward the LLCF. Figure 5.4-2 shows the pre-disturbance conditions of the Pigeon WRSA.

5.4.2.3 Panda/Koala/Beartooth WRSA

The Panda/Koala/Beartooth WRSA is located immediately to the northwest of Panda Pit and extends to the west and southwest of Koala Pit. This WRSA contains waste rock mined from the Panda, Koala, Koala North and Beartooth pits with smaller contributions from the Panda, Koala North and Koala underground operations. The south-west area of the WRSA contains the coarse kimberlite rejects from the Process Plant.

The pre-disturbance conditions of the Panda/Koala/Beartooth WRSA had a predominant cover of till and tundra. Granitic country rock outcrops were located in sparse patches throughout the area. The pre-disturbance terrain within the Panda/Koala/Beartooth WRSA consisted of low relief with elevation variations of approximately 15 m. Several small ponds were scattered to the north and east of Panda pipe. The pre-disturbance vegetation and wildlife conditions of the WRSA are typical of the EKATI Claim Block. Figure 5.4-3 shows the pre-disturbance conditions of the Panda/Koala/Beartooth WRSA.

5.4.2.4 Fox WRSA

The Fox WRSA is located in a horseshoe pattern around Fox Pit and covers the western, southern and eastern areas immediately adjacent to the pit. Prior to disturbance, the Fox Lake area was surrounded by a till veneer containing pebbles, cobbles and boulders in a silty matrix. The till veneer thickness area is generally less than 2 m. The WRSA is located within the Koala Watershed with the southern tail of the original Fox Lake draining to the southwest. The vegetation and wildlife conditions prior to disturbance of the Fox WRSA area are typical of the EKATI Claim Block. Figure 5.4-4 shows the pre-disturbance conditions of the Fox WRSA.

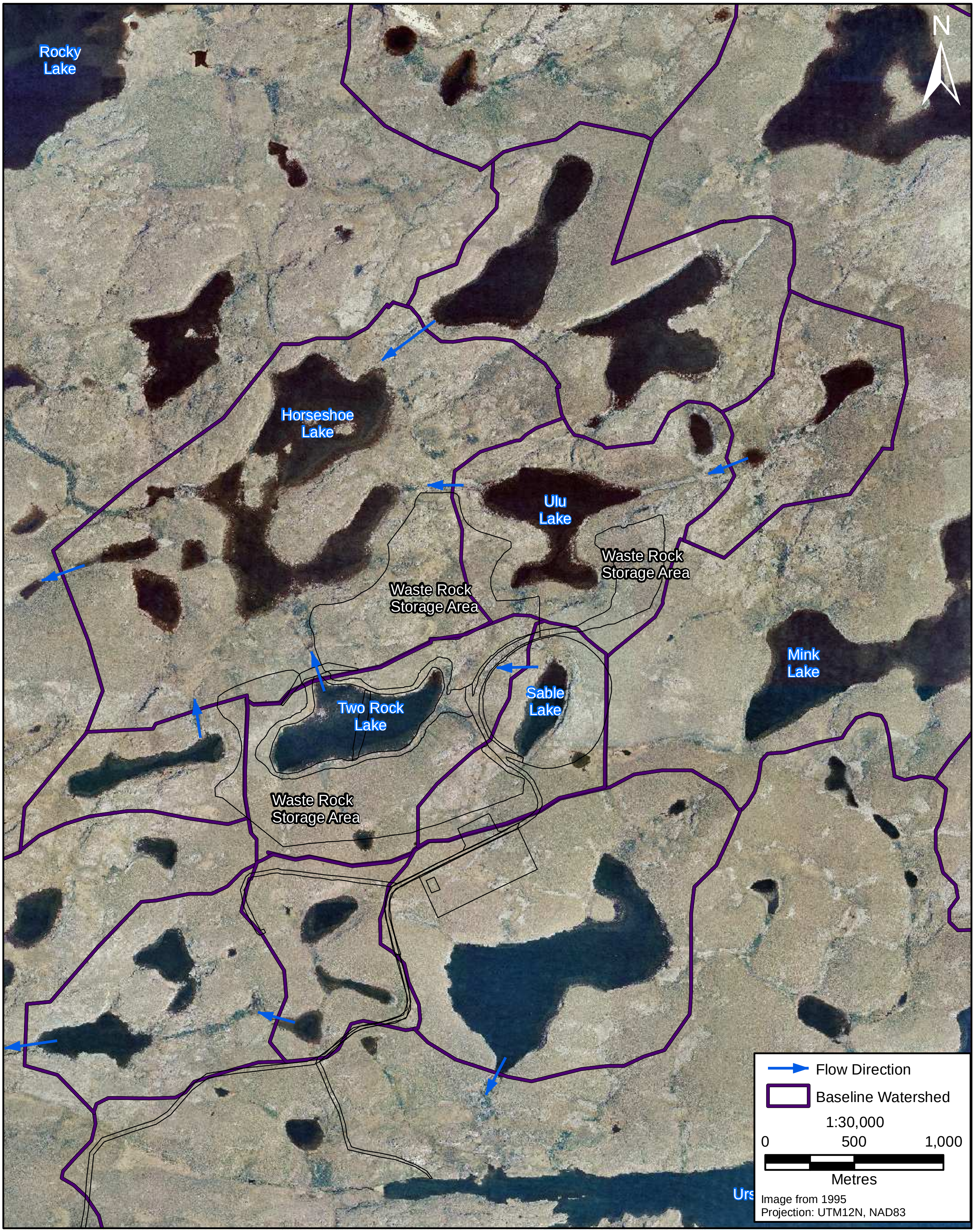

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FIGURE 5.4-1

Pre-Disturbance Conditions of the Sable WRSA (1995)

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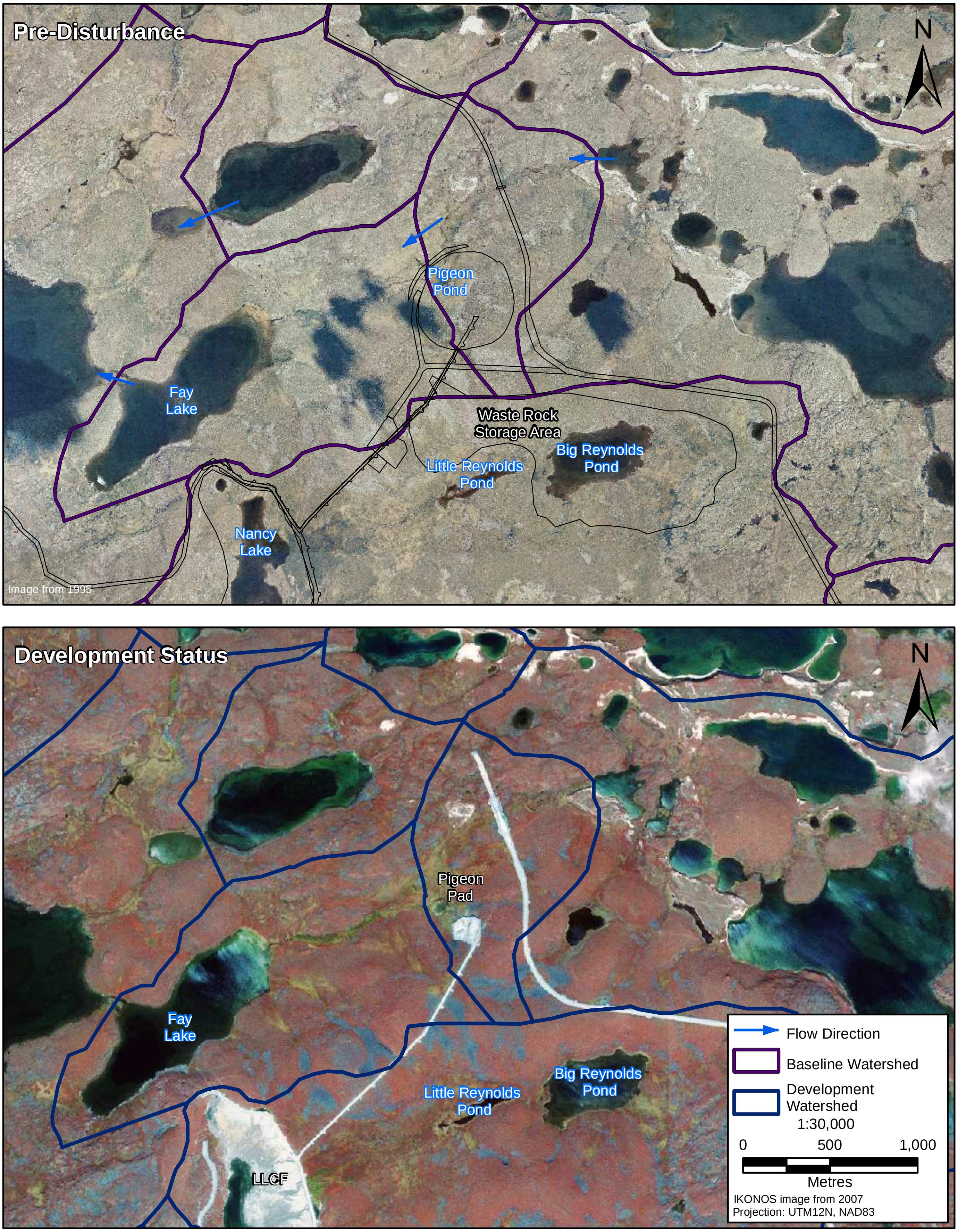

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Pre-Disturbance Conditions and Development Status of the Pigeon WRSA (1995 and 2007)

FIGURE 5.4-2

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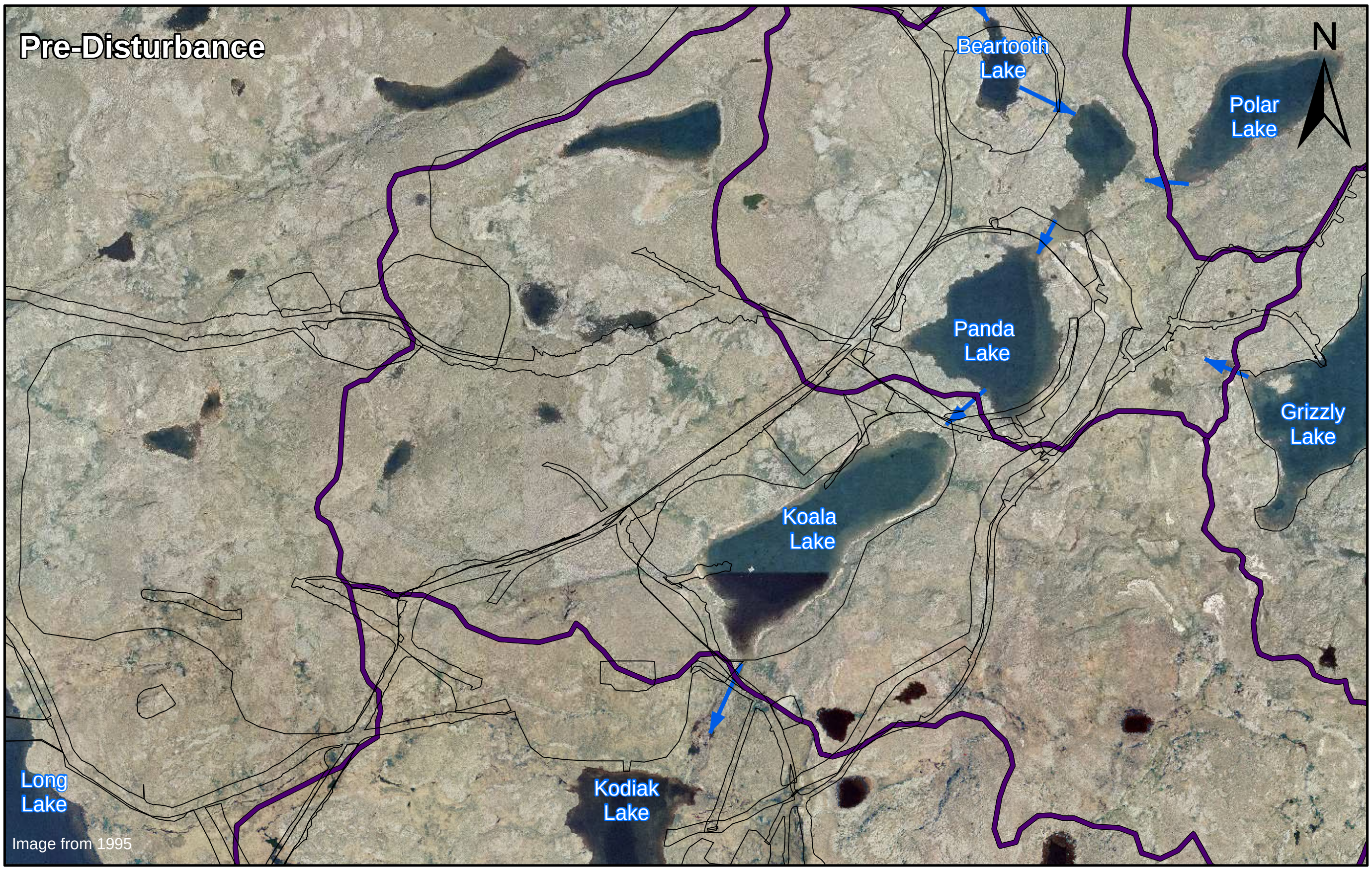

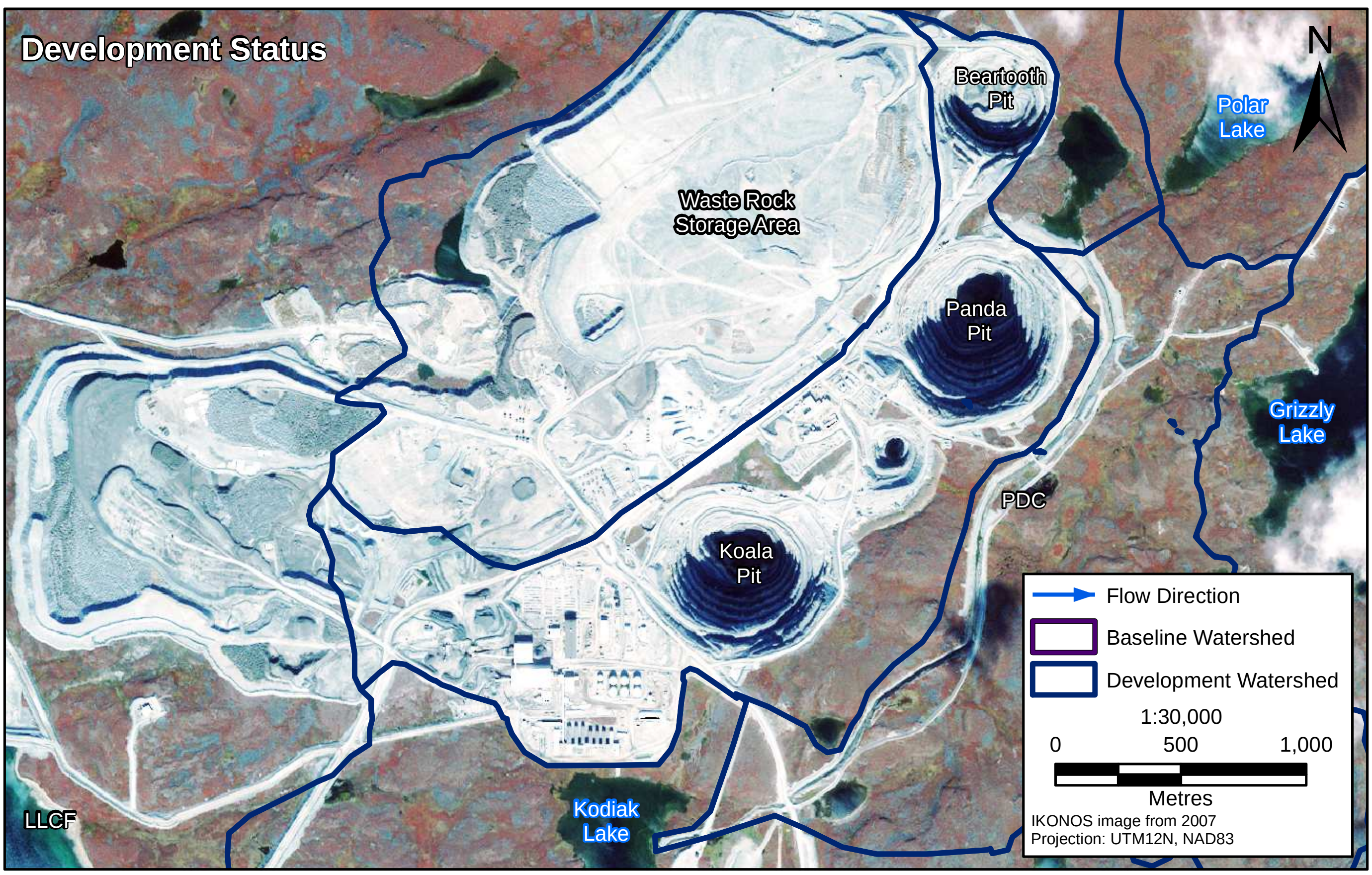

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Pre-Disturbance Conditions and Development Status of the Panda/Koala/Beartooth WRSA (1995 and 2007)

FIGURE 5.4-3

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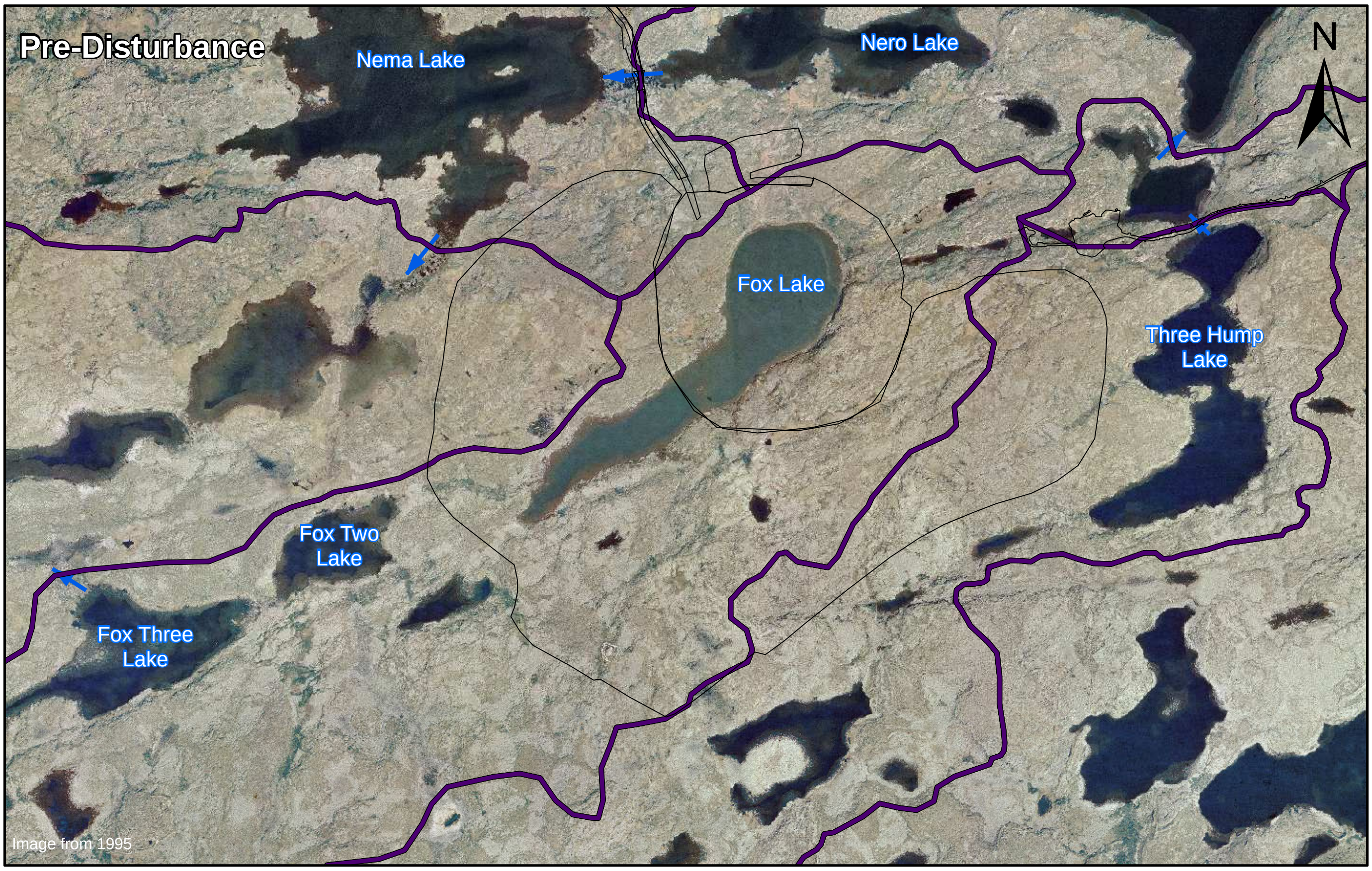

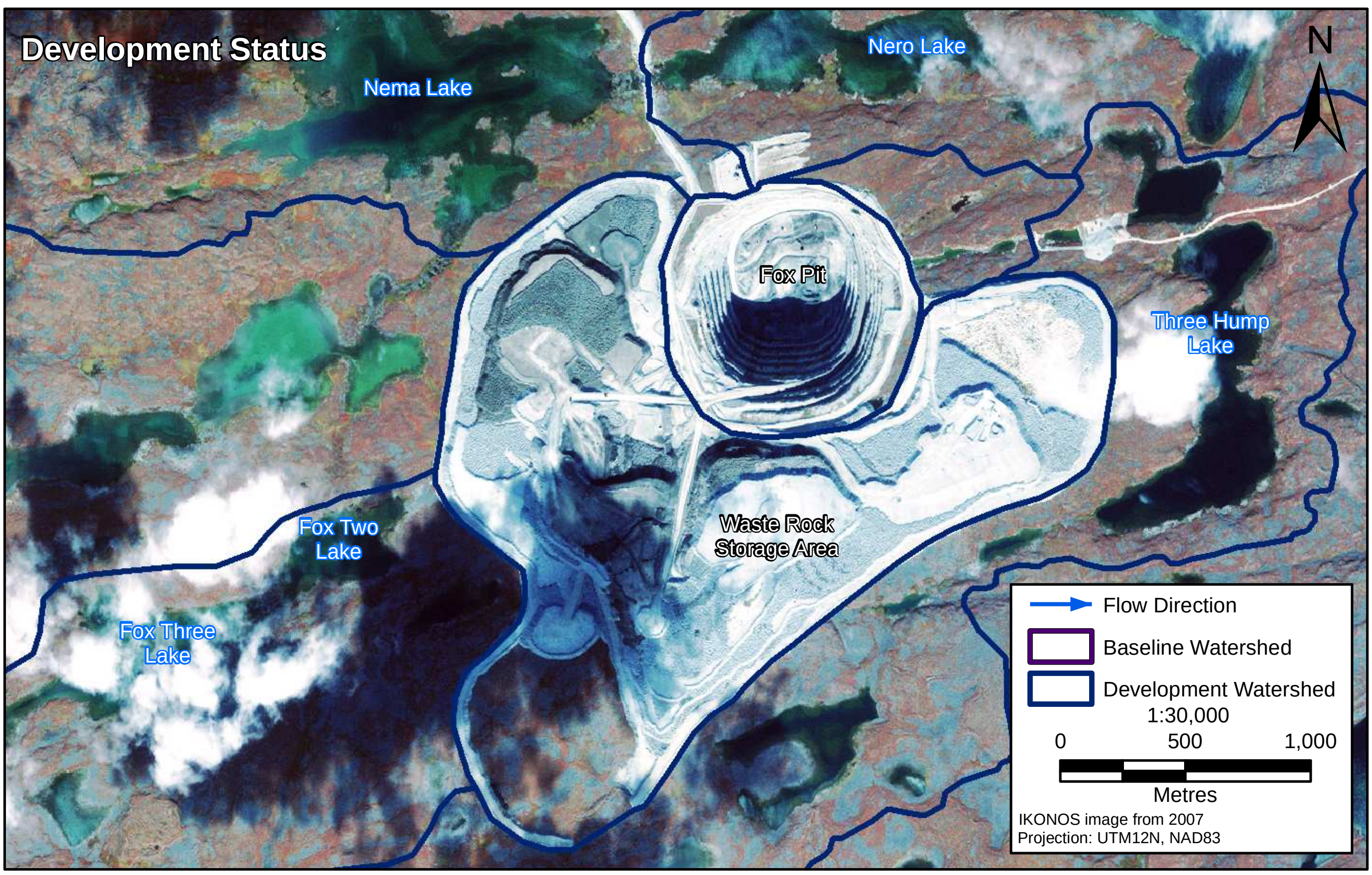

FIGURE 5.4-4

Pre-Disturbance Conditions and Development Status of the Fox WRSA (1995 and 2007)

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5.4.2.5 Misery WRSA

The Misery WRSA is located immediately northwest of Misery Pit. The pre-disturbance conditions and topography of the Misery Lake area were characterized by low to moderate relief with rolling hills and low-lying muskeg areas. Topographic variations correspond to the change in lithology from strongly resistant granitic rocks expressed by positive relief to less resistant schist and low-relief. Moraine, kames and eskers are common in the Misery Lake area. The vegetation and wildlife conditions prior to disturbance of the Misery WRSA area were typical of EKATI Claim Block. Figure 5.4-5 shows the pre-disturbance conditions of the Misery WRSA.

5.4.3 Development Status

5.4.3.1 Sable WRSA

No development has occurred at Sable pipe.

5.4.3.2 Pigeon WRSA

No development has occurred at Pigeon pipe.

5.4.3.3 Panda/Koala/Beartooth WRSA

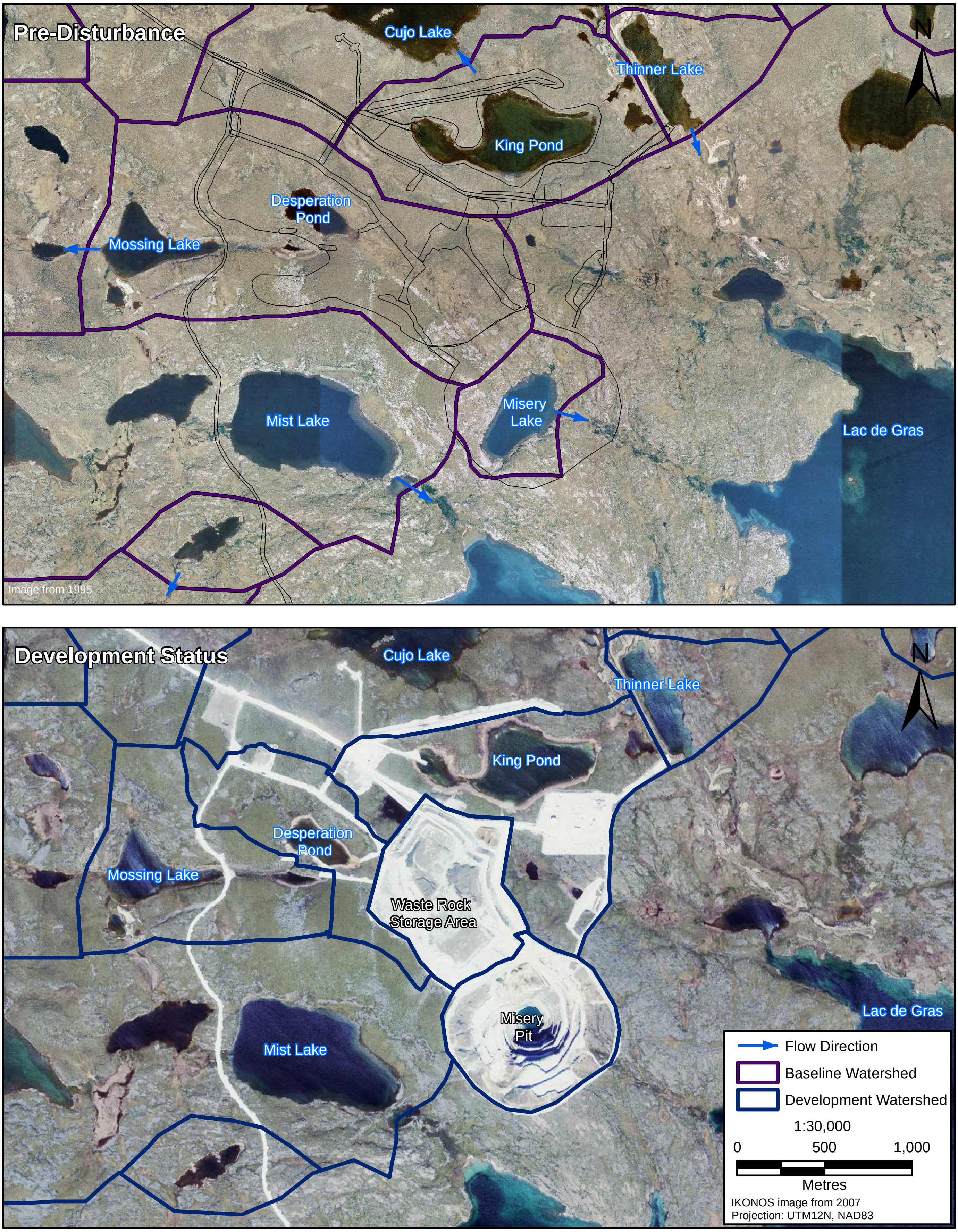
The Panda/Koala/Beartooth WRSA is the shared repository for waste rock from the Panda, Koala, Koala North and Beartooth Pits and their underground operations. The initial deposition of waste rock in this facility was in the north east of the current area and included only material recovered from Panda Pit.

Coarse kimberlite rejects from the process plant are placed in the Coarse Rejects Storage Area (CRSA) at the western end of the WRSA. This area was built prior to the knowledge that interaction of kimberlite materials with acidic conditions on the tundra can result in low pH waters resembling acid rock drainage (ARD) with high solute concentrations (sulphate, magnesium, calcium, sodium, potassium, aluminum, and iron), despite the high neutralization potential within the coarse kimberlite rejects (SRK 2001; Day *et al*. 2003; SRK 2006a). As such, portions of the CRSA were not built with an underlying pad and coarse kimberlite rejects were placed directly on the tundra.

After the discovery that the kimberlite rejects can produce waters of potential concern when in contact with more acidic tundra waters, a granite shell was constructed around the outer edges of the CRSA to ensure that the already placed kimberlite rejects remained in permanently frozen portions of the pile. In addition, the original management plan was modified such that subsequent expansions of the CRSA and all newly constructed WRSA were constructed with a pre-laid 5 m thick basement of granite to reduce the potential for contact between the kimberlite and the acidic conditions of the tundra. It also encourages the permafrost growth into the storage area as early as possible.

All water flows from the Panda/Koala/Beartooth WRSA, with the exception of some minor monitored seeps on the north eastern side of the rock pile, report to the LLCF. Information on the geochemistry of waste rock is found in *the Geochemical Characterization and ML/ARD Management Program* (SRK 2006a).

It is expected that waste rock will continue to be added to this WRSA until 2020 when Koala Underground waste mining is scheduled to be completed. Coarse kimberlite rejects from the processing of kimberlite ore from all pits and underground operations will continue to be added to the CRSA until the end of the mine life in 2020. The Panda/Koala/Beartooth WRSA will also act as a quarry to provide granite for the reclamation of the LLCF; most of the rock will be removed from the northern end of the storage area. The location and extent of the quarry will be verified through reclamation research studies.



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Pre-Disturbance Conditions and Development Status of the Misery WRSA (1995 and 2007)

FIGURE 5.4-5

Rescan™

The waste rock that has been deposited in the Panda/Koala/Beartooth WRSA consists primarily of biotite granite with minor quantities of kimberlite (estimated to be less than 3% of the total waste rock quantity) from rock near the waste/ore geological contact. Small amounts of diabase and metasediments have also been placed in the WRSA. Table 5.4-3 provides a list of the rock types deposited in the Panda/Koala/Beartooth WRSA and the approximate tonnages of each type.

Table 5.4-3. Waste Rock Types in the Panda/Koala/Beartooth WRSA

Material Type	Source	Location	Amount Placed Pre-2007 (Mt)	Amount to be Placed Post-2007 (Mt)	Re-usable For Closure
Granite	Panda	Used for co-disposal of waste and site-wide construction.	76	<1	Yes
	Koala		61	<1	
	Koala North	Granite only on eastern side of WRSA (minimal other material types).	3	<1	
	Beartooth	Eastern side of WRSA Construction	17	15	
Diabase	Beartooth	Co-disposal in centre of WRSA.	<0.5	none	No
Barren Kimberlite	Koala	Co-disposal in centre of WRSA.	1	none	No
Lake Sediment / Glacial Till	Panda and Koala North	Northern edge of WRSA.	10	none	Unknown
Topsoil	Koala	Northern edge of WRSA.	9	none	Yes
	Beartooth	Eastern bench of WRSA	2	none	Yes
Black Shale	Koala	In area of Till/Lake Bottom sediments storage area.	<0.5	none	Yes
Coarse Kimberlite Rejects	Process Plant	CRSA - Western portion of WRSA partially on 5m thickness of granite to encourage permafrost growth.	123		No

Mt = Metric tonnes

The majority of the waste rock in the WRSA are chemically benign (granite) or have relatively low reactivity (diabase, metasediments, kimberlite), and are therefore not expected to generate acidic drainage (NDM 1997; SRK 2003b, 2006a). The small amounts of diabase and metasediment waste rock mined from the Koala and Beartooth pits, contain elevated sulphide concentrations relative to granites, however concentrations are still low (<0.5%) and therefore not expected to generate acid (SRK 2006a). As a precautionary measure, however, these materials) have been co-disposed with granite in the centre of the WRSA to encourage freezing in place. Figure 5.4-6 shows the locations of the different rock types and areas of waste storage (permanent and temporary). The sloping topography north and east of the Koala Pit is the area containing the majority of granite rock wastes, while the area west of the Koala Pit contains mixed deposits (for example barren kimberlite and granite), other inert waste and coarse rejects storage. The Panda/Koala/Beartooth WRSA also contains EKATI's main depository for landfill materials during mining operations, a landfarm, and contaminated snow containment area.

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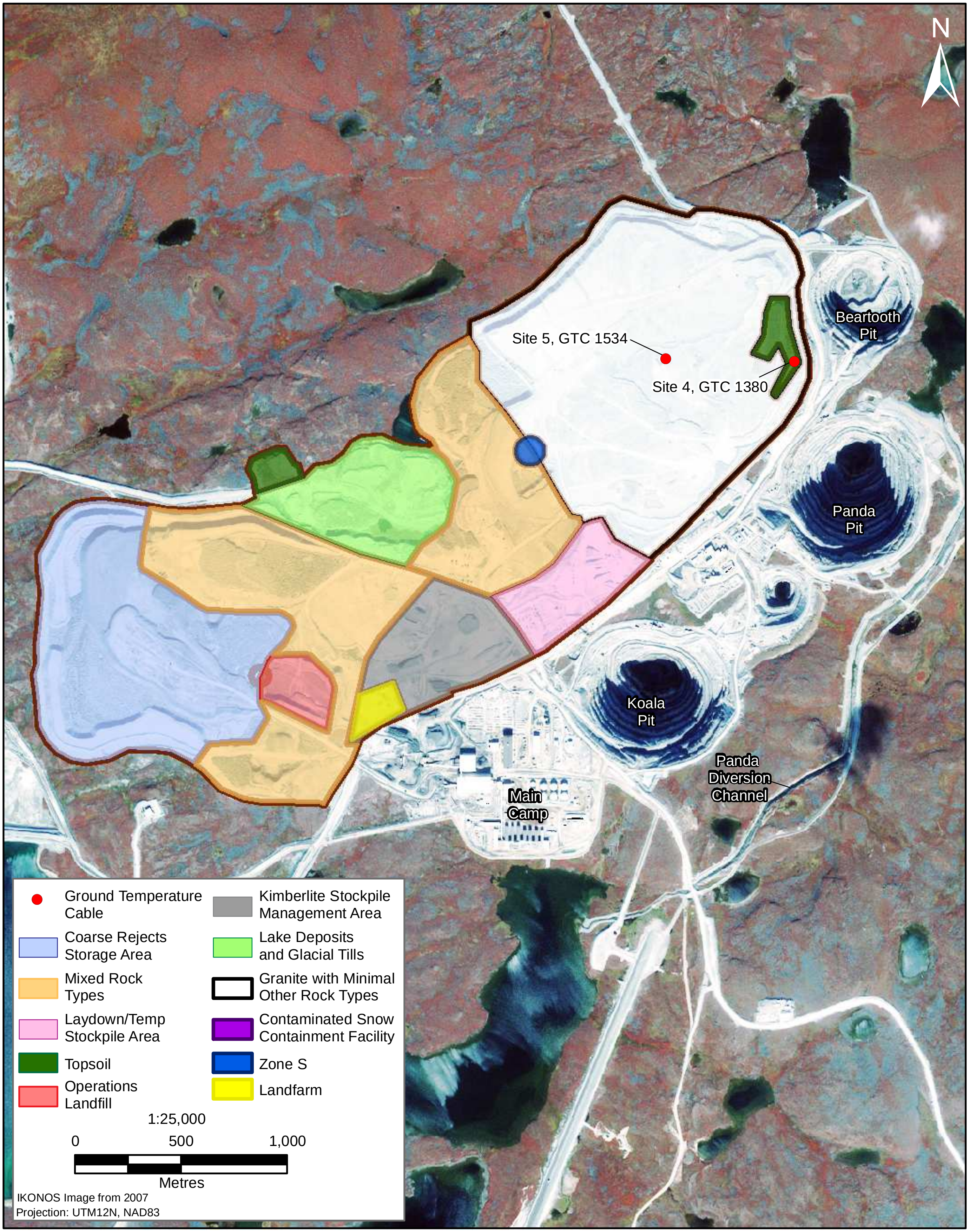

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Panda/Koala/Beartooth WRSA: Material Locations (2006)

FIGURE 5.4-6

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5.4.3.4 Panda/Koala/Beartooth Permafrost Development

The temperature of the Panda/Koala/Beartooth WRSA has been monitored since the thermistor cables were first installed in 2000, with later additions in 2002 and 2004. A total of ten cables are now installed in the rock pile and these are checked, monitored and recorded annually. More information on permafrost profiles and development trends can be found in *Thermal Evaluation of Waste Rock Piles, EKATI Diamond Mine* (EBA 2006d). A summary of measurements and results is provided in the following section.

Examinations of the ground temperature profiles from the ground temperature cables installed in the Panda/Koala/Beartooth WRSA show the following:

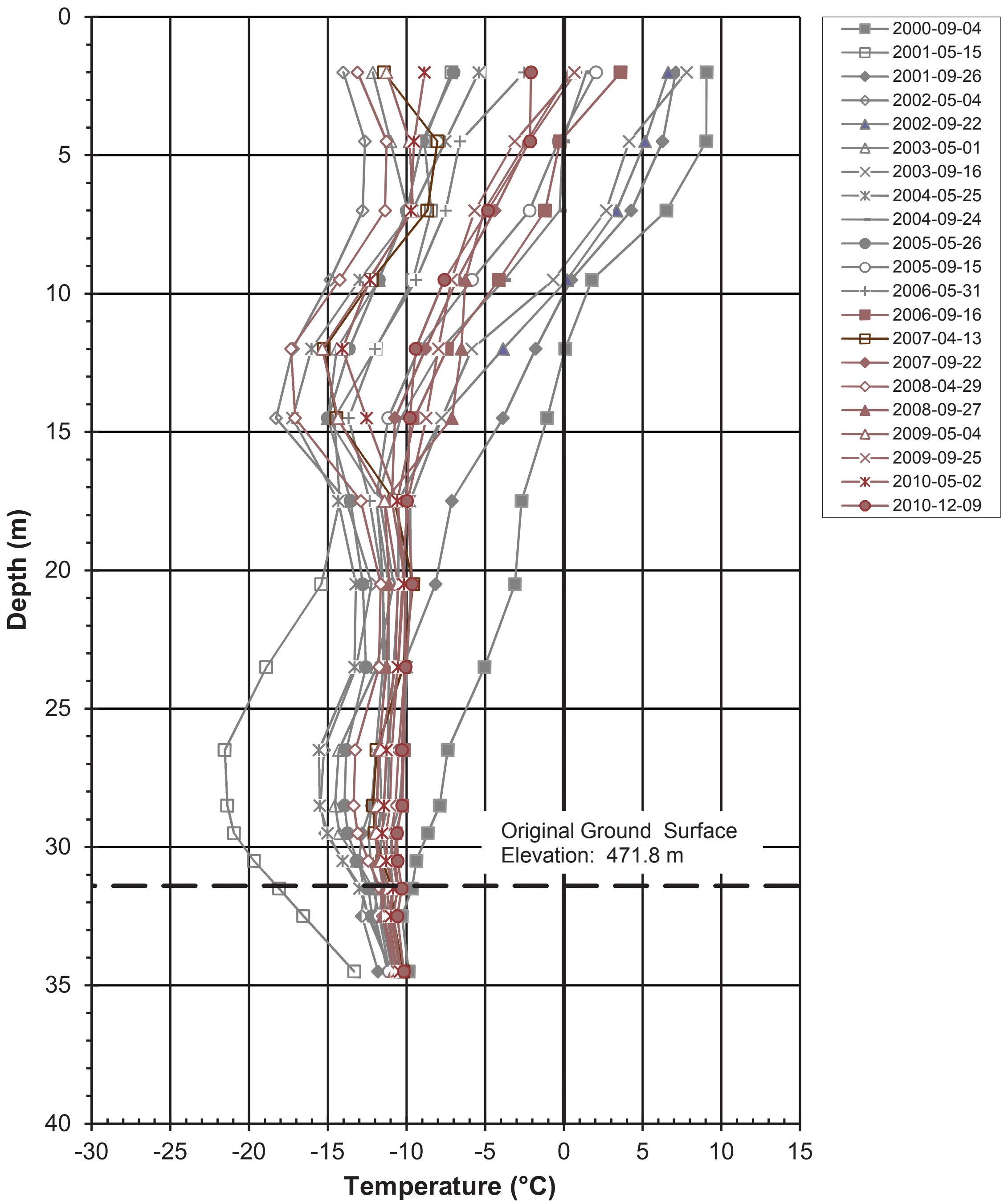
- The entire WRSA is in a permafrost condition with the exception of the surface “active layer” that thaws to a depth of 4 to 6 m each summer.
- The temperatures around the perimeter of the WRSA (typically within 200 m of the toe of the pile) are significantly colder than near the centre of the pile. This is the result of convection cooling cells that have become active around the perimeter of the WRSA.

Figure 5.4-7 shows an example profile of ground temperature from the margin of the Panda/Koala/Beartooth WRSA (Site 4 GTC in Figure 5.4-6), and Figure 5.4-8 shows an example from the centre of the same WRSA (Site 5 GTC in Figure 5.4-6). These data illustrate the following:

- The temperature profile at the centre of the WRSA is similar to those measured in similar natural permafrost soils/rock in undisturbed terrain around the EKATI site. Ground temperatures in the centre are controlled by heat conduction alone.
- The ground temperatures are continuing to get colder with time.
- There are two convective cooling cells occurring in the 30 m bench as evidenced by the bimodal temperature profiles that shows warmer ground temperatures at the boundary between the first and second lifts of waste rock (approximately at a depth of 15 m). This should be expected because the first lift of waste rock was capped with a finer grained much less air permeable surfacing material, to permit easier haul truck and equipment travel on the surface of the first lift. Rather than a single large convection cell occurring, the less permeable layer leads to the formation of the two cells separated by the less permeable zone. The temperatures in each of the two cells are getting colder with time.

Examinations of the ground temperature histories from the ground temperature cables installed in the Panda/Koala/Beartooth WRSA indicate the following (Figures 5.4-9 and 5.4-10):

- The amplitude of temperature fluctuations at a specific depth is decreasing with time.
- The magnitude of the effectiveness of convective cooling has been related to a parameter termed the “thermal offset” by Goering (2003). The thermal offset is the difference in winter temperature at the top of the embankment and at some depth within the embankment. A negative thermal offset indicates that the temperatures at depth in winter are actually colder than those near the surface, which can only be attributed to convective cooling. Sites 2, 4 and 5 show thermal offsets in the order of -5°C over a 10 m depth from 4 m to 14 m. This large offset, where the winter temperatures at 14 m below the surface are 5°C colder than those at 4 m depth, is unprecedented in terms of ground temperature profiles and clearly indicative of formation of strong convection cells.



Thermistor No.: 1380
Date Installed: 2000-08-30

Note: Surface covered with overburden September 2003

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Ground Temperature Profile for Site 4 (30 m Bench)
Panda/Koala Waste Rock Storage Area

Figure 5.4-7

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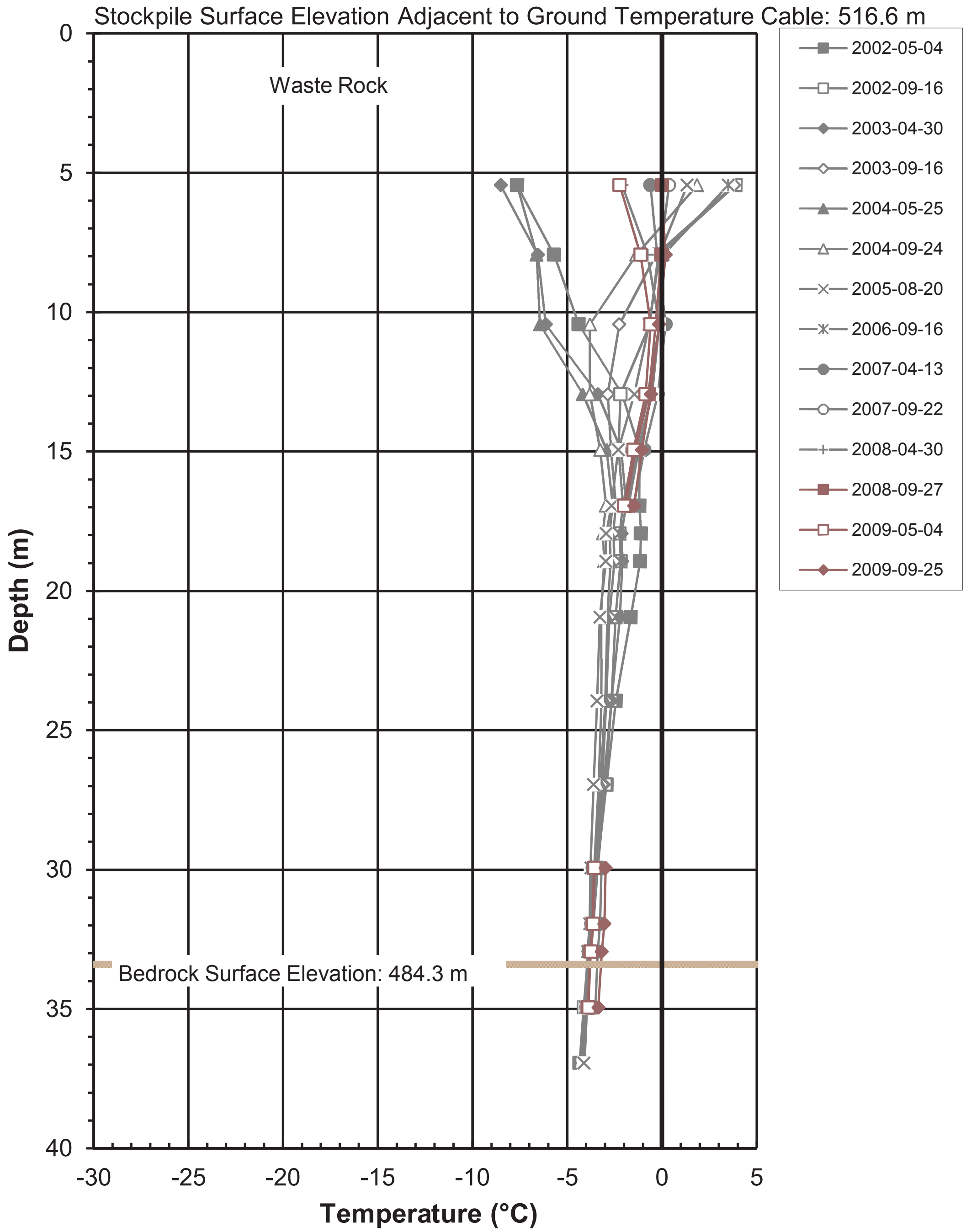
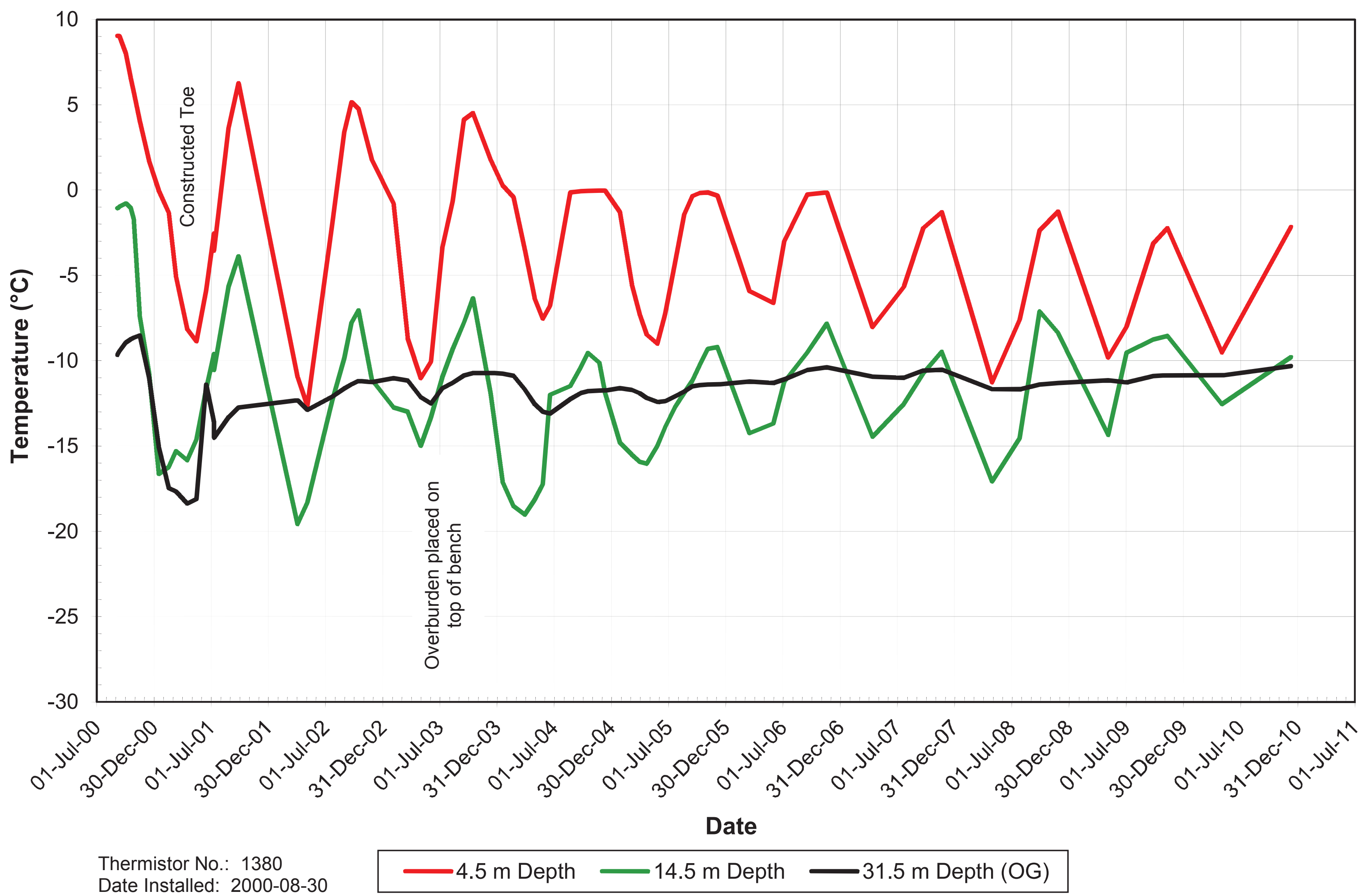


Serial No: 1534
Date Installed: 2002-02-16

Note: Stockpile surface elevation in the vicinity of cable raised to 516.6 m from 513.66 m in August 2006.

Figure 5.4-8

Ground Temperature Profile for Site 5 (Centre of Top Bench)
Panda/Koala Waste Rock Storage Area



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Ground Temperature History for Site 4 (30 m Bench)
Panda/Koala Waste Rock Storage Area

Figure 5.4-9

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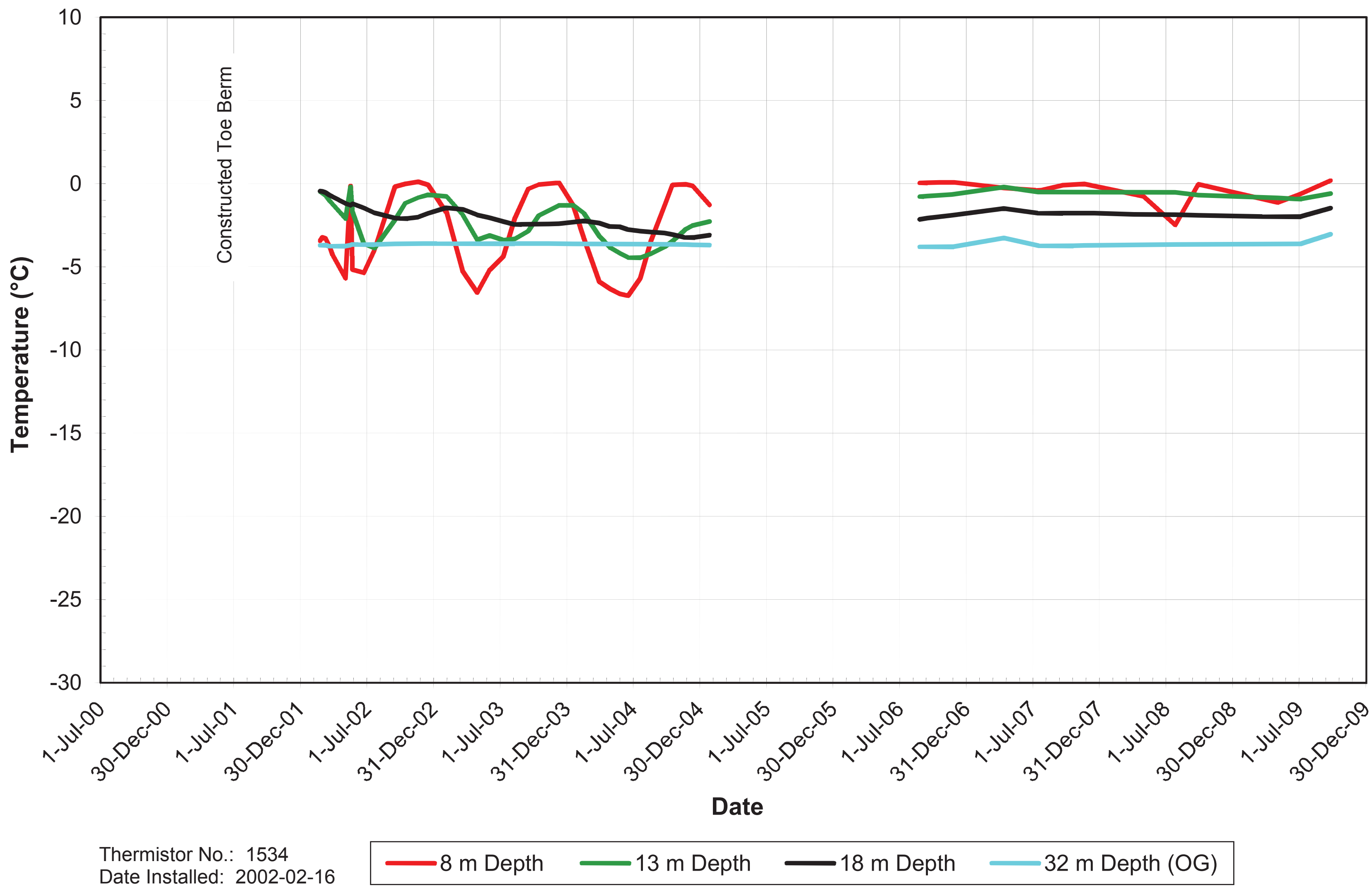

Note: Stockpile surface elevation in the vicinity of cable raised to 516.6 m from 513.66 m in August 2006.

Figure 5.4-10

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Ground Temperature History for Site 5 (Centre of Top Bench) Panda/Koala Waste Rock Storage Area

Figure 5.4-10

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- The temperatures nearer the surface of the WRSA (depths of approximately 4 m) are getting colder with time and this is an indication that the depth of seasonal thaw is also decreasing with time.
- The construction of the toe berm on the eastern side of the WRSA in the late winter of 2001 reduced the temperature fluctuations during the year at each of the plotted depths and led to colder temperatures at depth. The decrease in temperature fluctuations may be a result of a "choking off" of some of the convective cooling because of the impermeability of the toe berm. Alternatively, as the pile cools with time, the thermal gradient decreases in winter moderating the cooling effect.

It was initially estimated that the width of the unfrozen fringe (fringe active layer) could be on the order of 150 m in late summer. Examination of the results shows that the unfrozen fringe is considerably less than 150 m wide. It is believed that the unfrozen fringe is less than 10 m wide.

5.4.3.5 Toe Berm Results

Examinations of the ground temperature profiles from the ground temperature cables installed in the Panda and Bearclaw toe berms show that the toe berms are in a permafrost state at temperatures below regional ground temperature, and that the depth of seasonal thawing (thickness of the active layer) has reduced with time and is now in the order of 3 m.

Examinations of the ground temperature histories from the ground temperature cables installed in the Panda and Bearclaw toe berms indicate that the amplitude of seasonal temperature fluctuations has decreased slightly with time and that the temperatures in the core and base of the toe berms are below normal permafrost ground temperatures, confirming that the fine-grained fill inside the toe berm is benefiting from convective cooling cells that form each winter in the rock above the fill. There is insufficient thermistor data to evaluate the magnitude of the convective cooling effects. The temperatures at the base of the fill are continuing to decrease with time.

In summary, the Panda/Koala/Beartooth WRSA is cooling to temperatures below those of the ground permafrost. This effect is most significant around the sides of the WRSA where the convection currents impact on the temperature. Permafrost is developing as expected through the rock pile.

5.4.3.6 Panda/Koala/Beartooth Lake Sediments/Glacial Till

Lake sediments co-mixed with glacial till from overburden pre-stripping of the Panda and Koala North Pits was salvaged and stored to the north of the Panda/Koala/Beartooth WRSA. The original destination for this material was as a cap material for the LLCF to assist in the creation of a wetland landscape on top of the proposed rock cap of the processed kimberlite. BHP Billiton, through vegetation research on the LLCF, has identified that this material is no longer required for the reclamation of the LLCF because direct planting of vegetation into processed kimberlite has been shown to be successful (HMA 2005). Future use for lake sediments/glacial till from pre-stripping may be for construction of toe berms around WRSA. BHP Billiton is also researching the use of lake sediments as an amendment material for camp pad and laydown landscaping work at mine closure (HMA 2007). Until the decision is made for the final use of lake sediments the piles have been seeded and fertilized to provide a temporary stabilizing cover. Any remaining materials will be stabilized either with a rock or vegetation cover at mine closure.

5.4.3.7 Panda/Koala/Beartooth Topsoil Storage Areas

The Koala Topsoil Storage Area is located north of the Panda/Koala/Beartooth WRSA. The topsoil in this stockpile was salvaged during the advancement of Koala Pit in 2000 and 2001. The stockpile is 2.2 ha in area and contains approximately 46,300 m^3 of topsoil (HMA 2005). A 30 m-wide waste rock berm borders the stockpile on the east and west sides. The majority of the stockpile area has been levelled with some free dump piles still remaining on the south side. Small quantities of sewage sludge, generated during the flushing of the sewage treatment tanks, had been periodically disposed of in the stockpile to bolster the nutrient status of the topsoil (HMA 2005). In addition to sewage application, reclamation of the Koala Topsoil Storage Area was conducted in September 2002 in an effort to preserve and stabilize this important resource. Reclamation efforts included the addition of fertilizer (16-16-16 Nitrogen, Phosphorus and Potassium) at 200 kg/ha and seed at 25 kg/ha (HMA 2005).

The Beartooth Topsoil Storage Area is located west of the Beartooth Pit along the east side of the first lift of the Panda/Koala/Beartooth WRSA. This stockpile consists of topsoil stripped in preparation for the development of the Beartooth Pit in late 2003. The stockpile is 2.1 ha in surface area (approximately 600 m in length and 25 to 35 m in width) and contains approximately 38,000 m^3 of topsoil (HMA 2005). It has been maintained as free dump piles. A second, smaller, more recently deposited (July 2005) portion of the Beartooth topsoil stockpile is located on the second lift of waste rock below the area described above.

5.4.3.8 Landfill and Other Waste Disposal Areas

Landfill

The Main Camp solid waste landfill was commissioned in July 1998 and is located within the Panda/Koala/Beartooth WRSA footprint northwest of the primary crusher. The landfill is used for the disposal of inert solid wastes (non-hazardous materials) that are generated as part of the operation of the mine. The following are some of the inert materials acceptable for disposal at the landfill:

- ash;
- incinerator residue; and
- operational and construction wastes, including:
  - plastic or synthetics;
  - metals;
  - rubber and rubber coated products;
  - conduit and insulated electrical wire;
  - siding;
  - cardboard, paper and clean lumber; and
  - any other inert waste arising from mine operations.

In July 2002, the Main Camp landfill was redesigned and is now enclosed by a ring of waste rock. The ring will be filled starting at one side and working across to complete the level. Wastes are placed close to the working edge of the landfill before they are pushed over the active face and compacted. Wastes are placed and compacted several times per week by tracking up and down the face with a bulldozer. When filled, the area will be brought up to grade by addition of a coarse kimberlite blanket.

The Main Camp landfill will remain in the same area on the western side of the Panda/Koala/Beartooth WRSA for the life of the mine and will raise a level as each lift is added to the waste rock pile. The landfill presently accepts approximately 4,500 m^3 of inert material per month.

Contaminated Snow Containment Facility

The Contaminated Snow/Ice Containment Facility was constructed in 2004 and is situated on the CRSA north of the landfill on the western side of the Panda/Koala/Beartooth WRSA. It is a bermed and lined engineered facility designed for the containment of hydrocarbon-affected snow and ice that are generated at the site as a result of operational spills. Hydrocarbons include diesel, glycol, gasoline, kerosene, jet fuels, hydraulic oil, transmission fluid and lube oil. Water in the facility is aerated annually during the open water season, and sampled and tested for hydrocarbons as required by the Water Licence, then pumped to Cell B of the LLCF. Prior to pumping the water from the facility into Cell B hydrocarbons are skimmed off the surface. The water level in the facility is pumped down to a minimum to make room for 'new' contaminated snow/ice anticipated during the winter. The skimmed oil is placed into totes and stored for offsite shipment if contaminated, or incinerated on site if non-contaminated (BHP Billiton 2007c).

Sump Water Disposal Area

The Sump Water Disposal Area (also referred to as the Racetrack) was a designated area located within the footprint of the CRSA that was used for the disposal of excess water that has been decanted from the Landfarm, Contaminated Snow Containment Facility, truck shop sumps and collection ponds or other sources of mine water. Following approval of the September 2006 Wastewater and Processed Kimberlite Management Plan, a new procedure was implemented and all wastewater that formerly discharged to the Sump Water Disposal Area on the CRSA are now discharged directly to the LLCF (Cell B). The volume of wastewater collected from the entire mine site is estimated to be up to 10,000 m^3/year with an estimated average of approximately 6,000 m^3/year since the Sump Water Disposal Area was constructed in 1998.

Landfarm

The Landfarm was constructed in 1998. It is a lined engineered facility designed with a leachate collection system and side berms to control runoff. It is used for the management of hydrocarbon-affected soil generated at the site as a result of operational spills. Hydrocarbon affected soil remediated at the Landfarm includes clay, silt, sand and gravel with average particle sizes of less than 4.0 cm.

Materials placed in the Landfarm are aerated and treated with amendments such as the addition of fertilizer to promote the natural breakdown of hydrocarbons through bioremediation. Volumes treated and hydrocarbon content in the Landfarm are monitored. The Landfarm requires periodic skimming of the free phase hydrocarbons and subsequent draining of the sump. Oil skimmed from these sumps is placed into totes and stored for offsite shipment if contaminated, or incinerated on site if non-contaminated (BHP Billiton 2007c).

The Landfarm is also a secure temporary storage for hydrocarbon-impacted material unsuitable for bioremediation, prior to these materials being sent offsite for disposal. The Landfarm presently contains approximately 2,850 m^3 of material.

Hydrocarbon-affected material (from the former fuel farm) is also stored at the Old Camp, and at the northern end of the Panda/Koala/Beartooth WRSA (from the former Klempe sizer pad), and is monitored as part of Environmental Operations at EKATI. Both of these sites are bermed and lined.

Zone S

There are two Zone S locations at EKATI. The first is located within the footprint of the Panda/Koala/Beartooth WRSA (Figure 5.4-6), and the second is located on the Fox WRSA

(Figure 5.4-11). These areas accept hydrocarbon-affected rock and soil with an average diameter greater than 4 cm originating from spills, or that which is not suitable for bioremediation in the Landfarm. With the addition of waste rock to these areas, materials which have been deposited into Zone S will be encapsulated in permafrost.

5.4.3.9 Fox WRSA

The Fox WRSA is the repository for all waste rock from Fox Pit. Fox Pit is currently in production and mining is planned to continue until approximately 2014. The majority of stripping has occurred, including a quantity of barren and very low grade kimberlite which is stored in the WRSA. Figure 5.4-11 shows the location of the kimberlite storage areas, all of which have all been placed on a granite basement pad with a minimum thickness of 5 m. In addition, toe berms were constructed around the perimeter of the Fox WRSA to impound water and allow it to freeze within the voids of the waste rock storage piles. Table 5.4-4 shows the type and quantity of material in the Fox WRSA.

Table 5.4-4. Rock Types in the Fox WRSA

Material Type	Source	Location	Amount pre-June 2006 (Mt)	Amount post- June 2006 (Mt)	Re-usable for Closure
Granite	Fox	Co-disposed with other rock types.	54.286	6.223	No
Diabase	Fox	Co-disposed in center of WRSA	3.341	0.499	No
Barren Kimberlite	Fox	Low grade kimberlite placed on western edge for potential future use potential. Waste kimberlite placed in south-central WRSA for future encapsulation	44.319	2.474	No
Till/Lake Bottom Sediments	Fox	Co-disposed with granite in WRSA Does not include materials in toe berms around WRSA perimeter	0.011	0	No
Topsoil	Fox	North of Fox Pit	0.026	0	Yes

Mt = Million Tonnes

The waste and low grade kimberlite will be covered with granite at closure. This process has commenced on the outer sides of the kimberlite areas and will continue as granite is produced during mining.

5.4.3.10 Fox Permafrost Development

The temperature of the toe berms constructed at the Fox WRSA have been monitored since 2004, when three thermistor cables were installed within the perimeter toe berms. Three additional thermistors were installed in the main body of the WRSA in October 2006 to enable monitoring of the internal storage pile temperatures. Measurements from all six thermistors are collected and plotted regularly to monitor trends. More information on permafrost profiles and development trends can be found in *Thermal Evaluation of Waste Rock Piles, EKATI Diamond Mine* (EBA 2006d). A summary of the measurements and results is provided here.

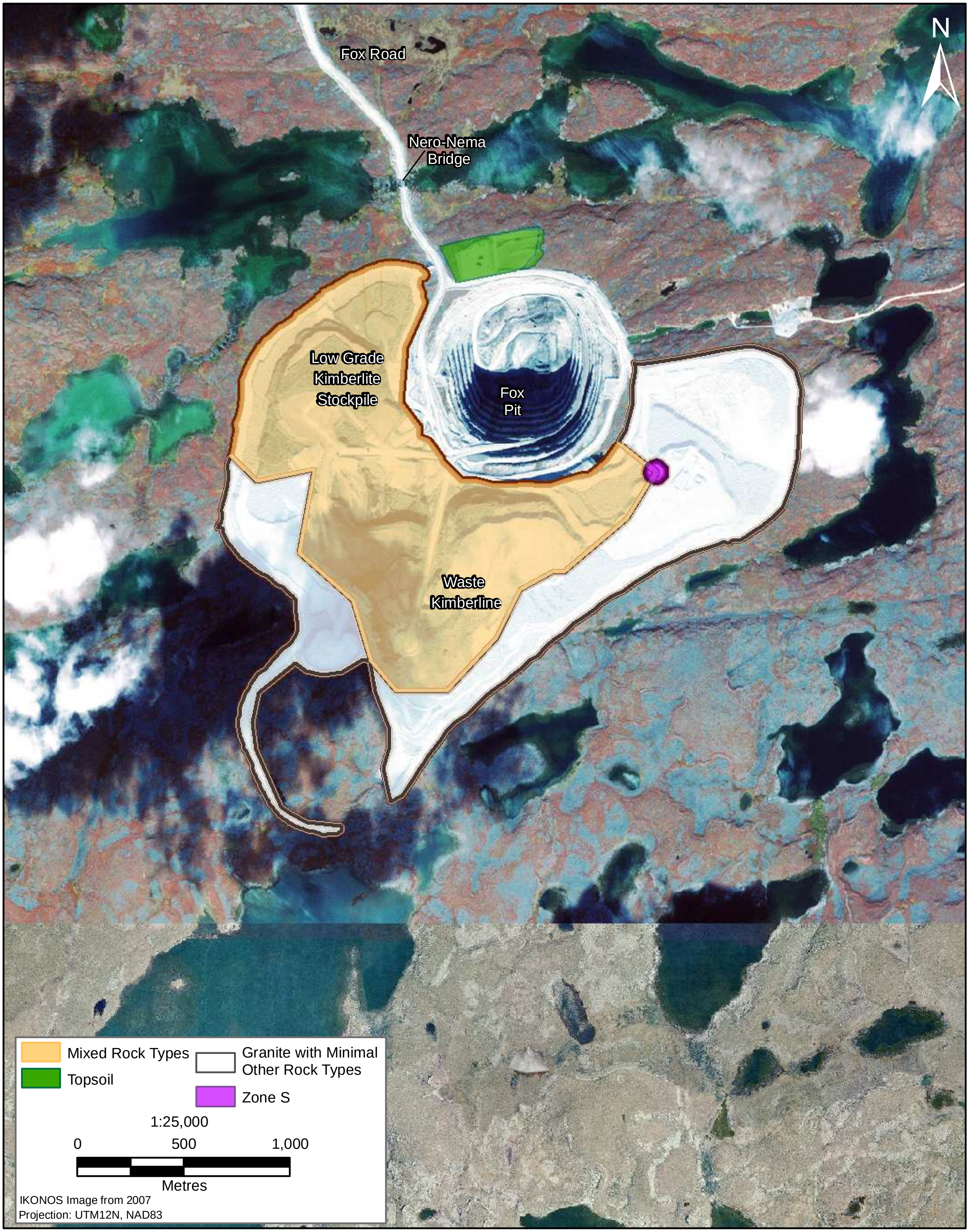


FIGURE 5.4-11

Fox WRSA:
Material Locations (2006)

Examinations of the ground temperature profiles from the three ground temperature cables installed in the Fox toe berms show the following:

- The depth of seasonal thawing is now between 3 and 5 m in the toe berms. Thus, seasonal thawing is restricted to the cap of run-of-mine rock that covers the less permeable lacustrine sediment core.
- All of the less permeable lacustrine sediment core materials in the toe berms are in a permafrost state.
- At the two locations where ground temperature cables were installed in the east berm (Southeast Valley and 3 Hump Lake Streams) the lacustrine sediment core is colder than the typical permafrost at EKATI. This may be an indication that some convective cooling is happening in the coarse run-of-mine rock cap material at these two locations. It is, however, difficult to state this with certainty because of the short time frame during which monitoring has been carried out in the Fox toe berms.
- Ground temperatures in the foundations of the toe berms are becoming colder with time and are now typically on the order of -4 to -5°C.
- The thickness of the run-of-mine rock cover is just over 4 m thick at the Fox Lake Tail ground temperature cable location. This is the deepest active layer in the run-of-mine cap materials in the three toe berm locations where ground temperatures are available.

Examinations of the ground temperature profiles from the three ground temperature cables installed in the Fox WRSA show the following:

- Large portions of the waste rock pile are presently unfrozen. This is likely a function of placing warm (above-freezing) waste rock or placing material in above-freezing temperatures.
- Unfrozen conditions are observed in two of the three profiles at original ground elevations.
- The Fox WRSA has shown an overall cooling trend during 2007. This trend is expected to continue and culminate in freezing the pile; however, the length of time required to freeze back the pile is unknown (SRK 2008).

In summary, the toe berms in the Fox WRSA are cooling to temperatures below those of the ground permafrost likely due to convective cooling. Materials in the WRSA are cooling slowly, but likely affected by the placement of materials in warmer months. This has slowed the freeing process but in general permafrost is developing as expected through the rock pile.

5.4.3.11 Fox Topsoil Storage Area

Topsoil from the perimeter of Fox Lake was salvaged during pre-stripping of Fox Pit in 2002. This material has been stored north of Fox Pit and is intended for future reclamation efforts to promote vegetation establishment at other sites at EKATI. The storage area was levelled after dumping, and consists of three distinct rows of material. The stockpile is 3.7 ha in surface area and contains approximately 38,000 m^3 of topsoil (HMA 2005). Rehabilitation of this topsoil stockpile was conducted in September 2004 with seed and fertilizer application similar to that of the Koala topsoil storage area.

5.4.3.12 Misery WRSA

Misery Pit is currently in temporary suspension of operations. The 2005 LOM Plan has scheduled the pushback of Misery Pit to begin in approximately 2012, with ore production commencing in 2016.

Table 5.4-5 shows the amount of waste rock that will be produced at that time (as currently included in the LOM Plan) as “post-2006”. Additional waste rock from the pushback is expected to be placed adjacent to the existing WRSA, based on the approved Waste Rock and Ore Storage Management Plan (2000). It is expected that all granite available will be used in encapsulating the metasediment using the same methodology as the existing Misery WRSA.

Table 5.4-5. Rock Types in the Misery WRSA

Material Type	Source	Location	Amount pre-June 2006 (Mt)	Amount post- June 2006 (Mt)	Re-usable for Closure
Granite	Misery	Co-disposed with other rock types & Misery pad construction.	11	20	No
Diabase	Misery	Co-disposal in centre of WRSA	1	2	No
Barren Kimberlite	Misery	Co-disposal with granite or left in pit	<0.5	<0.5	No
Till/Lake Bottom Sediments and Topsoil	Misery	North-eastern edge of WRSA	3	<0.5	Yes
Metasediment	Misery	Co-disposed with granite	15	26	No

Mt = Million Tonnes

The waste rock in the Misery WRSA consists primarily of granite and metasediments, with minor amounts of diabase and waste kimberlite. Acid-base accounting (ABA) results from pre-mining geochemical characterization work indicated that the metasediments had low sulphide concentrations (typically <0.5%; average ~0.2%), however, they also contained low neutralization potential (NP) and were classified as potentially acid generating (PAG) (NDM 1997). Laboratory kinetic tests (humidity cells) showed that Misery metasediment did generate acid under laboratory conditions (NDM 1997; SRK 2002). However, oxidation rates were low and any significant acidity and metal release is expected to be a short-term effect due to low sulphide concentrations. ABA results for 318 blast muck samples of metasediments collected as part of the routine geochemical monitoring program during operations at Misery Pit were comparable to pre-mining characterization, indicating the material to be PAG (SRK 2006a). Such acid conditions have not been observed in the seepage draining the Misery WRSA (SRK 2006a).

In order to mitigate against the potential acid generation from Misery metasediment, all metasediments encountered at Misery were encapsulated in granite at a thickness of 5 m to ensure encapsulation by permafrost in the long term. In order to aid the growth of permafrost through the WRSA, the two main rock types were placed in layers so that any heating by oxidation of the metasediments would result in cold air being drawn along the granite layers. At the end of the current production phase, care was taken to ensure a complete capping of granite was in place. Figure 5.4-12 illustrates a schematic section of the Misery WRSA and shows the method of encapsulation. Monitoring of the WRSA during mining operations, and continued monitoring during temporary suspension of operations at Misery demonstrates that the design is effective, because acid conditions have not been observed in the seepage draining from the Misery WRSA (SRK 2006a).

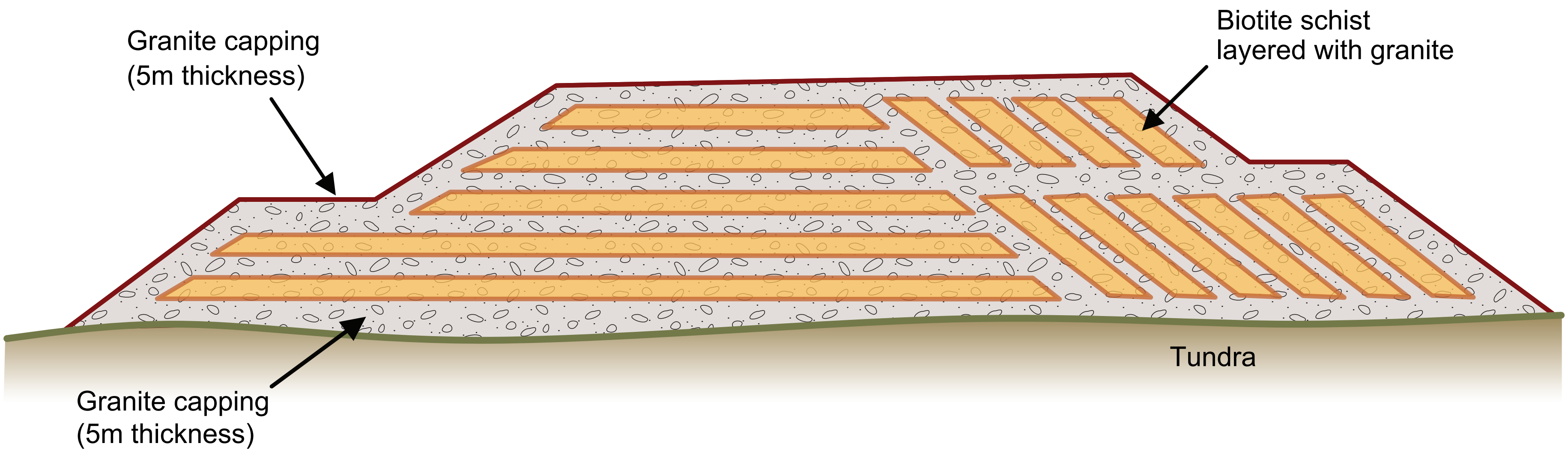


Figure 5.4-12

Schematic Cross-Section of the Misery WRSA Showing Method of Metasediment Encapsulation

Reclamation studies are in place to continue monitoring and assessing permafrost development in the WRSA including Misery. These studies include convection cooling, freezing variations for different materials in the pile and review of experiences at other sites, including the Diavik test piles. Appendix 5.1-4 describes the research plan for permafrost growth in the WRSA.

5.4.3.13 Misery Permafrost Development

The temperature of the Misery WRSA has been monitored since the thermistor cables were first installed in 2001, with later additions in 2002 and 2005. A total of six cables are now installed in the rock pile. Measurements are taken and plotted regularly to monitor trends. More information on permafrost profiles and development trends can be found in *Thermal Evaluation of Waste Rock Piles, EKATI Diamond Mine* (EBA 2006d). A summary of the monitoring results is provided here.

Examination of the ground temperature profiles from the ground temperature cables installed in the Misery WRSA show the following:

- The waste rock below the active layer in the monitored areas of the WRSA is now in a permafrost state.
- The thickness of the active layer is quite variable in the Misery WRSA. The active layer thickness varies from 3 to 21 m.
- Ground temperature cable WRP#2 (10 m) and WRP#5 (21 m) are both located very close to the slope of the WRSA and because of slope orientation and proximity to the outside of the WRSA, the active layer is considerably thicker. Ground temperature cable WRP#5 is installed in a location where water ponded prior to the construction of the Misery WRSA. The original ground was very warm, probably due to the influence of the ponded water, and in fact, may not have been frozen when the Misery WRSA was constructed in this area. The foundation soils and the waste rock will likely take more time to overcome this originally warm condition and equilibrate to the expected colder state.
- The ground temperature cable WRP#1 (13 m) is installed at the toe of a slope where snow is known to drift extensively during the early winter. It is believed that this large drift of snow effectively insulates the area against the penetration of cold winter air during the remainder of the winter and may also reduce the potential for convective cooling.
- There does not appear to be significant indications of convective cooling at the locations of WRP#1 or WRP#2, rather the measured temperatures are trending towards those for typical permafrost found in the Misery area. However, temperatures in the center of the pile (WRP#3) are still colder than the typical ground temperatures. This may be a result of some convective cooling at this location or simply that the materials are still stabilizing from the very cold temperatures that existed in the area because of winter placement of the waste rock.
- The other measured active layer thicknesses are similar to what would be expected and are also similar to those measured at the Panda/Koala/Beartooth WRSA.

Examinations of the **ground temperature histories** from the ground temperature cables installed in the Misery WRSA indicate the following:

- The amplitude of temperature fluctuations at specific depths is decreasing with time.
- The temperatures near the original ground surface (in the foundation of the Misery WRSA) are generally trending towards the temperature of typical permafrost soils found at depth in the Misery area (typically -4°C).

In summary, permafrost conditions have formed in the Misery WRSA although active layers at this time are variable. Although the cooling is not as significant as in the Panda/Koala/Beartooth WRSA, it is below local permafrost temperatures. The temperatures inside the rock pile appear to be influenced by:

- Snowdrifts on the side of the WRSA which reduce air flow.
- Temporary stockpiles on the WRSA cause snowdrifts on the surface of the rock pile reducing air flow.

Convective cooling does not appear to be as important as in Panda/Koala/Beartooth WRSA and this may be due to the finer size distribution of the layers of metasediment when compared with the distribution of granite.

5.4.3.14 Misery Topsoil Storage Area

The Misery Topsoil Storage Area is located on the east side of the Misery WRSA. The topsoil in this stockpile was salvaged in the advancement of Misery Pit and King Pond Dam and was stockpiled in 2000 and 2001. The stockpile was levelled after dumping and covers an area of approximately 1 ha. The Misery Topsoil Storage Area contains about 17,000 m^3 of topsoil mixed with glacial till (HMA 2005). Rehabilitation of this storage area was conducted in September 2002 to preserve and stabilize this important resource. Rehabilitation efforts included the addition of fertilizer and seed similar to that described above for the Koala Topsoil Storage Area.

Figure 5.4-13 shows the location of the different types of material in the Misery WRSA, and Table 5.4-5 shows their tonnages.

5.4.3.15 Misery Landfill

A landfill at the Misery site was commissioned in August 2001. It is located northwest of Misery Pit within the footprint of the Misery WRSA. The following are some of the inert materials deposited in the Misery landfill:

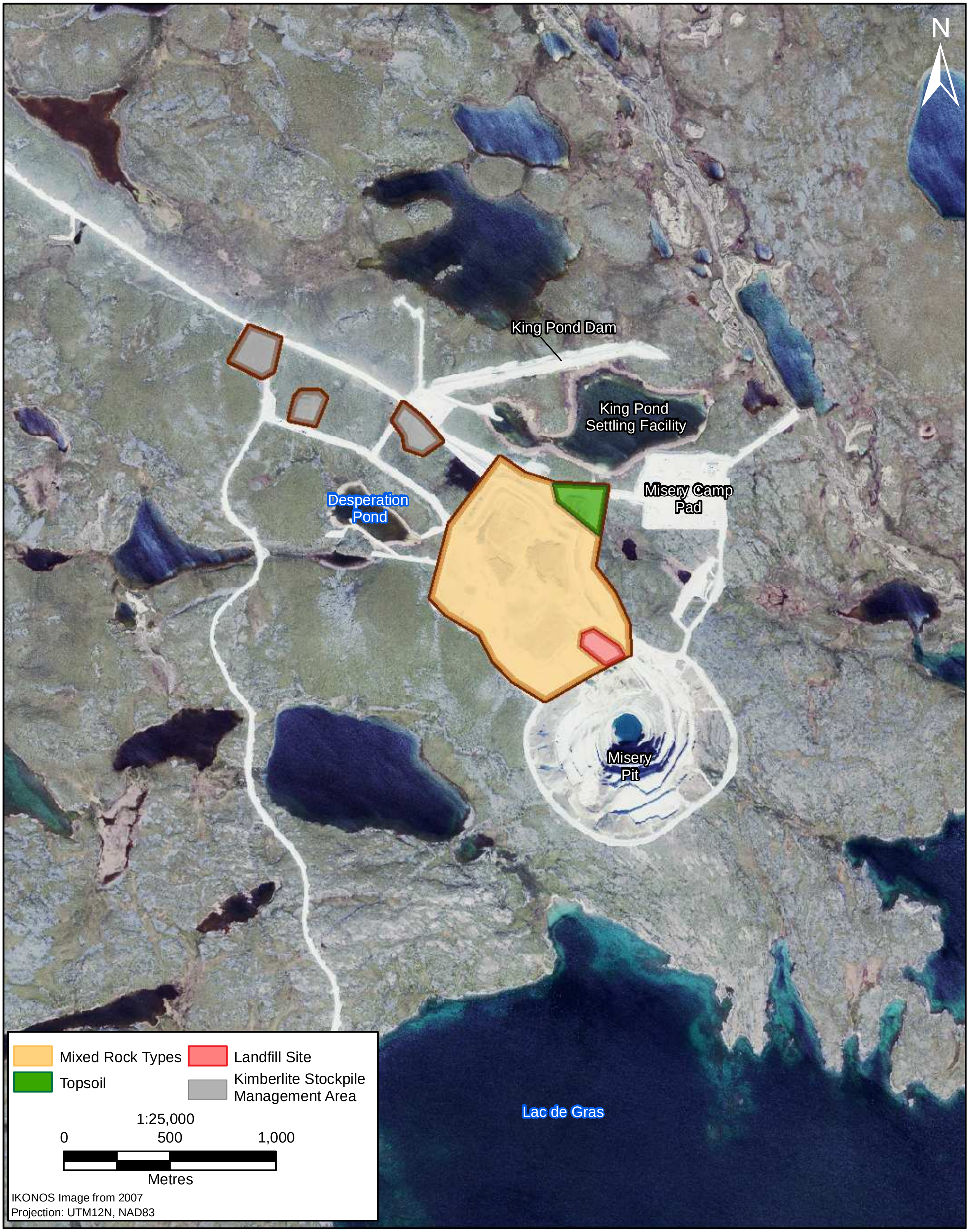
- plastic or synthetics;
- metals;
- rubber and rubber coated products;
- conduit and insulated electrical wire;
- siding;
- cardboard, paper and clean lumber; and
- any other inert waste arising from mine operations.

At the time of the temporary suspension of mining, the Misery landfill was covered with a granite cap.

5.4.4 Projected Development

5.4.4.1 Sable WRSA

The Sable WRSA will be located north and west of Sable Pit (BHP Billiton 2002b). Sable Pit is expected to produce an estimated total of 120 Mt of waste rock consisting of 95% granite and 5% diabase, 3 Mt of glacial till and sediments and 13 Mt of kimberlite ore. All of the kimberlite is expected to be ore-grade and will therefore be transported to the Process Plant at the Main Camp, and coarse kimberlite rejects from processing Sable ore will therefore be placed in the CRSA. Where possible, topsoil will be salvaged, similar to previous development sites at EKATI, and used later for reclamation purposes.



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Misery WRSA and Temporary Ore Storage Pads: Material Locations (2006)

FIGURE 5.4-13

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The use of frozen toe berms will be used where considered prudent to minimize impact on the receiving environment. When not required for construction glacial till will be placed in the Sable WRSA.

5.4.4.2 Pigeon WRSA

The Pigeon WRSA will be placed over the Big Reynolds Pond and south of Pigeon Pit within the drainage basin of the LLCF (BHP Billiton 2002c). Pigeon Pit is expected to produce an estimated total of 45 Mt of waste rock, 8 Mt of glacial till and 5 Mt of kimberlite ore. All the kimberlite is expected to be ore grade and will therefore be transported to the Process Plant at the Main Camp, and coarse kimberlite rejects from processing Pigeon ore will be placed in the CRSA.

If metasediments are encountered in the Pigeon Pit, then samples will be collected and analyzed following established protocols for the routine geochemical monitoring program (SRK 2006a). Analyses include acid-base accounting (ABA), including total sulphur, neutralization potential, and paste pH. The results are used to evaluate the neutralization potential ratio (NPR, or NP/AP). If results indicate this material to be potentially acid generating, then the metasediment will be placed in the WRSA in such a way as to be completely encapsulated by granite waste rock.

Glacial till, when not required for construction, will be placed in the Pigeon WRSA. Where possible, topsoil will be salvaged, similar to previous development sites at EKATI, and used later for reclamation purposes.

5.4.4.3 Panda/Koala/Beartooth WRSA

The Panda/Koala/Beartooth WRSA is expected to be added to until 2020 when Koala Underground waste mining is scheduled to be completed. Coarse rejects from the processing of kimberlite ore will continue to be added to the CRSA until the end of the mine life (2020). There are several potential and required uses of waste rock during operations and at final closure, including granite for the reclamation of the LLCF; most of the rock will be removed from the northern end of the storage area. Table 5.4-6 outlines these uses.

Table 5.4-6. Future Construction Uses for Granite Waste Rock

Use of Granite	Source of Granite	Quantity Required (m^3)	Timing
Operational road construction	Panda / Koala / Beartooth WRSA	800,000	2009 - 2014
Pipeline road construction	Panda / Koala / Beartooth WRSA Sable WRSA	50,000	2013 - 2020
LLCF rock cover	Panda / Koala / Beartooth WRSA	2,800,000	2013-2022
Coarse rejects rock cover	Panda / Koala / Beartooth WRSA	1,000,000	2018 - 2022
Final Landfill cover	Panda / Koala / Beartooth WRSA	200,000	2022
WRSA access ramps	Panda / Koala / Beartooth WRSA Sable WRSA	100,000	2018 - 2022
Phase 1 Pond rock cover	Panda / Koala / Beartooth WRSA	30,000	2010-2011
Pipeline base and access roads for pit flooding	Panda / Koala / Beartooth WRSA	50,000	2013-2020
Fox low grade ore and waste kimberlite capping	Panda / Koala / Beartooth WRSA	2,180,000	2014-2016

5.4.4.4 Fox WRSA

The Fox WRSA is expected to be added to until 2014 when Fox open pit mining is scheduled to be completed. Figure 5.4-11 shows the location of the permitted footprint of the Fox WRSA.

5.4.4.5 Misery WRSA

The Misery Pit pushback is included in the 2005 LOM Plan and is scheduled to be producing ore in 2016. In order to mine the ore using open pit techniques it will be necessary to strip waste rock for 3 to 4 years prior to ore production. The amount of waste rock that will be mined is 47 Mt split into 26 Mt of metasediment and 20 Mt of granite, plus some very minor amounts of overburden, diabase and waste kimberlite. The placement of the metasediments will follow a similar pattern to that previously employed at the site (*i.e.*, encapsulation in granite).

Figure 5.4-14 shows the location of the permitted extension to the existing WRSA. This location includes the requirement to de-water Desperation Pond and cover existing ore storage pads.

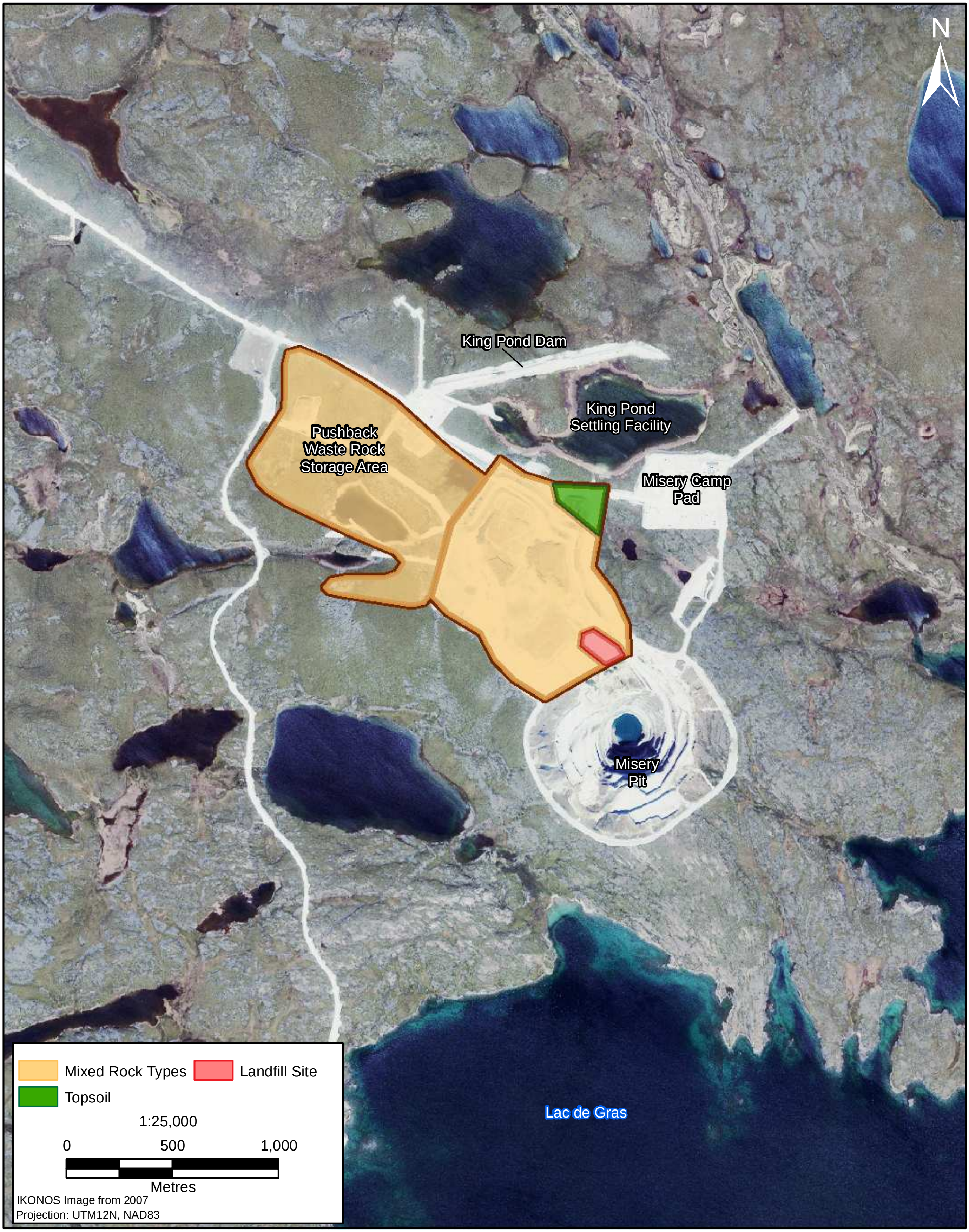
5.4.4.6 Waste Rock Characterization

Waste rock at EKATI consists predominantly of granitic rock that forms a regionally extensive host to the EKATI deposits. Metasediment is a waste rock at Misery, and minor quantities of metasediment have been mined from Beartooth. Low-grade kimberlite and related sediments have been an important source of waste material at Fox, and to a lesser extent at Koala and Misery, and very minor quantities of kimberlite have been mixed with granite in all dumps as a function of irregular waste/ore geological contacts. Diabase dikes were mined from Fox, Misery and Beartooth, with diabase making a minor contribution to overall waste volumes. Detailed descriptions of the rock types and the distribution of waste rock at the various deposits can be found elsewhere (*e.g.*, NDM 1997; BHP Billiton 2002a, 2002b, 2002c, 2003a; SRK 2006a).

Pre-mining and supplemental geochemical characterization and operational monitoring has resulted in an extensive dataset related to the metal leaching and acid rock drainage (ML/ARD) characteristics of waste rock at EKATI. Detailed geochemical results have been provided in pre-mining characterization reports (NDM 1997; BHP Billiton 2002a; SRK 2003a, 2003b, 2003c), annual seepage and waste rock monitoring reports (SRK 2001, 2002, 2003d, 2004, 2005, 2006b), and most recently summarized in the Geochemical Characterization and Metal Leaching Management Plan (SRK 2006a). Table 5.4-7 provides summary statistics of the ABA characteristics of the main waste rock types generated from the various pits and stored at the different WRSA. The summaries are based on data collected during operational monitoring from project inception through the end of the 2005 reporting year (October 2005).

In summary, operational monitoring has confirmed the ABA characteristics determined during pre-development *(i.e.,* little or no potential for acid generation from the waste rocks at EKATI). Uniform results have been obtained for the major rock types throughout the property and the results are consistent with the mineralogy (SRK 2006a). The geochemical characteristics of the primary waste rock types are summarised below:

- Granite waste rock has very low sulphur concentrations (near the detection limit) and neutralization potential, except when containing kimberlite or mafic xenoliths. Granite is not potentially acid generating.
- Metasediments contain higher sulphur concentration (average concentrations between 0.1% and 0.2%) and generate acid under laboratory conditions, however, ARD has not been observed under field conditions.



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Misery WRSA and Ore Pads: Material Locations at End of Mine Life

FIGURE 5.4-14

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Table 5.4-7. Summary of Acid Base Accounting Characteristics of EKATI Waste Rock and Coarse Kimberlite Rejects

Material Description	Summary Statistics	Paste pH log units	S (T) %	S (SO_4) %	CO_3-NP kg $CaCO_3$ eq/tonne	NP kg $CaCO_3$ eq/tonne	MPA kg $CaCO_3$ eq/tonne	NNP kg $CaCO_3$ eq/tonne	NP/MPA	CO_3 - NP/MPA
Panda Granite	Average	9.5	0.02	0.012	4.9	16	1	15	34	11
	Max	12.1	0.39	0.07	18	153	12	150	64	15
	Min	8.4	0.01	0.01	5	7	0.31	4.4	1.8	0.8
	Count	397	397	43	43	379	397	379	379	43
Koala Granite	Average	9.1	0.037	-	-	16	1.1	15	21	-
	Max	10.1	0.31	-	-	248	9.7	238	77	-
	Min	7.2	0.01	-	-	5	0.00	3.4	1.5	-
	Count	297	297	-	-	275	298	275	275	-
Koala Black Clay	Average	7.5	0.40	0.069	125	293	13	281	25	11
	Max	7.9	0.93	0.12	175	351	29	340	32	16
	Min	7.2	0.31	0.01	68	202	10	173	7.0	2.5
	Count	20	20	20	20	20	20	20	20	20
Koala Waste Kimberlite	Average	7.9	0.26	0.023	35	192	8.1	184	32	6.7
	Max	8.3	0.96	0.05	59	363	30	358	133	17
	Min	7.3	0.07	0.01	16	76	2.2	68	8.9	2.0
	Count	22	22	20	20	22	22	22	22	20
Beartooth Granite	Average	9.0	0.056	-	-	15	1.8	13	20	-
	Max	9.8	0.29	-	-	70	9.1	67	102	-
	Min	7.8	0.01	-	-	8	0.3	6	1.7	-
	Count	70	70	-	-	70	70	70	70	-
Misery Metasediments	Average	8.7	0.2	0.012	8.1	18	4.9	14	5.0	2.2
	Max	9.7	1.0	0.09	173	406	31	402	110	43
	Min	7.1	0.01	0.010	0.0	1.0	0.30	-14	0.33	0.21
	Count	315	315	308	297	315	315	315	315	287

(continued)

Table 5.4-7. Summary of Acid Base Accounting Characteristics of EKATI Waste Rock and Coarse Kimberlite Rejects (completed)

Material Description	Summary Statistics	Paste pH log units	S (T) %	S (SO_4) %	CO_3-NP kg $CaCO_3$ eq/tonne	NP kg $CaCO_3$ eq/tonne	MPA kg $CaCO_3$ eq/tonne	NNP kg $CaCO_3$ eq/tonne	NP/MPA	CO_3 - NP/MPA
Misery Granite	Average	8.9	0.03	0.0	5	11	1	10	19	7.7
	Max	10.1	0.42	0.0	9	331	13	323	496	29
	Min	6.5	0.01	0.0	5	2	0.3	3	1.5	1.1
	Count	308	308	14	10	280	308	280	280	10
Fox Granite	Average	9.1	0.04	-	-	19	1.2	18	23	-
	Max	10.0	0.29	-	-	217	9.1	213	102	-
	Min	7.5	0.01	-	-	5.0	0.3	5	1.5	-
	Count	397	394	0	0	397	376	397	397	0
Fox Waste Kimberlite	Average	8.2	0.35	0.0	62	262	11	251	29	7.7
	Max	8.8	1.62	0.3	258	334	51	329	71	28
	Min	7.1	0.14	0.0	30	73	4.4	62	4.0	2.4
	Count	138	138	129	138	138	138	138	138	40
Coarse Kimberlite Rejects	Average	8.2	0.35	0.03	53	237	11	226	26	5.1
	Max	9.0	0.61	0.12	95	337	19	324	100	11
	Min	7.4	0.10	0.01	20	78	3.1	70	4.8	2.3
	Count	104	104	90	90	104	104	104	104	90

Note: All results reported as 'below detection' were replaced with detection limit values for the calculation of summary statistics.
'NP': neutralization potential as determined by the standard Sobek method.
'MPA': maximum potential acidity (calculated from S(T)).
'NNP': net neutralization potential.
'CO3-NP': carbonate neutralization potential.
'-': indicates parameter not measured.

- o Diabase contains sulphide concentrations between granite and metasediments and due to its competent nature is not expected to generate acid. It is also volumetrically a small unit.
- o Kimberlite contains comparable or slightly higher sulphur concentrations to metasediments but abundant neutralization potential is present. Kimberlite is not potentially acid generating.

5.4.4.7 Waste Rock Water Quality Trends

The main potential source of chemical loading from WRSA is runoff during late freshet as a result of seasonal melting of surface snow and ice. In addition, there is a small amount of melting within the active layer during the summer. As described above, WRSA have been constructed so that the active layer is composed of granite. In addition, toe berms have been constructed around areas of the waste rock that might discharge to the receiving environment. Not withstanding this control measure, a component of this water runs off the piles and mixes with natural tundra runoff. Most of such drainage however currently reports to approved containment facilities.

Waste rock leachate quality is dependent on the actual minerals present and mechanisms by which the minerals break down chemically (decompose) to release metal ions to solution. Since weathering processes occurring now are expected to continue and slowly diminish into the future, current drainage chemistry can be used to predict long-term water quality. Seepage chemistry data collected as part of the seepage monitoring program are reported annually in *Waste Rock Area Seepage and Waste Rock Survey Reports* (SRK 2001, 2002, 2003d, 2004, 2005, 2006b). More recently, annual seepage monitoring data collected since start of operations was summarized in the *Geochemical Characterization and Metal Leaching (ML) Management Plan* (SRK 2006a) and used to make predictions of long-term seepage chemistry from each of the WRSA.

Table 5.4-8 provides a summary of these long-term seepage chemistry predictions for key parameters at the Panda/Koala/Beartooth WRSA and CRSA, and the Fox and Misery WRSA. Median concentrations provide an indication of typical values that can be expected for long-term drainage chemistry. The 95th percentile concentrations and 5th percentile pH values represent upper bound predictions because locally elevated concentrations have been observed. Observed dissolved aqueous elemental concentrations are presented to remove the variable influence of suspended solids on elemental concentrations.

The range of observed seepage water quality has been generally stable over the period of operational monitoring, with seasonal and year-over-year variability and localized areas with minor elevations. The following subsections provide a summary of the long-term seepage quality that is expected from each of the waste rock storage areas, as described in the *Geochemical Characterization and Metal Leaching (ML) Management Plan* (SRK 2006a).

Once the saturated core has reached its maximum elevation in the WRSA, runoff will flow through the active layer and ultimately out of the pile. However, prior to developing a fully saturated core, multiple freshet and storm events will flush water through the active layer and into the lower portions of the pile where it will freeze. No deleterious material is expected to be in the active layer once the saturated core reaches its maximum elevation.

<u>Panda/Koala/Beartooth WRSA Water Quality Predictions</u>

The monitoring results for the Panda/Koala/Beartooth WRSA indicate that runoff from the predominantly granitic waste rock can be expected to have similar chemistry as naturally acidic tundra water, indicating that the weathering of waste rock materials from this WRSA have not caused considerable changes to the water chemistry. The exceptions are primarily those elements associated with granitic alumino-silicate minerals (calcium, magnesium, manganese, sodium and potassium) and kimberlite (magnesium and nickel). Other exceptions occur where kimberlite and waste rock is leached by contact with the acidic tundra soils (SRK 2003d), such as those described in Section 5.4.3.3.

Table 5.4-8. Summary of Operational WRSA Seepage Monitoring Water Quality

		Panda/ Koala/Beartooth Area				Misery Area		Fox Area	
		WRSA		CKRSA		WRSA		WRSA	
Parameter	Unit	Median	P95	Median	P95	Median	P95	Median	P95
Field pH	s.u.	5.7	4.1	6.3	3.9	5.9	4.9	5.8	4.3
TSS	mg/L	5.0	69.4	7.0	38.0	6.4	77.8	5.4	109
Alkalinity (HCO_3)	mg $CaCO_3$/L	5	36	20	201	10	65	5	12
SO_4	mg/L	34	657	387	4240	24	237	2.3	12.1
Ammonia-N (NH_4)	mg/L	0.2	14.0	1.2	22.7	2.41	25.0	0.027	0.803
Dissolved Metals									
Al	mg/L	0.24	3.29	0.09	6.46	0.20	0.81	0.17	0.45
As	mg/L	0.0004	0.0021	0.0010	0.0047	0.0011	0.0057	0.0004	0.0013
Cd	mg/L	0.00010	0.00129	0.00040	0.00239	0.00010	0.00060	0.00010	0.00011
Ca	mg/L	12.1	112	90	353	7.50	78.6	1.73	6.81
Cr	mg/L	0.0005	0.0040	0.0006	0.0049	0.0007	0.0026	0.0005	0.0014
Co	mg/L	0.0035	0.0698	0.0058	0.0540	0.0084	0.0360	0.0004	0.0027
Cu	mg/L	0.0034	0.0130	0.0034	0.0115	0.0038	0.0095	0.0034	0.0076
Fe	mg/L	0.13	3.36	0.08	9.44	0.41	2.64	0.18	0.83
Pb	mg/L	0.00010	0.00051	0.00010	0.00117	0.00020	0.00169	0.00010	0.00020
Mg	mg/L	7.1	66.2	76	835	6.8	70.9	0.95	4.08
Mn	mg/L	0.128	1.64	0.343	1.15	0.125	1.23	0.008	0.055
Mo	mg/L	0.0001	0.023	0.03	1.05	0.0012	0.0275	0.00020	0.00160
Ni	mg/L	0.006	0.747	0.049	0.374	0.012	0.182	0.0016	0.0044
K	mg/L	3.3	30.1	18.6	104	5.8	23.5	2.0	4.5
Si	mg/L	3.0	4.1	3.4	6.8	1.7	5.0	0.9	3.1
Na	mg/L	3.8	30.2	16.3	49.0	8.9	34.1	2.0	5.4
Zn	mg/L	0.011	0.227	0.014	0.075	0.012	0.068	0.0040	0.0158

P95 = 95th percentile (for pH, the 5th percentile value is reported rather than the 95th percentile to show the low pH values that could be expected).
WRSA = Waste Rock Storage Area.
CKRSA = Coarse Kimberlite Reject Storage Area

The 5th percentile pH value of 4.1 and 95th percentile metals concentrations show that at some point in the past, weathering of materials in the Panda/Koala/Beartooth WRSA have produced low pH drainage resembling ARD (though not produced by ARD processes; see Section 5.4.3.3) which, in addition to the elevated parameters listed above, also contained elevated concentrations of aluminum, cadmium, cobalt, copper, iron, molybdenum, and total suspended solids (TSS). These values reflect monitoring locations such as SEEP-18 where seepage chemistry is atypical and possibly reflects the presence of larger quantities of waste kimberlite placed in the WRSA, some of which may be in contact with the naturally acidic tundra. However, this is not expected to be an issue for future drainage as measures have been taken to rectify the problem (encapsulation with granite within frozen portions of the pile) and because seepage chemistry would be expected to improve as sulphide minerals from material in the active layer are depleted rapidly, and neutralizing silicate weathering products decompose gradually.

Coarse Rejects Storage Area Water Quality Predictions

Compared to reference stations, typical drainage from the CRSA is expected to have a field pH of approximately 6.3 and contain elevated concentrations (*i.e.,* greater than 95th percentile concentrations from reference stations) of sulphate, alkalinity, ammonia, calcium, magnesium, manganese, molybdenum, nickel, potassium, and sodium, and slightly elevated concentrations of cadmium, cobalt, and zinc. In addition to these parameters, the 95th percentile metal concentrations and 5th percentile pH values indicate that the CRSA could have low pH drainage (5th percentile field pH of 3.9) which would also have elevated concentrations of TSS, aluminum, copper, iron, silica, and slightly elevated arsenic, chromium, and lead concentrations.

Fox WRSA Water Quality Predictions

Median values for field pH (5.8) and all other parameters indicate that long-term concentrations are expected to be within the range of baseline concentrations observed in the Fox area. As an upper bound prediction of water quality, the 95th percentile metal concentrations and 5th percentile pH values indicate that the Fox WRSA could produce drainage with field pH levels as low as 4.3 and, relative to baseline concentrations, could contain elevated concentrations of TSS, sulphate, ammonia, calcium, potassium, magnesium, and sodium, and slightly elevated concentrations of cobalt, copper, manganese, molybdenum, nickel, and zinc. However, these 95th percentile concentrations are considerably lower than drainage from the Panda/Koala/Beartooth and Misery WRSA, and are not considered to be an issue.

Misery WRSA Water Quality Predictions

Compared to reference area values, median seepage concentrations show that long-term drainage from the Misery WRSA is generally expected to have a slightly low pH of 5.9, typical of tundra drainage. It is also expected to contain elevated (*i.e.,* greater than 95th percentile concentrations from reference stations) concentrations of sulphate, ammonia, calcium, magnesium, manganese, potassium, and sodium, and slightly elevated concentrations of alkalinity, cobalt, molybdenum, nickel, and zinc. Although elevated relative to natural tundra water, these expected concentrations do not exceed limits set by the Water Licence, except for ammonia.

The 5th percentile pH and 95th percentile metal values indicate that the Misery WRSA could produce drainage with pH as low as 4.9 and could contain elevated concentrations of TSS, aluminum, and iron, and slightly elevated concentrations of arsenic, cadmium, copper, and lead in addition to the elevated parameters listed for median values.

Although Misery metasediments have produced acid in the laboratory, it is anticipated that the Misery WRSA will not produce ARD because the waste of potential concern (*i.e.,* metasediments) was managed to minimize this potential. The existing seepage chemistry in the Misery WRSA is believed to be a good indicator of long-term seepage chemistry. In fact, seepage chemistry would be expected to improve as sulphide minerals from material in the active layer are depleted, and silicate minerals weather very gradually. Furthermore, layering of potentially acid generating (PAG) metasediments within the permanently frozen portions of the pile, as per the Waste Rock and Ore Storage Management Plan (BHP Billiton 2000b), will slow down the oxidation of sulphides contained in these materials.

5.4.5 Final Landscape at Closure

The WRSA were all constructed based on the original approved plans, which stated that they would remain as permanent structures after mining was completed. Permafrost growth and super-cooling has been incorporated in the design to mitigate against water infiltration and the low potential for the filtrate to move into the receiving environment. Placement of materials follows this design and the overall profile ensures the cooling process is maintained.

During operations, it has been noted that the flat shape of Panda/Koala/Beartooth WRSA ensures that snow blows clear from the top of the rock pile whereas the rounded temporary stockpiles cause snow build up on the top of the WRSA. To ensure maintenance and continued aggradation of permafrost in the piles, the top surface of all WRSA will be kept flat with little topographic feature and all temporary stockpiles will be removed. This will prevent snow build up and potential for insulation of the pile, which may retard permafrost development. The aim of closure is to maintain the permafrost status quo whereby the WRSA is at a colder temperature than the surrounding natural tundra. These design features are the primary reasons for selection of the preferred closure options for the WRSA.

The following summarizes the closure measures and final landscape proposed in this document for the WRSA:

- The profile of WRSA will remain as a stepped profile with coarse fragmentation on the lower embankments to maintain permafrost. The overall slope angle will be 23 to 25º, although individual benches will be at 35º (angle of repose). The current WRSA configuration is expected to remain stable long-term, without flattening the benched slopes or completing other remedial work. Several factors contribute to the long-term stability:
  - the topography is very flat;
  - foundation characteristics are good, including rock with shallow overburden with permafrost and a shallow active layer;
  - the WRSA are relatively low (50 m maximum);
  - the WRSA are constructed in shallow lifts (15 m);
  - the majority of the waste rock is very competent and does not weather and breakdown; and
  - the overall dump face angle is very shallow (23 º from bottom toe to highest crest). This influences global stability more so than localized bench slope angles.
- Quarry sites within WRSA (granite for construction or reclamation) will be re-contoured to allow water runoff and permafrost maintenance.
- Stockpiles will be removed and free-dump piles graded on the tops of WRSA to encourage the snow to blow clear during the winter months. This will reduce available melt water in the spring for filtration and remove the ‘blanketing’ effect of deep snow on air circulation. These measures will aid the maintenance of permafrost and reduce the seepage through WRSA.

- Materials which have been identified as having a potential to provide an adverse impact on the receiving environment will be covered by granite to a thickness necessary to ensure the material is within the permafrost zone. This is estimated to be a minimum of 5 m cap thickness. Areas currently expected to require a granite cap include schistose rock types, waste kimberlite storage areas, Landfarm, Zone S, CSCF, CRSA and landfill locations.
- Topsoil, and lake bottom sediment/glacial till storage materials will be used for reclamation (where possible) and any remaining material will be stabilized to prevent erosion with the use of plants or a skin of granite and contoured into the local topography.
- Access ramps will be constructed to permit access and egress from the WRSA by wildlife and people. The final locations of the ramps will be determined at closure depending upon the final profile of the WRSA. The locations and design are to be defined based on consultation with local communities and their understanding of caribou migration pathways and observations made local to the site prior to and during operations.
- Seepage from the WRSA will be negligible and will be monitored for signs of adverse trends in seepage quality for a period after closure.
- Hydrocarbon storage sites will have been removed or remediated prior to closure.
- The amount of material remaining in the Landfarm at closure cannot be accurately estimated at this time, as it will be based on size of releases, success of treatment, and removal rates of clean material following treatment. Material that is successfully treated to the Government of Northwest Territories Industrial remediation criteria will either be used for site remediation work or placed in the WRSA.
- Liners associated with the Landfarm will be left in place. The Landfarm, landfills and the CSCF will each be capped with 5 m of waste rock so that permafrost can eventually move into the capped area. The area will remain part of the WRSA, and the 5 m granite cover will provide the insulation required to keep these areas out of the active zone. Permafrost aggradation remains the primary long-term means of storage at the landfarm.

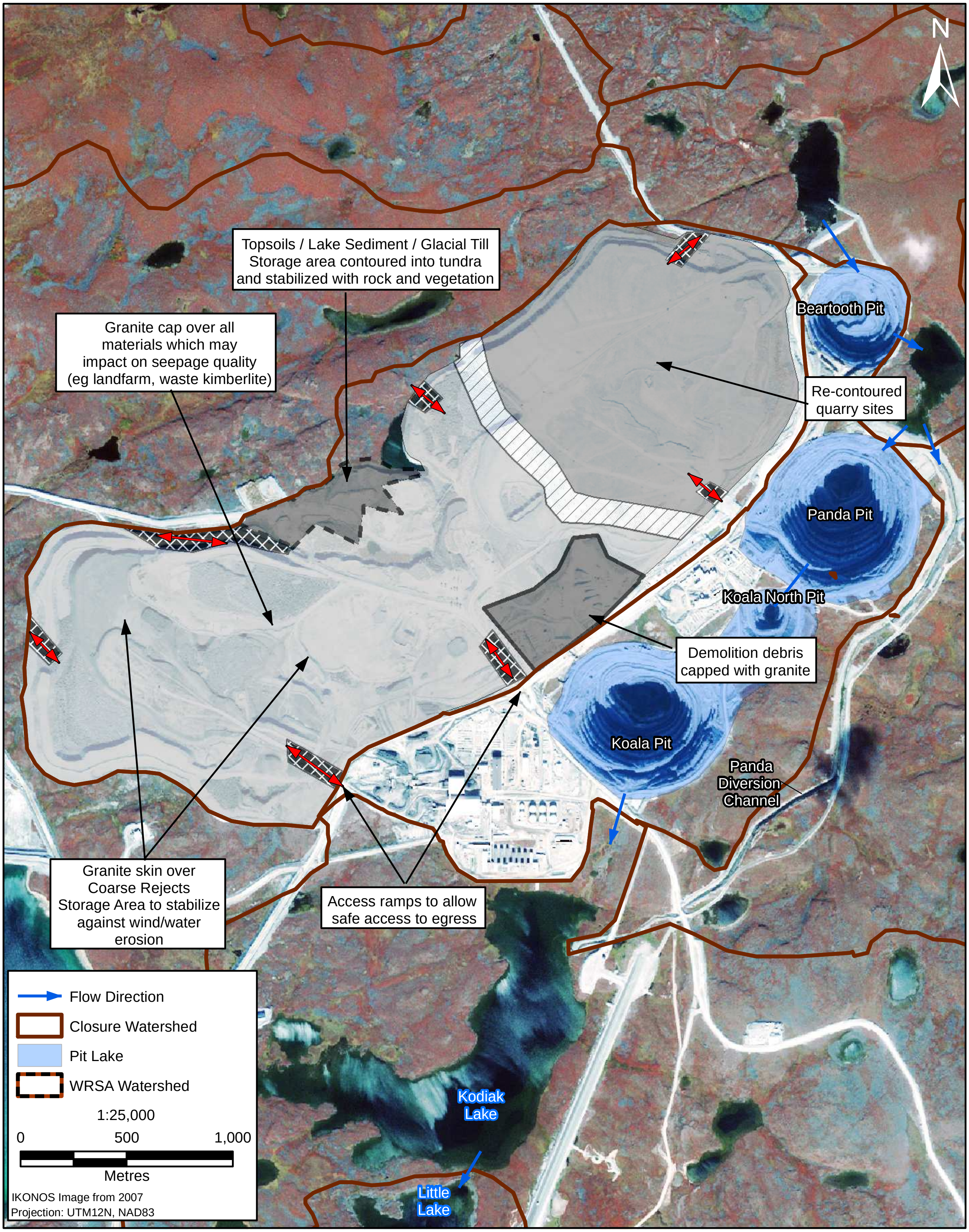
No active re-vegetation of the WRSA will be conducted. Natural colonization will most likely come from lichen colonization, but this will take many years given the spatial extent of the pile and the distance for colonizers to travel, as well as a lack of suitable soil properties and short Arctic growing seasons. Caribou may gain access to the WRSA and use these areas for relief from insects, and therefore safe access on and off of the WRSA will be provided through the access ramps. The final elevation of the WRSA will be a maximum of 50 m above the highest point of ground that the piles are placed on. This limit was set by BHP Billiton as a safety height for local air traffic, and also to ensure that the profiles of the storage piles remain close to the ground and the tundra landscape.

The expected aerial views of the Panda/Koala/Beartooth, Fox, Misery and WRSA at closure are shown in Figures 5.4-15, 5.4-16 and 5.4-17, respectively. The access ramp locations are indicative only and final positioning will require input from TK to ensure they meet caribou migratory pathways.

5.4.5.1 Designing for Closure

Examples of designing for closure for the waste rock storage areas include:

- Overall slope angles designed for stability – confirmed by no significant instability observed to date. Examples include the Panda/Koala/Beartooth WRSA, Misery WRSA and Fox WRSA.



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Panda/Koala/Beartooth WRSA: Projected Landscape at Closure

FIGURE 5.4-15

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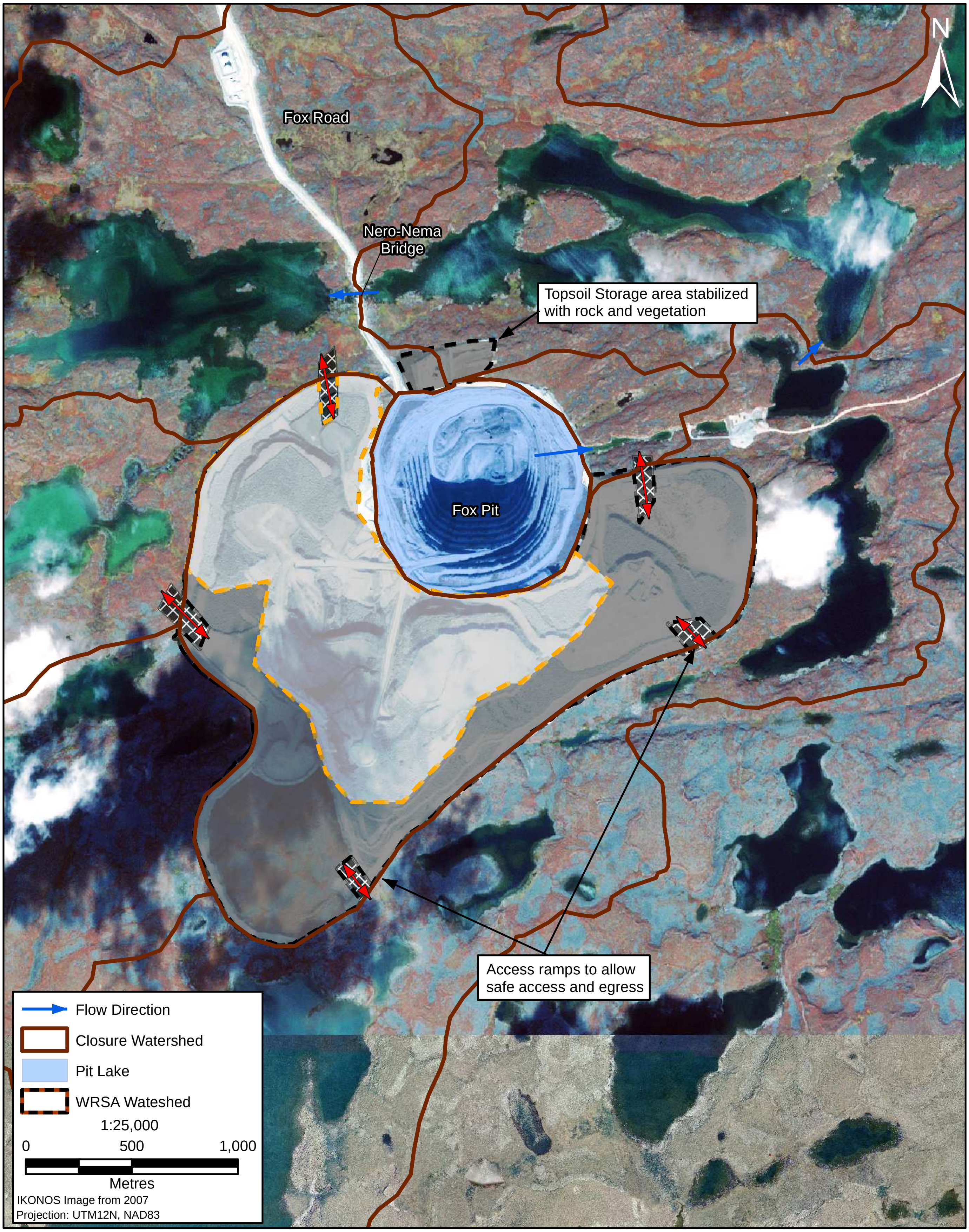
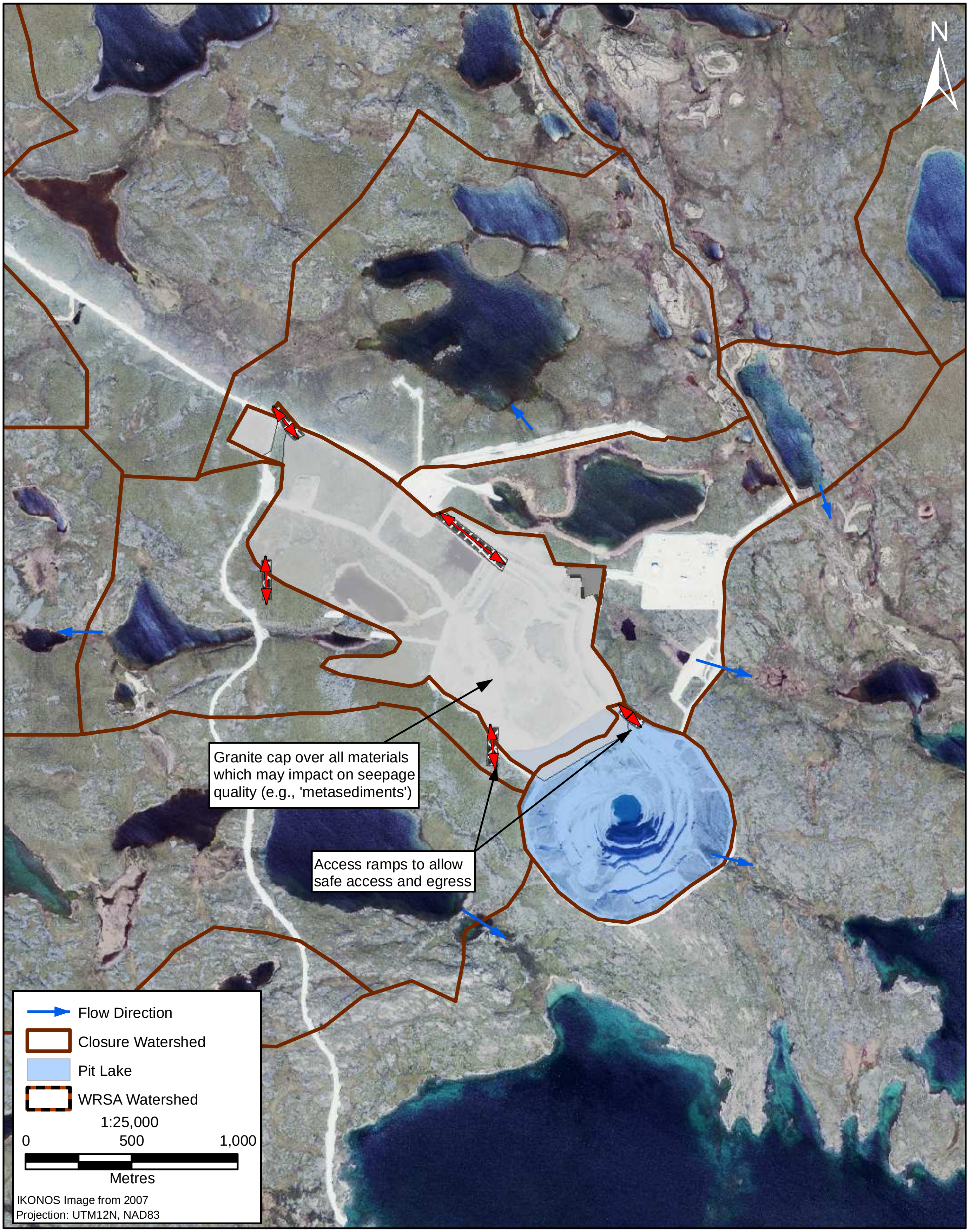


FIGURE 5.4-16

Fox WRSA: Projected Landscape at Closure



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Misery WRSA: Projected Landscape at Closure

FIGURE 5.4-17

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- Consideration of natural drainage patterns to mitigate against any potential for poor quality water to reach the receiving environment. Examples include the Panda/Koala/Beartooth WRSA, where a blanket is in place at the CRSA for future placement of coarse rejects; the Misery WRSA, where water quality is monitored in areas specifically constructed to collect any water flow (i.e., Waste Rock Dam); and the Fox WRSA where all waste kimberlite is located on the inside of the Fox Lake watershed to ensure any seepage from this material is collected in the pit where it can be monitored.
- Construction of a blanket of coarse waste rock on the tundra prior to construction of the WRSA to provide a reservoir of pore space for any surface water infiltration and encourage early aggradation of permafrost into the base of the waste rock. Examples include the Panda/Koala/Beartooth WRSA where in the area of the CRSA the blanket for the future placement of coarse rejects is in place; the Misery WRSA where a blanket of granite was put in place prior to any potentially reactive rock being added to the rock pile; and the Fox WRSA where a blanket of granite was placed beneath the waste kimberlite storage and stockpile areas.
- Encapsulating potentially reactive materials by granite so that the reactive materials remain permanently in sub-freezing conditions. Examples include the Panda/Koala/Beartooth WRSA where all potentially reactive materials have been placed in the central area of the rock pile; the Misery WRSA where all metasediments were layered and encapsulated with granite; and the Fox WRSA where encapsulation of the waste kimberlite and the low grade stockpile is underway and will be continued as mining progresses.
- Toe berm construction in areas identified as a location for potential seeps based on pre-existing drainage patterns. An example is the Fox WRSA where toe berms were included as an integral part of the WRSA design and construction. They were constructed in all areas identified as at high risk (i.e., existing drainage patterns) and also some where the risk was considered low (higher ground). Also, toe berms are incorporated into the design of the (future) Sable WRSA.
- Use of coarse rock layers and maintenance of coarse rock perimeters to ensure well-ventilated conditions occur in the waste rock to encourage natural convective cooling, which maintains internal sub-freezing temperatures. Examples include the Panda/Koala/Beartooth WRSA where coarse rock profiles have been maintained around the perimeter; the Misery WRSA where coarse rock has been used around the perimeter and layers of coarser granite have been used to encourage ventilation throughout the rock pile; and the Fox WRSA where coarse rock profiles have been maintained around the perimeter.
- Placement of rock with low reactivity (granite) in zones expected to be subject to seasonal thawing. An example is Misery WRSA where at temporary shutdown the final capping with granite ensured that granite was the rock type in the seasonal thawing zone in the long term.
- Incorporation of setbacks from receiving water bodies as a mitigation measure to allow for attenuation of drainage by tundra soils and contingency construction measures such as additional frozen toe berms and water collection structures. Examples include the Panda/Koala/Beartooth WRSA where the setback from water bodies was enforced during construction and this allowed the mitigation measure of the construction of the frozen toe berms when required; the Misery WRSA where setback from water bodies during construction is in place; and the Fox WRSA where setback distance from water bodies around the rock pile is in place.

5.4.6 Closure Objectives and Criteria

Section 1.4 describes the Reclamation Goal, Closure Objectives and Closure Criteria. Appendix 5.1-1C shows the comprehensive list of closure objectives and criteria for the WRSA mine component, with

Actions/Measurements and linkages to reclamation research, engineering studies, and closure monitoring. The closure objectives that were developed for the WRSA are:

- fugitive dust levels meet Canadian Ambient Air Quality Objectives;
- materials defined in the Waste Rock and Ore Storage Management Plan as potentially acid generating, are encapsulated;
- remove (or cut to surface) surface infrastructure (i.e., buildings, pipelines, tanks, electrical);
- waste rock side slopes are stable;
- dump height designed to appropriate elevation;
- WRSA is appropriate distance from adjacent natural lakes;
- permafrost is maintained or growing in the WRSA;
- landfill encapsulated in the WRSA;
- landfarm decommissioned and encapsulated in WRSA;
- Contaminated Snow Containment Facility is decommissioned;
- Coarse Rejects are stabilized;
- waste kimberlite areas are stabilized to prevent seepage and erosion;
- topsoil storage sites are stabilized;
- lake sediments/glacial till storage sites are stabilized;
- native vegetation used for rehabilitation work on topsoil and lake sediment/glacial till storage site;
- quarry sites within WRSA are stabilized to prevent permafrost degradation;
- removal/remediation of hydrocarbon contamination in hydrocarbon-contaminated materials management areas of the Panda/Koala/Beartooth WRSA;
- seepage discharge at the receiving environment meets water licence criteria;
- access and egress available for wildlife on WRSA;
- wildlife are using the EKATI Claim Block;
- appropriate safety control measures in place for reclamation activities associated with reclaiming WRSA;
- WRSA mine component is left in a healthy state that supports continuation of human land use activities;
- community land use expectations and TK have been considered in the closure planning;
- Transition Plan in place;
- compliance with legal, regulatory, and corporate obligations;
- appropriate documentation is maintained for closure operations of WRSA; and
- business procedures and policies in place for reclamation project development.

5.4.7 Reclamation Activities

The Contaminated Snow Containment Facility will be drained of water after testing and skimming off of hydrocarbons. The water will be placed in the LLCF and the liner will be landfilled. The skimmed oil will be placed into totes and shipped offsite.

The landfill location for demolition materials from camps, fuel farms, pipelines and other mine infrastructure has been proposed in the Panda/Koala/Beartooth WRSA in the 2000 Closure Plan, and BHP Billiton has prepared an area for this material (Figure 5.4-15). However the company is researching other possible locations for demolition landfill, such as the open pits. This engineering study is identified in Appendix 5.1-5. Only inert materials will be buried in landfills, to ensure there are no effects on long-term seepage water quality. Materials buried in landfills will be layered and capped with waste rock. A 5 m-deep cap of waste rock will be placed over the landfill to allow for permafrost to grow into the material. Other options for landfill locations under assessment include open pits and underground mines, and are included with the Engineering Studies Plan.

The specific WRSA engineering and environmental works which will be used to meet the closure objectives are presented in Tables 5.4-9 to 5.4-14.

Table 5.4-9. Sable WRSA Reclamation Activities

Description	Waste Rock Storage Area
Reclamation Method	Create smooth profile on top of WRSA, and construct access ramps.
Start Reclamation Activities	2018
End Reclamation Activities	2022
Monitoring Period	2022-2032
Engineering Works: • Construct access ramps. • Remove any remaining waste rock piles and wind rows over the top of the WRSA to provide a smooth surface. • Prepare final as-built drawing of WRSA including locations of separate lithologic units within the WRSA. **Environmental Works:** • Clean up and dispose of any debris and garbage. • Environmental assessment of the top of the WRSA following mining activities. • Conduct post closure monitoring.	

5.4.8 Residual Effects

An assessment of potential negative residual effects which may remain in the WRSA mine component after reclamation work has been completed. No minor or higher residual effects were identified. Results from the environmental assessment which include the predicted potential negative effects during the reclamation period, the contingencies in place to control effects and the predicted residual effects after reclamation work is completed are included in Table 7.3-1. Research studies to address how residual effects in the WRSA mine component can be removed have been included in the Reclamation Research Plan (Appendix 5.1-4). Post-reclamation effects that were evaluated as negligible were:

- incorrect material is buried during decommissioning;
- drainage from WRSA that effects water quality;
- long term contamination from landfarm, landfill sites;
- degradation of permafrost in WRSA; and
- incorporation of TK into reclamation planning.

Table 5.4-10. Pigeon WRSA Reclamation Activities

Description	Waste Rock Storage Area
Reclamation Method	Create smooth profile on top of WRSA, and construct access ramps.
Start Reclamation Activities	2017
End Reclamation Activities	2021
Monitoring Period	2021-2031

Engineering Works:
- Cap any remaining exposed metasediments with a 5 m cap of granite.
- Construct access ramps.
- Remove any remaining waste rock piles and wind rows over the top of the WRSA and contour to provide a smooth surface.
- Prepare final as-built drawing of WRSA including locations of separate lithologic units within the WRSA.

Environmental Works:
- Clean up and dispose of any debris and garbage.
- Environmental assessment of the top of the WRSA following mining activities.
- Conduct post closure monitoring.

Table 5.4-11. Panda/Koala/Beartooth WRSA Reclamation Activities

Description	Waste Rock Storage Area
Reclamation Method	Create smooth profile on top of WRSA, and construct access ramps.
Start Reclamation Activities	2020
End Reclamation Activities	2024
Monitoring Period	2024-2034

Engineering Works:
- Cap any remaining exposed metasediments and low grade kimberlite ore with 5 m-thick cap of granite.
- Cap all Landfill, Landfarms and CRSA with 5 m cap of granite.
- Construct access ramps.
- Contour any remaining topsoil, lake bottom sediment and glacial till storage areas.
- Remove through dozing any remaining waste rock piles and wind rows over the surface of the WRSA and contour to provide a smooth surface.
- Prepare final as-built drawing of WRSA outlining locations of deposits in the WRSA.

Environmental Works:
- Clean up and dispose of any debris and garbage.
- Environmental assessment of the top of the WRSA following mining activities.
- Remove and remediate any hydrocarbon contaminated soils.
- Conduct post closure monitoring.

Appendix 5.1-3 shows the results of a risk assessment on the preferred closure option for the WRSA mine components.

Table 5.4-12. Fox WRSA Reclamation Activities

Description	Waste Rock Storage Area
Reclamation Method	Create smooth profile on top of WRSA, and construct access ramps.
Start Reclamation Activities	2014
End Reclamation Activities	2015
Monitoring Period	2015-2025

Engineering Works:
- Cap any remaining low grade kimberlite ore with 5 m cap of granite.
- Construct access ramps.
- Contour any remaining topsoil, lake bottom sediment and glacial till storage areas.
- Remove any remaining waste rock piles and wind rows over the top of the WRSA to provide a smooth, surface.
- Prepare final as-built drawing of WRSA including locations of rock types within the WRSA.

Environmental Works:
- Clean up and dispose of any debris and garbage.
- Environmental assessment of the top of the WRSA following mining activities.
- Conduct post closure monitoring.

Table 5.4-13. Misery WRSA Reclamation Activities

Description	Waste Rock Storage Area
Reclamation Method	Create smooth profile on top of WRSA, and construct access ramps.
Start Reclamation Activities	2018
End Reclamation Activities	2021
Monitoring Period	2021-2031

Engineering Works:
- Encapsulate any remaining exposed metasediments and low grade kimberlite ore with 5 m cap of granite.
- Construct access ramps.
- Remove any remaining waste rock piles and wind rows over the top of the WRSA and contour to provide a smooth surface.
- Prepare final as-built drawing of WRSA outlining locations of rock types within the WRSA.

Environmental Works:
- Clean up and dispose of any debris and garbage.
- Environmental assessment of the top of the WRSA following mining activities.
- Conduct post closure monitoring.

Table 5.4-14. Landfill and Landfarm Reclamation Activities

Description	Landfill – storage of inert materials. Landfarm – storage of hydrocarbon contaminated materials.
Reclamation Method	Cap with waste rock
Start Reclamation Activities	2020
End Reclamation Activities	2024
Monitoring Period	2024-2034

Engineering Works:
- Cover existing operations landfills with 5 m-deep layer of waste rock.
- Cover (in layers) demolition materials at closure.
- Cover demolition materials with 5 m waste rock.

Environmental Works:
- Conduct post closure monitoring.

5.4.9 Reclamation Research

Reclamation research for the WRSA addresses uncertainties associated with the expected permafrost state and extent in WRSA at mine closure, as well as the design and location of an appropriate number of access ramps on WRSA that will allow safe use of WRSA by people and wildlife after mine closure. Research studies are also in place to determine what the long term seepage of WRSA will be post-closure, and the potential environmental effects of this seepage. Vegetation research will focus on the establishment and sustainability of plant covers on any remaining topsoil and lake sediment/glacial till stockpiles after this material has been used for reclamation of mine components. TK ideas that will assist reclamation of WRSA will also be incorporated into the reclamation research plans. The reclamation research objectives and work scope are provided in Appendix 5.1-4, and a schedule for completion of research studies is shown in Figure 5.1-4 of this appendix.

Identified reclamation research studies for the WRSA mine components include:

- permafrost growth in WRSA;
- design and location of ramps on WRSA that allows safe access and egress by people and wildlife;
- waste rock seepage and water quality;
- establishment of self-sustaining plant communities on topsoil and lake sediment storage sites;
- vegetation cover and surface stability of topsoil and lake sediment storage sites; and
- TK incorporation into reclamation planning.

5.4.10 Engineering Questions

Identified engineering questions for the WRSA mine component include:

- landfill location and volumes; and
- WRSA surface stability after quarry work.

A summary of the engineering studies identified for the WRSA mine component is presented in Appendix 5.1-5.

5.4.11 Post-Closure Monitoring

The post-closure monitoring program for the WRSA mine component proposes to use a combination of the current monitoring programs at EKATI adapted to suit specific closure needs, including to a large degree geotechnical inspections (stability and permafrost growth) and waste rock seepage monitoring. The list of indicators for monitoring effectiveness of reclamation activities and to establish that closure objectives are meet for the WRSA mine components are listed below. Details of the proposed closure monitoring program, including monitoring schedules, QA/AC protocols for monitoring and discussion on adaptive management are included in Appendix 5.1-6.

The indicators selected for monitoring of the WRSA mine components to establish when closure objectives have been met are listed below:

- fugitive dust (monitored under general site AQM);
- slope drainages and surface stability;
- percent vegetation cover;

- o surface stability at quarry sites;
- o seepage water quality;
- o wildlife movement and safety (monitored under general site WEMP);
- o safe working procedures/practices;
- o incorporation of TK into closure; and
- o operations, procedures and reporting.

5.5 PROCESSED KIMBERLITE CONTAINMENT AREAS

5.5.1 Overview

There are two PKCA for deposition of processed kimberlite at EKATI. The Phase 1 Pond was part of the original kimberlite bulk sample processing conducted at Old Camp and has not been in operation since 2002. The LLCF has been in operation since 1998 and will contain the processed kimberlite from all open pits and underground mines in the 2005 LOM Plan.

Table 5.5-1 summarizes the current and projected Processed Kimberlite Containment Area infrastructure.

Table 5.5-1. EKATI Processed Kimberlite Containment Areas and Associated Infrastructure

PKCA	Infrastructure	PKCA	Infrastructure
Phase 1	Processed Kimberlite Containment Area (kimberlite beach, pond and dam).	LLCF	Cells A, B, C, D and E Cell A North Channel Cell A South Channel Cell A East Channel East Diversion System Cell B Interior Channel Cell C Interior Channel West Diversion A Diversion Berm B West Diversion B Dikes B, C and D Outlet Dam Spillway Dam[1] East Dam[1]

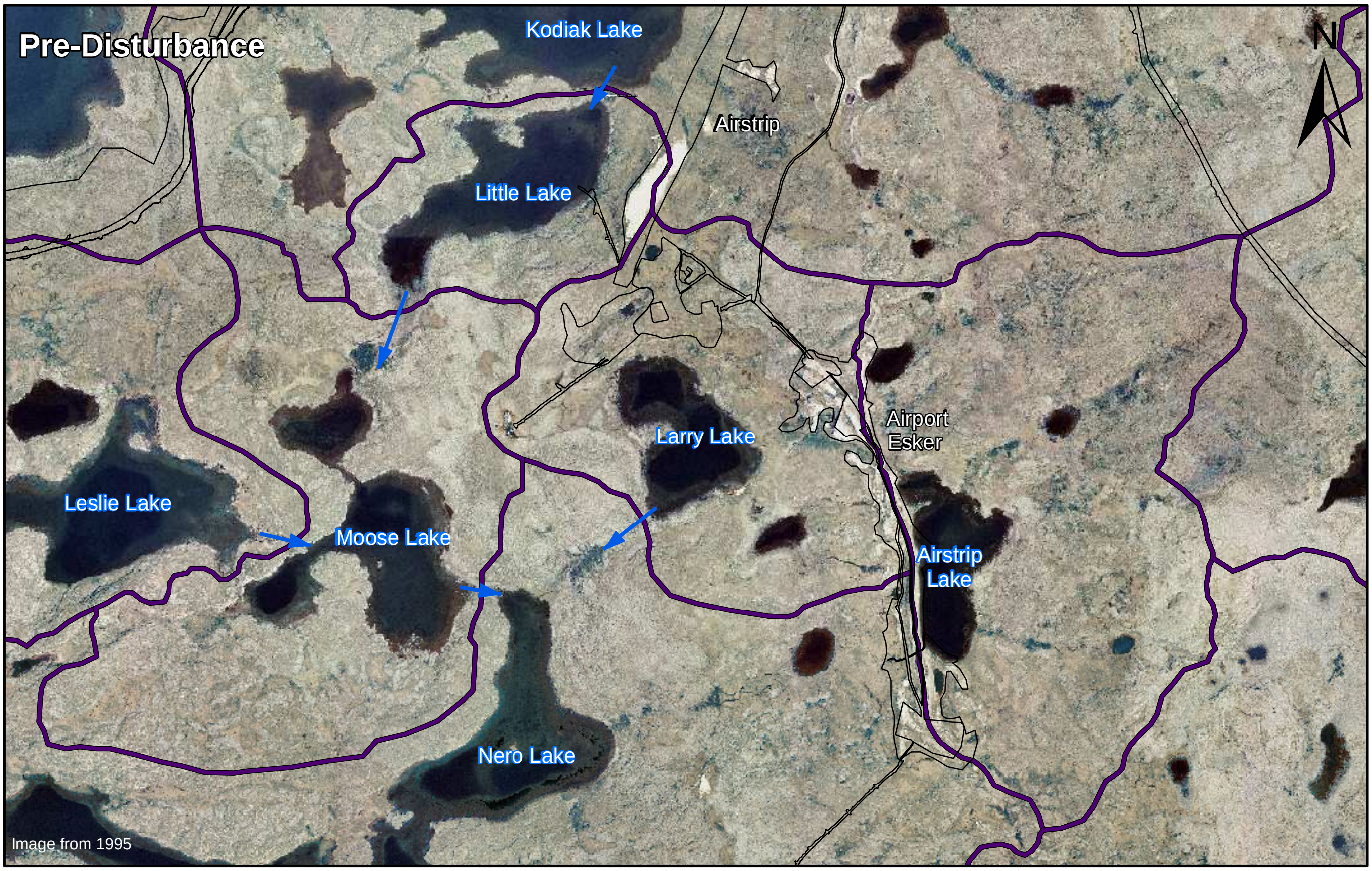
[1]. *Spillway and East Dam infrastructure undetermined at this time.*

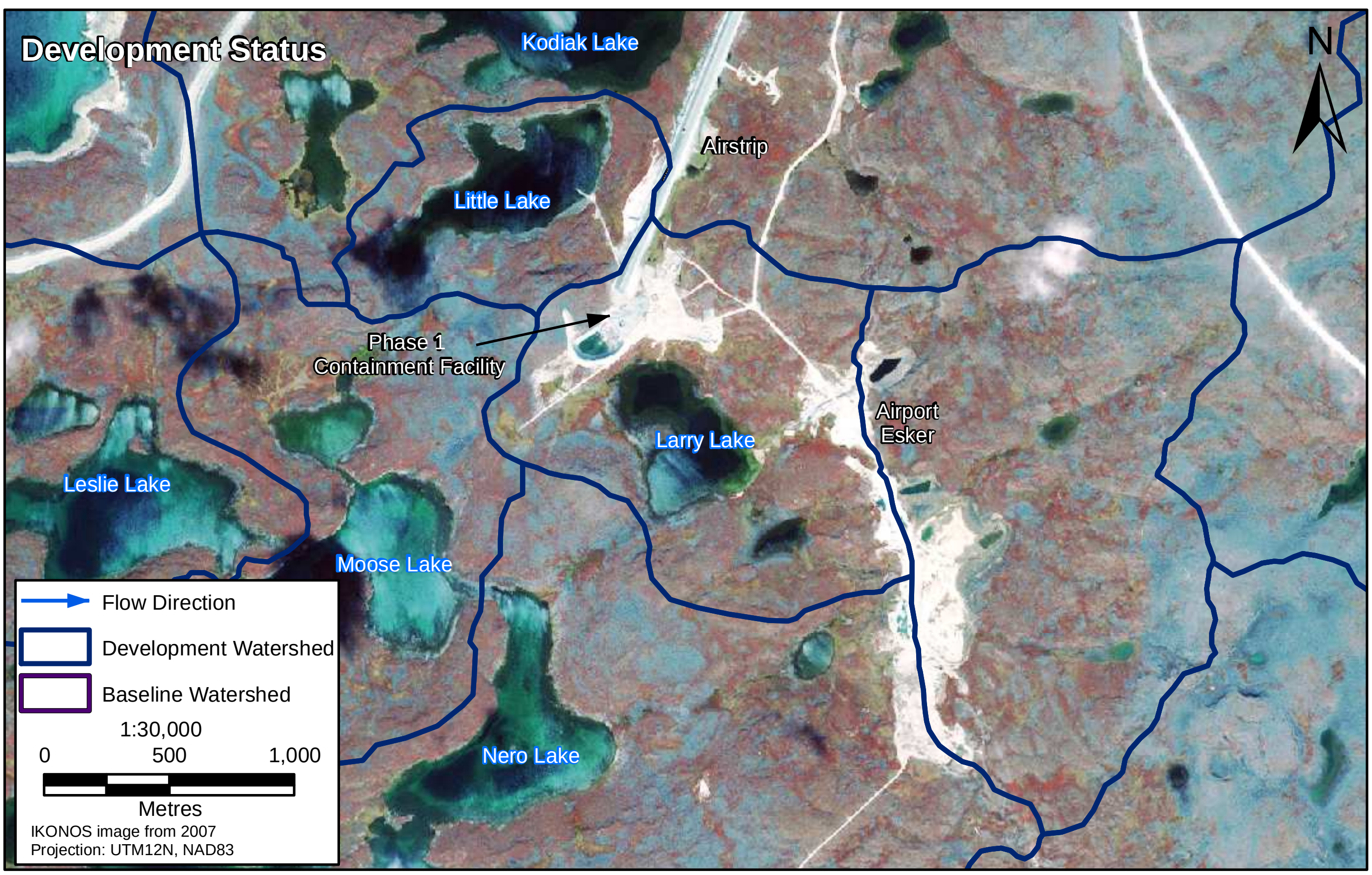
5.5.2 Pre-Disturbance Conditions

5.5.2.1 Phase 1 Containment Facility

The Phase 1 Pond is located in a natural draw, receiving surface runoff from a catchment area to the northeast of the pond. The catchment area is 18.1 ha. The natural drainage runs in a south-westerly direction, and discharges into a small lowland area flowing into Larry Lake. Organic deposits, and a shallow wetland area are located northwest of Larry Lake, just south of the Phase 1 pond.

Figure 5.5-1 shows the pre-disturbance conditions of the Phase 1 Containment Facility.





Pre-Disturbance Conditions and Development Status of the Phase 1 Containment Facility (1995 and 2007)

FIGURE 5.5-1

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5.5.2.2 Long Lake Containment Facility

The Long Lake drainage basin is at the headwater of the western Koala watershed which feeds into the Lac de Gras watershed. The LLCF encompasses Long Lake, which was a large, deep lake, and the former headwater lakes within the Long Lake drainage basin, including Nancy Lake, Brandy Lake and Willy Lake. Down gradient of the LLCF in the Koala watershed are Leslie Lake, Moose Lake, and Nero, Nema, Martine and Slipper Lakes. Prior to development of the LLCF Long Lake encompassed an area of approximately 614 ha.

Table 5.5-2 summarizes the pre-development physical characteristics of Long Lake, and Figure 5.5-2 shows the pre-development conditions as described in the 1995 EIS (BHP and Dia Met 1995).

Table 5.5-2. Physical Characteristics of the Pre-Disturbance Long Lake

Maximum Breadth (m)	Length (m)	Max Depth (m)	Mean Depth (m)	Lake Area (ha)	Watershed Area (ha)	Volume (m^3)	Average Discharge (Mm^3/Yr)
729	8,430	32	7.4	614.4	4,400	45,000,000	8.0

Source: BHP and Dia Met (1995).

The fish species found in Long Lake were lake trout, round whitefish, Arctic grayling and burbot. More information on the fish species of the lakes in the EKATI Claim Block is found in Section 3.6. Typical of most headwaters, pre-disturbance water quality in Long Lake can be characterized as soft, of low ionic strength and circum-neutral pH. Long Lake was chemically homogeneous prior to development. Since Long Lake is situated on Precambrian Shield, water runoff that accumulated in Long Lake contained few particulates or dissolved components.

Table 5.5-3 shows pre-operational water quality baseline data for Long Lake. More detailed information on the Long Lake hydrology, water quality and biological setting is found in the 1995 EIS (BHP and Dia Met 1995).

The Long Lake basin is characterised by predominant heath mat tundra ecosystem which occurs on moderately-well drained upland sites. The vegetation is typically a well developed mat of low shrubs including dwarf birch, willow and Labrador tea. Frost boil areas are typical throughout the watershed, with areas of boulders and rock slopes. In sheltered pockets along the eastern perimeter of the watershed tall shrub communities dominated by willow, have developed.

5.5.3 Development Status

5.5.3.1 Phase 1 Containment Facility

The Phase 1 Containment Facility was constructed in stages beginning in 1993. In the fall of 1993, an initial dam comprising a gravel core and a geosynthetic clay liner was built. In the winter of 1994 the dam was raised by placing additional gravel core and geosynthetic clay liner and shell material above the existing structure. In 1994, a toe berm was placed on the upstream side of the dam to minimize seepage from the facility. In August 1995, the original pond was divided into two portions following review of the required containment space. Berms were constructed to the east and north of the existing dam, forming the Phase 1 pond as it currently exists with its lined portion (south) and unlined portion (north).

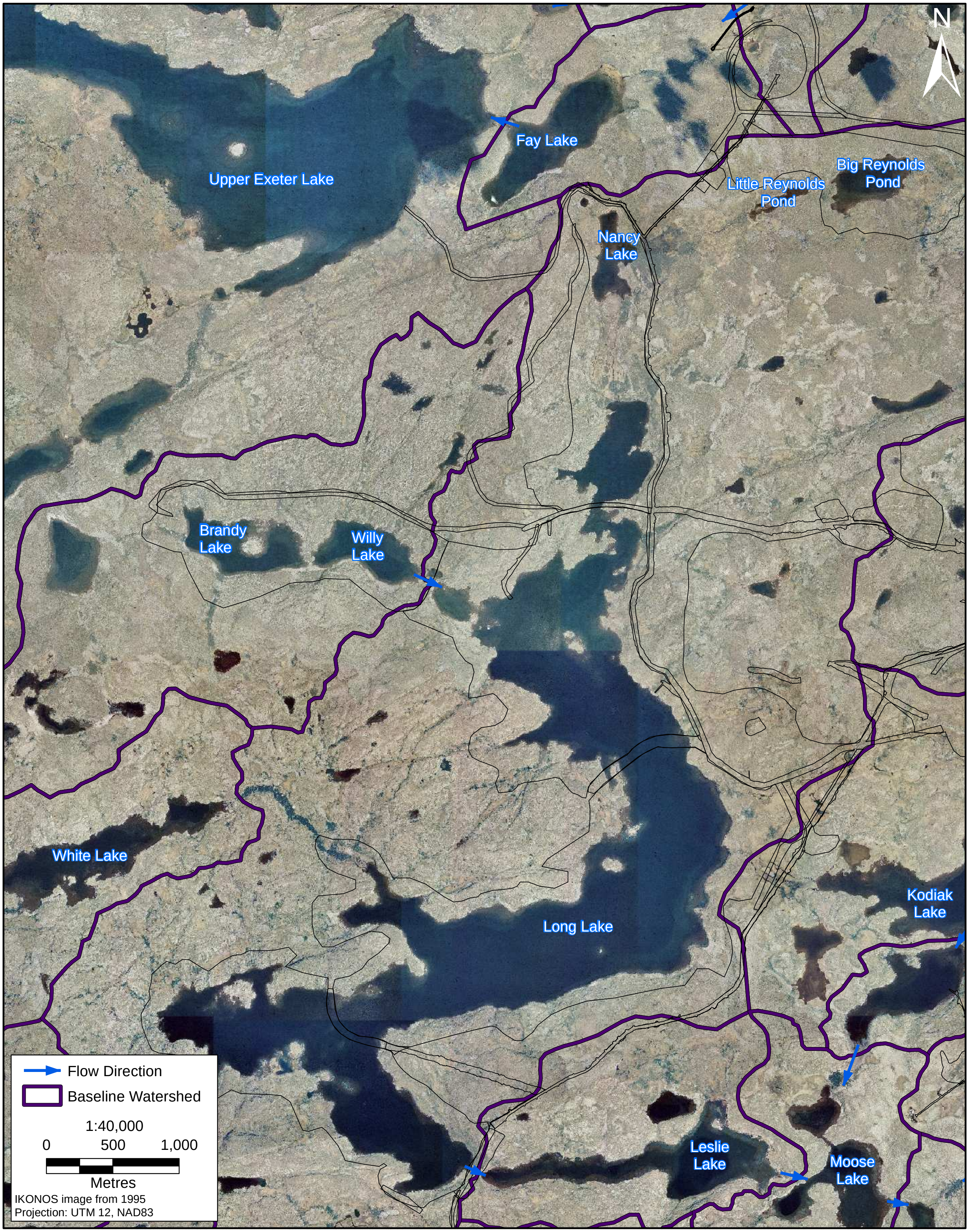

FIGURE 5.5-2

Pre-Disturbance Conditions of Long Lake (1995)

Table 5.5-3. Baseline Water Quality Long Lake Pre-Disturbance

Parameter	Concentration (mg/L)
Physical	
Alkalinity	3
Hardness	3.5
Nutrients	
Ammonia-N	0.012
Nitrite	0.00075
Nitrate	0.01
T-Phosphorous	0.003
Orthophosphate	0.0005
Total Metals	
Aluminum	0.02
Arsenic	0.0001
Barium	0.00234
Cadmium	0.000025
Calcium	0.66
Chromium	0.00025
Copper	0.001
Magnesium	0.44
Molybdenum	0.000025
Nickel	0.0004
Potassium	1.0
Sodium	1.0
Strontium	0.0053
Lead	0.0001
Zinc	0.003
Additional Ions	
Chloride	0.25
Sulphate	0.50

Bold values indicate level below analytical detection limits. These values are given as half the lowest detection limit to provide an assumed baseline.

Table 5.5-4 shows a summary of discharge water quality from the Phase 1 Tailings Containment area between 1994 and 2003. There was no active discharge after 2003.

In 1997 a high density polyethylene liner was installed above the initial liner in the Phase 1 pond. Also in that year the unlined portion of the north pond located northeast of the Phase 1 pond was filled with a mixture of lake-bottom sediment and rock. Chemical evaluation of the lake sediment can be found in ABR (1999). In 1999, this was then capped by run-of-mine waste rock.

Deposition of processed kimberlite into the pond began in 1994 and continued through to 2002. Processed kimberlite deposition in the north pond ceased in 1995. Treated sewage effluent was also deposited into the pond, concurrent with processed kimberlite deposition. Currently there is an estimated 30,000 m^3 of material contained in the Phase 1 pond. This material comprises processed kimberlite, treated sewage effluent and till toe berms. Due to its close proximity to the airstrip, air navigational landing lights are located in and around the Phase 1 Pond.

Table 5.5-4. Summary of Discharge Water Quality from Phase 1 Containment Area Between 1994 and 2003

	Water License			1994		1995		1997		1999	
Parameter	Units	Maximum Average Conc.	Maximum Grab Sample Conc.	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum
Total Ammonia	mg/L	2.0	4.0	0.49	0.67	0.54	0.85	0.25	0.54	0.24	0.49
Total Aluminum	mg/L	1.0	2.0	13.6	13.6	0.41	0.48	1.18	1.96	0.51	0.90
Total Arsenic	mg/L	0.5	1.0	0.0018	0.0022			0.01	0.0164	0.001	0.001
Total Copper	mg/L	0.1	0.2	0.0063	0.008			0.02	0.021	0.01	0.024
Total Nickel	mg/L	0.2	0.3	0.212	0.563			0.05	0.081	0.04	0.135
Total Suspended Solids	mg/L	25.0	50.0	21.8	273			62.67	87	15.43	34
pH		6 to 9	6 to 9	8.2	9.04	7.44	7.59	8.9	10	7.51	7.8

	Water License			2000		2001		2002		2003	
Parameter	Units	Maximum Average Conc.	Maximum Grab Sample Conc.	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum
Total Ammonia	mg/L	2.0	4.0	0.04	0.07	0.01	0.01	0.01	0.07	0.02	0.07
Total Aluminum	mg/L	1.0	2.0	1.01	3.62	0.7	0.94	0.372	0.47	0.83	2.71
Total Arsenic	mg/L	0.5	1.0	0.0005	0.0015	0.0012	0.0014	0.00083	0.0016	0.00174	0.0026
Total Copper	mg/L	0.1	0.2	0.01	0.01	0.005	0.005	0.0038	0.006	0.016	0.046
Total Nickel	mg/L	0.2	0.3	0.02	0.0234	0.02	0.0281	0.0268	0.0336	0.031	0.059
Total Suspended Solids	mg/L	25.0	50.0	20.88	64	17	22	8.67	16	41.4	117
pH		6 to 9	6 to 9	7	7.8	7.67	7.8	7.6	7.8	7.96	8.2

Above criteria outlined in EKATI's Mackenzie Valley Land and Water Board Licence
Average = average over the discharge period
Maximum = represents the highest value for each parameter over the discharge period

Figure 5.5-3 shows the current status of the Phase 1 Pond.

5.5.3.2 Long Lake Containment Facility

The LLCF comprises the basin and containment structures that are designed to contain processed kimberlite and other waste as defined by the Water Licence MV2003L2-0013. The LLCF is designed to contain the 58 Mt of fine processed kimberlite that was projected by the original NWT Diamonds Project design to be produced from the milling of 84 Mt of ore. Processed kimberlite is separated at the Process Plant and the fine fraction (less than 0.65 mm: fine sand, silt and clay) is sent to the LLCF by slurry pipeline. The LLCF currently includes the following components (Figure 5.5-4):

- ***Cells A, B, C, D and E***. Cells A, B and C currently receive and store fine processed kimberlite. Cell D may receive and store it in the future. Cell E provides water storage capacity for surplus water and acts as a polishing pond prior to discharge to the receiving environment. It will never receive processed kimberlite.
- ***Dikes B, C and D (designation corresponds to upstream cell)***. These filter dikes retain fine and extra-fine processed kimberlite solids within the upstream cell, but allow process and contact water to filter through to the downstream cell. These dikes will provide secure storage of processed kimberlite in the future.
- ***Dams***. Outlet Dam at the southern end of Cell E is a frozen-core, water retention dam that serves as the downstream water control structure. Two possible additional perimeter dams, Spillway Dam and East Dam, have been assessed and are permitted as water management contingencies, but the need for their construction remains a possibility at this time.
- ***Water Pumps***. The reclaim water barge contains pumps that return water to the processing plant. Pumps at Dike D seasonally assist transfer of the water to Cell E. Pumps in Cell E transfer water that meets licence discharge criteria to Leslie Lake. Pumps are also located at Dike C to assist with the transfer of water from Cell C to D.
- ***Access Roads***. These are located along the north side of Cell A, the west side of Cell B, and the east and south sides of Cells B, C and D. An access road extends from the plant to the Outlet Dam. A high road along the north side of Cell A is planned and permitted but has not yet been constructed.
- ***Power lines, Pipelines, Pump Stations, and Discharge Spigots***. These are on pipe beds along the access roads from the plant site, along the east and north side of Cell C, and along the north side of Cell A and the west side of Cell B.
- ***Drainage Channels, Diversion Channels and Diversion Berms***. These have been permitted but not yet constructed. The permitted structures include diversion channels A and B and berm B located on the west side of the LLCF.

<u>Processed Kimberlite Deposition</u>

Following discharge into the active disposal cell, the processed kimberlite stream segregates into coarser grained fine processed kimberlite (FPK) and extra fine processed kimberlite (EFPK) in the LLCF. The FPK settles first to form well defined sub-aerial and sub-aqueous beaches. Up to 20% of the FPK is incorporated into the fine sand beach as it advances forward. Much of the remainder is covered by selective relocation of the discharge spigots. This material accounts for 88% by mass of the processed kimberlite. The EFPK (mainly silt and clay-sized <0.1 mm particle size) that does not settle on beaches is carried to the lowest point in the active cell and into the ponds and settles as an undulating, low-density mass. EFPK constitutes 12.6% by mass and 35% by volume of the processed kimberlite in the LLCF (BHP Billiton 2007d). These estimates were based on beach topography, bathymetry conducted as part of the LLCF review in 2004, as well as cone penetrations tests conducted by EBA in 2006 (EBA 2006a). The EFPK is expected to accumulate and gradually restrict flow through the dikes.

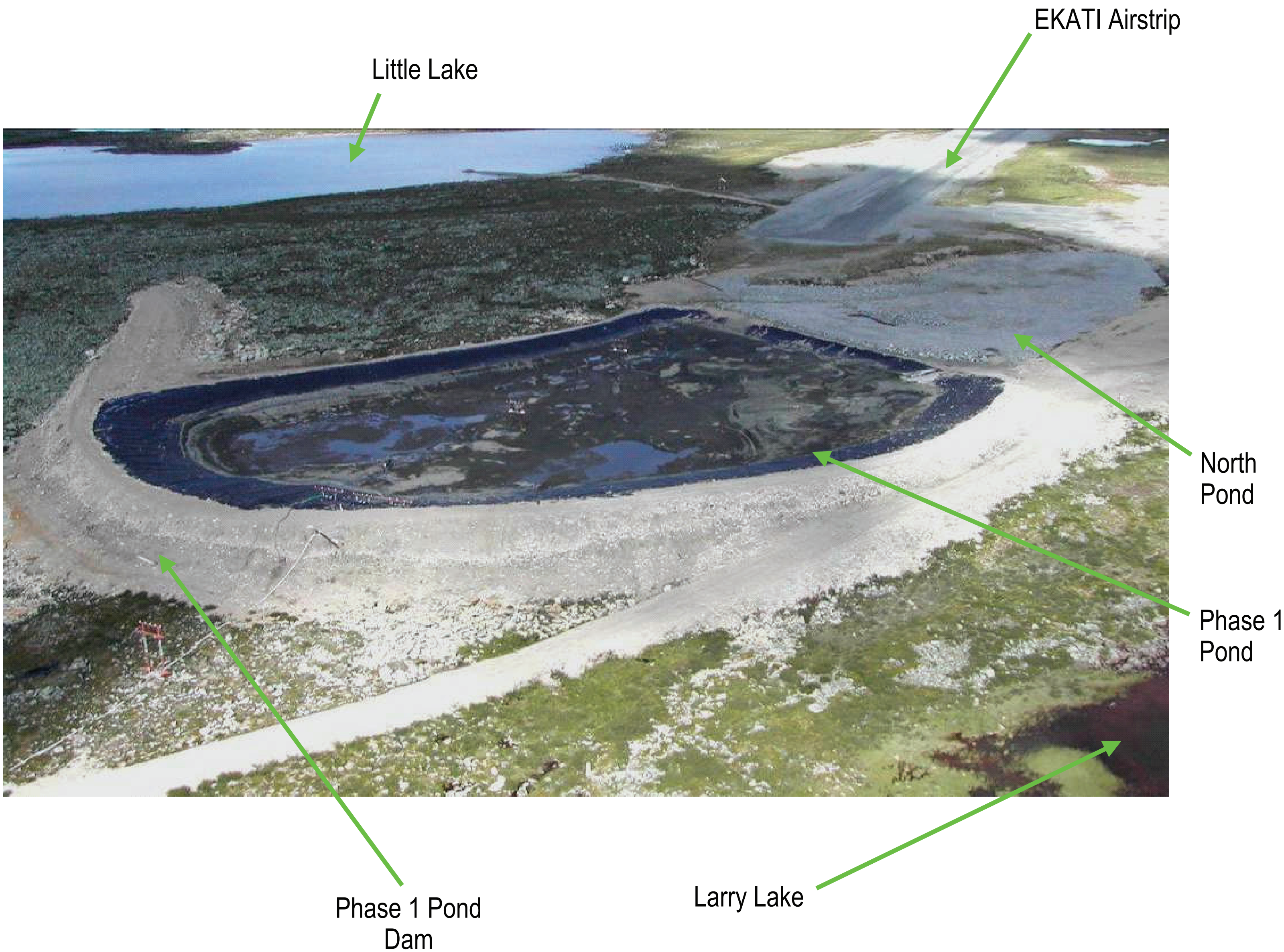

Figure 5.5-3

Current Development of Phase 1 Pond (2006)

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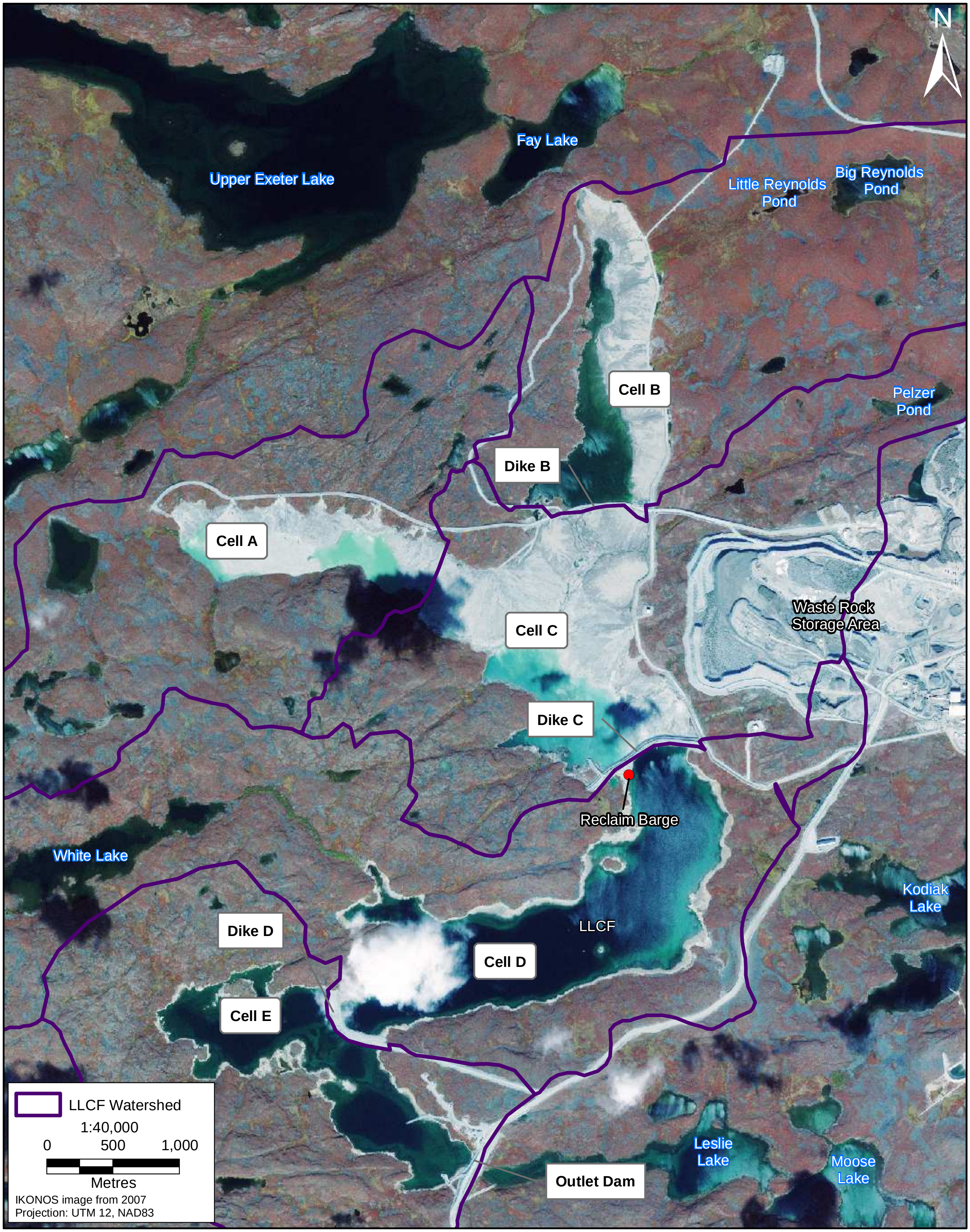


FIGURE 5.5-4

Current Development of the LLCF (2007)

To date, processed kimberlite has generally been discharged from the north side of Cell A, the east and west sides of Cell B, and the north and east sides of Cell C. No processed kimberlite has been deposited into Cells D or E. A primary objective of the operation of the LLCF is to avoid depositing processed kimberlite into Cell D for as long as practical in order to maintain water quality in Cell D.

In 2005 a Plum Line Survey was conducted on the depth of penetration of a lead plumb ball (specific gravity of 11.4) and a glycol plumb bottle (specific gravity of 1.1) to determine the distribution of the EFPK in Cells B and C, and prediction of EFPK quantities at mine closure. The survey demonstrated that the mass of EFPK has very low shear strength and behaves essentially like a ‘heavy’ liquid flowing to fill the pond zone. EFPK was found to exist in very low solids content (less than 10% solids by weight) above the elevation of the glycol plumb depth. Depths of 6 to 13 m were determined for zones of maximum depth. A second Plum Line Survey, and a LiDAR Survey to update the processed kimberlite deposition profile in the LLCF is to be completed over 2008 and 2009.

Table 5.5-5 summarizes the volume and tonnage of processed kimberlite deposited in the LLCF up to the end of 2005, and a visual representation of the current LLCF development is shown in Figure 5.5-4.

Table 5.5-5. LLCF Historic Tonnage and Volumes to the End of 2005

Parameter	Cell A	Cell B	Cell C	Cell D	Cell E	Total
Dike Crest Elevation (m)	N/A	459	454	449	458.75	N/A
Total fine processed kimberlite deposited to date (Mt)	1.58	5.70	11. 65	0	0	16.65
Portion of EFPK (at 12% by mass) to date (Mt)	0.19	0.68	1.4	0	0	2.0
Planned fine processed kimberlite deposition at the end of mine life (Mt)	18.00	19.00	13.40	7.60	0	58.00
Portion of EFPK (at 12% by mass) at end of mine life (Mt)	2.16	2.28	1.61	0.91	0	6.96

N/A = not applicable. The above quantities are based on a total reserve of 85 Mt, and a coarse processed kimberlite and fine processed kimberlite split of 30:70.

<u>LLCF Water Management</u>

During operations the outlet of Cell E is controlled by the Outlet Dam, a frozen core dam. Cell E is used as a final polishing pond where water quality can be monitored and water levels can be controlled. Water is only released to the downstream receiving environment when it meets the water quality requirements specified in the mine’s Water Licence MV2003L2-0013.

Operational water quality monitoring is conducted within the LLCF at Cell E (1616-30) and in Leslie Lake and other lakes downstream of the LLCF. Indicators measured are water quality, sediment quality, physical limnology, phytoplankton, zooplankton, and lake benthos. Details on the monitoring methods and results are found in AEMP annual reports (Rescan 2006c). Water levels in the cells are driven by the 1 m level freeboard elevations in the dikes and the Outlet Dam. The maximum freeboard elevation for Dike D is 446.5 masl, and for the Outlet Dam is 448.3 masl. Water levels are monitored weekly during the open water season with the use of staff gauges, and surveys are also taken on a regular basis in Cells D and E. Target water level elevations for Cells D (446.5 masl) and for Cell E (446.8 masl) are used to determine when pumping should occur from Cell E into Leslie Lake. Water discharge occurs only when water licence criteria are met. Monthly water levels for Cell E, summary of process water use in the LLCF, water discharge to the LLCF, discharges from the LLCF, summary of treated sewage effluents to the LLCF, and discharge water quality are reported annually in the Water Licence and Environmental Agreement Annual Reports (BHP Billiton 2007b). More detail on the operational aspects of water volumes can also be found in the Waste Water and Processed Kimberlite Management Plan (BHP Billiton 2007d).

The quality of water discharged from the LLCF is regularly monitored (weekly) and reported on (monthly) through the Surveillance Network Program (SNP). All water released from the LLCF has been in compliance with the EKATI water licence. This licence covers pH, total ammonia, aluminum, arsenic, copper and nickel concentrations, total suspended solids, total petroleum hydrocarbons and biological oxygen demand. All water released from the LLCF has been in compliance with the EKATI Water Licence (refer to BHP Billiton's *Environmental Agreement and Water Licences Annual Reports*).

Wildlife Use of the LLCF

Caribou access and travel through the LLCF as part of their seasonal migrations through the mine area. Observations are made primarily at the north end of Cell B where re-vegetation has occurred through natural colonization from the tundra, mostly since 2005. Wildlife monitoring of the LLCF is conducted through the Wildlife Effects Monitoring Program (WEMP). A total of 51 groups of caribou were observed in the LLCF from 2000 to 2006. The majority of these groups were observed to exhibit travelling behaviours (*i.e.*, walking, trotting and running) more often than feeding, bedding, or standing. Evidence from tracks and observed caribou behaviour does not suggest that the processed kimberlite inhibits caribou movement (Rescan 2007c).

The proposed establishment of a vegetation cover has lead to questions about whether the health of wildlife could be affected by exposure to metals in processed kimberlite by directly ingesting processed kimberlite or by indirectly ingesting metals that have been taken up into vegetation. Similarly, there have also been questions about whether the health of people could be affected by eating animals that could have accumulated metals from the processed kimberlite and vegetation. A wildlife and human health risk assessment of the potential risks to wildlife and human receptors exposed to metals from the LLCF was conducted in 2006 (Rescan 2006b). The objectives of the risk assessment were to identify and assess the metals which could pose a potential risk to wildlife grazing on vegetation at the LLCF, and to humans that consumed the wildlife that grazed on the LLCF. Potential risks to wildlife receptors were evaluated by comparing the estimated daily intake of the metals for each wildlife receptor to toxicity benchmark values. Caribou, grizzly bear, muskox, wolf, wolverine, hare, ptarmigan and Canada goose were evaluated with regards to their exposure to aluminum, barium, chromium, cobalt, magnesium, manganese, molybdenum, nickel, selenium and strontium at the LLCF. Caribou were evaluated under two soil ingestion scenarios: normal soil ingestion, and elevated soil ingestion. Potential impacts to humans were evaluated by comparing the estimated daily intake of each metal to toxicity reference values. All metals in the wildlife risk assessment were included in the human health risk assessment. Selected human receptors were adults (ages 20+ years old) and toddlers (6 months to 4 years old). The exposure pathway evaluated was ingestion of caribou (using both soil ingestion scenarios) and goose meat from animals that have taken up metals from the LLCF. The risk assessment indicated acceptable risks from the human consumption of Canada geese and caribou for all metals evaluated except nickel. Nickel was identified as a parameter requiring further assessment. It is likely that the concentrations in meat tissue have been over-predicted based on the assumptions made regarding the diets of caribou. These assumptions are:

- LLCF does not currently present a risk to human or wildlife receptors as there is almost no vegetation cover in this area. Because this land use scenario does not exist, several conservative assumptions had to be made in order to predict the amount of exposure that each of the receptors may receive. These assumptions included:
  - the LLCF will be suitable habitat for the selected wildlife receptors (once it is re-vegetated);

  - the receptors will have full access to the LLCF (once it is re-vegetated); and
  - the LLCF will provide adequate vegetation for the receptors daily dietary requirements *(i.e.,* all vegetation is palatable and preferred).
- Receptors will feed solely in the LLCF, ranging from 5 months to all year, with the exception of the wolf receptor where it was assumed that they would only spend a total of 8 days per year at the site.
- All metals evaluated are 100% bio-available to all wildlife and human receptors evaluated.

Additional information on the risk assessment is found in the *EKATI Wildlife and Human Health Risk Assessment* (Rescan 2006b).

5.5.4 Projected Development

5.5.4.1 Phase 1 Containment Facility

Operations in the Phase 1 pond at Old Camp were completed in 2003, and the site is now scheduled for reclamation. A number of options for reclamation and closure of the facility are currently under review by BHP Billiton, and include:

- Construction of a channel through the pond to control drainage from the upper watershed and the north pond (which is capped with waste rock), and cap the processed kimberlite with waste rock.
- Construction of a channel around the perimeter of the pond to control watershed drainage, and cap the facility with waste rock.

Closure work on the Phase 1 Pond is expected to start in 2010. A separate Final Closure Plan document will be submitted to the WLWB for the Old Camp (including Phase 1 Pond) prior to commencement of reclamation activities.

5.5.4.2 Long Lake Containment Facility (LLCF)

A 5 year review of the performance of the LLCF was undertaken by BHP Billiton in 2004 and 2005. Results from the review were incorporated into the optimized operation and development plans for the LLCF. The review included an evaluation of alternative plans for optimizing the system through a Multiple Accounts Analysis (MAA). An MAA is a framework for alternatives evaluation. It provides a forum in which stakeholders can express their concerns and communicate and defend their assessments of the positive and negative impacts of a specific alternative and subsequently compare that, or any, alternative against others. The general objective of an MAA is to provide the means by which evaluators can select the most suitable, or advantageous, alternative from a list of alternatives by weighing the relative benefits and costs of each.

The EKATI LLCF 5-Year Review Process was the first time a mining company in Canada had used such a process to involve its stakeholders in a decision process regarding its mining activities.

During the 5 year review alternative operation and development options were presented to communities and regulatory stakeholders during a series of three meetings in 2004 and early 2005. The meetings were attended by BHP Billiton staff, consultants to BHP Billiton, regulators (including INAC, Environment Canada and the Government of the Northwest Territories), and representatives from the Aboriginal community and the IEMA. As a result of the performance review, the current projected development plan for the LLCF is described as Option 3aM. The aim of this option is to delay the placement of fine processed kimberlite into Cell D for as long as possible to maintain water quality downstream.

Option 3aM involves the construction of 6.8 km of access roads that incorporate the support pads for the processed kimberlite distribution pipelines and discharge spigots for the west side of Cell B and north side of Cell A. The access road on the north slope of Cell A will be relocated upslope from its current elevation to a higher elevation (currently estimated to be about 472 m). This will provide a higher platform for the discharge spigots. This location incorporates most of the area of the catchment on the north side of the impoundment and maximizes the volume of processed kimberlite that can be placed in Cell A. The current access road at the lower elevation will be covered by the new beach that forms on the slope below the new road.

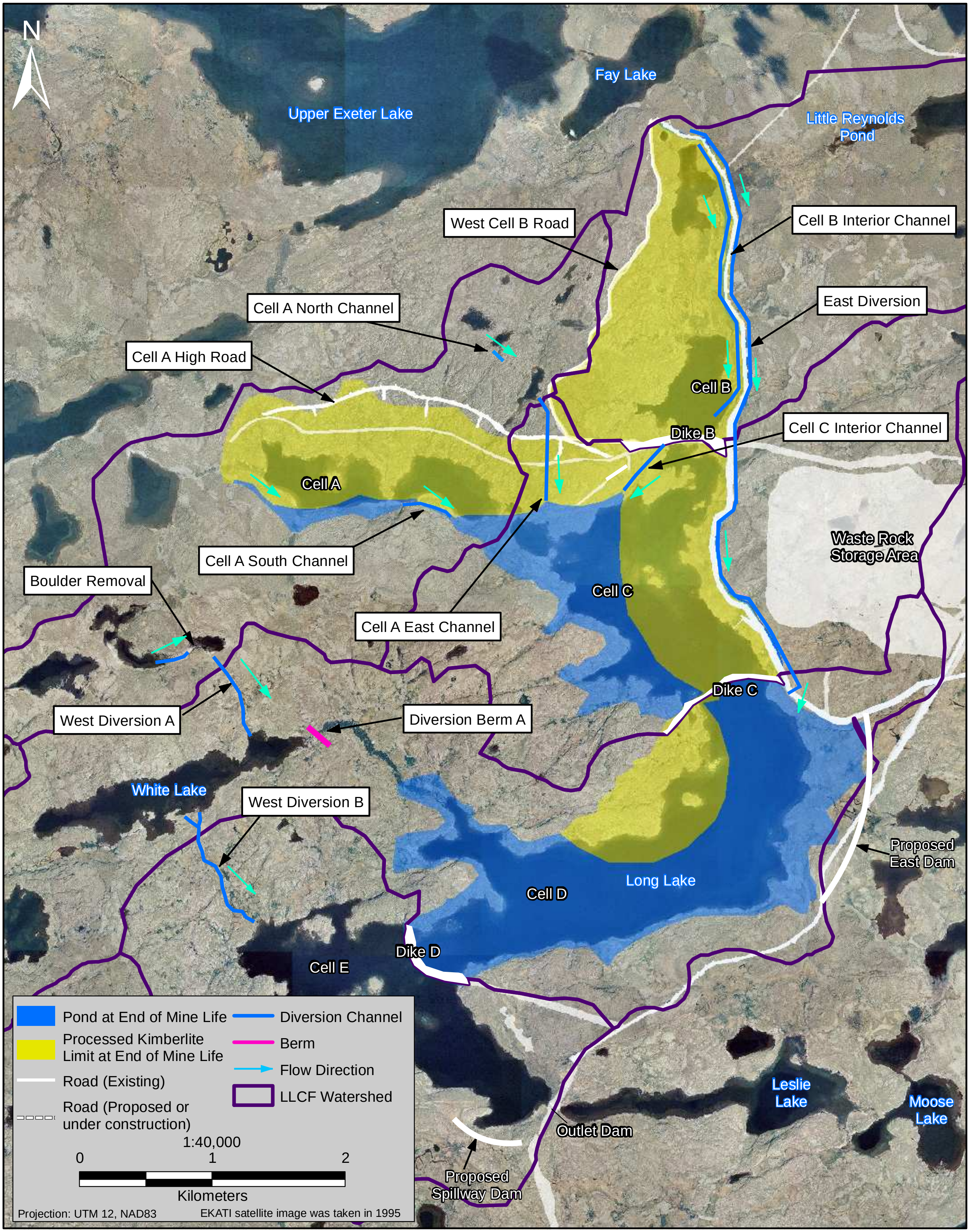
The road on the west side of Cell B was constructed in 2007. This west access road and pipeline have been designed to allow deposition into Cell B from west to east using the high ridge that bounds Cell B to elevate the spigot points. It incorporates almost all of the catchment west of Cell B and maximizes the volume of processed kimberlite that can be stored in Cell B. Distribution pipelines are located on the inside shoulder of the access roads consistent with past practice.

Spigots are used to rotate processed kimberlite deposition with valves allowing discharge to be directed from any spigot by opening or closing the appropriate valves. The purpose of rotating spigots is to provide flexibility of discharge location without major infrastructure relocation. Processed kimberlite will be discharged into the cells to a maximum height of the expected active layer (the maximum depth of processed kimberlite that is expected to thaw in the summer following deposition). This will allow summer thawing of ice lenses which may be incorporated during winter months, and ensure efficient use of the available storage capacity of the facility.

Surface Water Management

The Option 3aM deposition plan involves improvements of operational and post-closure surface drainage. This drainage system in the LLCF has been developed to a concept level and presented in Figure 5.5-5, with more detailed final landscape water management systems to be provided in future ICRP submissions. Section 5.1-2M of Appendix 5.1-2 provides preliminary designs for the LLCF channels, and dike and Outlet Dam breaches. The following described water management structures will be completed during the operations phase of the mine. Descriptions for water management are provided for each cell in the LLCF, running from north to south.

The most significant improvement is in Cell B where renewed deposition from west to east will cause surplus water to flow to the east side of Cell B where it will collect along the existing access road. An internal channel (Cell B Interior Channel) will run from north to south inside the eastern perimeter of Cell B to pick up beach surface flow from the central zone and directing it to a small pond at the southern end of the cell. Extra freshet flow from the lower end of Cell B will flow over a spillway constructed in Dike B into the north end of Cell C and through the Cell C Interior Channel into Cell C Pond. Overland tundra flow from the east of Cell B will be channelled through an East Diversion Channel running north to south along the outside and east of Cells B and C roads, and will not enter Cell B, but enter directly into the northern end of Cell D Pond. This will reduce the number of flow channels within the facility which have the potential to erode the processed kimberlite.



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Projected Development of the LLCF

FIGURE 5.5-5

Rescan

During operations processed kimberlite will be deposited from discharge points currently located on the Cell A Road which runs along the north side of the cell, and later from a newer road that will run approximately parallel with the current road but at a higher elevation. Water from a small upland catchment above Cells A and C will be redirected to a small natural pond through the Cell A North Channel, a currently dry natural channel at the north eastern end of Cell A, where it will flow into the Cell C Pond via the Cell A East Channel after the new Cell A Road is constructed. It is expected that the volume of water from this catchment will be small given that the Cell A Road will be located relatively close to the watershed divide north of Cell A. Water from the north and west of Cell A will be directed into the western end of Cell A, with flow through the Cell A South Channel into Cell C Pond. Surface water from Cell A will also collect along the southern margin of the cell and flow via the Cell A South Channel into the Cell C Pond.

Surface water from Pelzer Pond that is situated just north of the Panda/Koala/Beartooth WRSA (Figure 5.5-4) currently flows west in a well defined stream to the Dike B access road where it then flows through the rockfill in a French drain; seepage from the rockfill has cut a channel across the adjacent processed kimberlite. This stream course, as well as runoff from the Panda/Koala/Beartooth WRSA and the small area of exposed tundra between the cell and the waste rock pile, will be intercepted by the East Diversion Channel which will run along the east side of Cell C and drain into Cell D Pond.

Water diversion structures comprising some boulder removal between two small lakes, West Diversion A, West Diversion B and Diversion Berm A will be constructed in the uplands west of Cells C and D and will be completed during mine operations. The improvements will divert approximately 1 million m^3 of surface water at freshet that currently enters Cells C and D, to Cell E. These structures were assessment as part of the 1995 EIS (BHP and Dia Met 1995).

The proposed East Dam and Spillway Dams in Figure 5.5-5 are required to provide containment in Cell D if processed kimberlite deposition occurs in this cell, and if water levels rise above 449 m.

Wildlife Use of the LLCF

In the metals bioaccumulation risk assessment completed in 2006 (Rescan 2006b) reasonable conservative assumptions were made which likely overestimated the risk predictions. If the risk assessment had been found acceptable, based on the conservative assumptions, then no further evaluation would likely be required.

Because potential risks were predicted, the conservative assumptions that are considered the “drivers” of the predicted risk could be re-evaluated in the form of a Tier 2 risk assessment. However, because the land use scenario under which the 2006 risk assessment was based did not exist at the time, re-evaluating the conservative assumptions would not increase the certainty in the risk assessment. BHP Billiton plans to conduct a pilot study of the LLCF in approximately 2013. This pilot study will comprise a large unfenced area potentially at the upper end of Cell B of the LLCF. This project will proceed once processed kimberlite deposition has been completed in an appropriate area. During this pilot study, it may be possible to re-evaluate some of the assumptions in this assessment because it is likely that the pilot study will more closely represent the future-vegetated scenario. This pilot study and metals bioaccumation research has been identified in the Reclamation Research Plan.

LLCF Pilot Study

An opportunity to pilot test various reclamation activities in the LLCF will be conducted in approximately 2013 when the upper (northern) portion of Cell B will have completed processed kimberlite deposition. Opportunities for earlier research on the facility will be sought. These will be dependent on the deposition planning for the LLCF. The pilot study will be designed to include the following research activities. Each of these activities has been addressed in the Reclamation Research Plan (Appendix 5.1-4), and the Engineering Studies Plan (Appendix 5.1-5).

- ***Rock Cover Constructability Test.*** The constructability study would include testing of appropriate equipment for quarrying, hauling and placement, trafficability, dust generation and mitigation measures, and appropriate thickness covers for the Upper, Central and Water Interface Zones, and final cover design that allows safe access by people and wildlife. Results from the pilot study will be used to develop the construction plan and associated schedule for the reclamation of the facility. Appendix 5.1-5 shows more detail on the larger study of rock cover stability.
- ***Geotechnical Assessment.*** The study would assess processed kimberlite consolidation and frost heaving processes, and how these are likely to develop on the LLCF. Frost heave in the LLCF due to freeze back of the underlying processed kimberlite could cause movement in the stabilization features, leading to potential erosion or ineffective vegetation catches. The pilot study will establish monitoring points to measure movement of the stabilization components, and the information gathered will be used to develop quantifiable measurement for surface stability on the LLCF after capping, and construction of internal channels. Appendix 5.1-5 shows more detail on the larger study of processed kimberlite consolidation and frost heaving.
- ***Soil Stability Assessment.*** This study will research levels of plant cover and canopy structure needed to provide surface stability, including natural colonization by native plants. Research will also include analysis of moisture regimes and areas of soil instability where vegetation cover will be needed, as well as assessment of surface flow patterns, severity of flood events, and sensitivity of substrate to erosion. The study will also look at rates of plant establishment and growth and persistence, cover and other community characteristics over time. This research will also will include monitoring of the establishment of weeds on the LLCF. Appendix 5.1-4 shows more detail on the large study of LLCF plant establishment.
- ***Metals Bioaccumulation***. The study will address the following key assumptions made in the 2006 Risk Assessment (Rescan 2006b):
  - assesses the palatability of vegetation growing on the LLCF;
  - assess grazing/residence times by animals on the LLCF;
  - determine bioavailability of metals in plant tissue to wildlife and human receptors; and
  - update risk assessment with the above information.
- ***Grazing Impacts on Vegetation.*** The pilot study will assess caribou and hare grazing preference for the LLCF re-vegetation species. Research will involve the establishment of blocks (*e.g.*, 50 m x 100 m) of native-grass cultivars and indigenous species (as individual species and mixtures of species) and periodic monitoring of wildlife utilization. The study will address whether a self-sustainable vegetation cover can be maintained and whether this cover is capable of maintaining a stable soil surface. Research may involve the assessment of methods to control grazing during early vegetation establishment because this is the period when many young plants are vulnerable to grazing impacts. Appendix 5.1-4 shows more detail on the study of grazing impacts on vegetation.

5.5.5 Final Landscape at Closure

5.5.5.1 Phase 1 Containment Facility

Based on the current options under assessment the Phase 1 Pond processed kimberlite will be capped with granite waste rock and a channel will be in place to allow natural drainage flow either through or around the facility into Larry Lake. A number of options for reclamation and closure of the facility are currently under review by BHP Billiton, and include:

- Construction of a channel through the pond to control drainage from the upper watershed and the north pond (which is capped with waste rock), and cap the processed kimberlite with waste rock.
- Construction of a channel around the perimeter of the pond to control watershed drainage and cap the facility with waste rock.

An engineered construction plan and project budget is expected to be developed in 2009. Closure work is expected to start in 2010.

5.5.5.2 Long Lake Containment Facility

<u>Overview</u>

At completion of processed kimberlite deposition in the LLCF, the deposition area will consist of dry, sandy beaches near spigot points, with wetter, silty to fine sands near the Water Interface Zones. Small and relatively shallow ponds are expected to remain in Cells A and B and an internal drainage channel is expected to exist on the eastern side of Cell B.

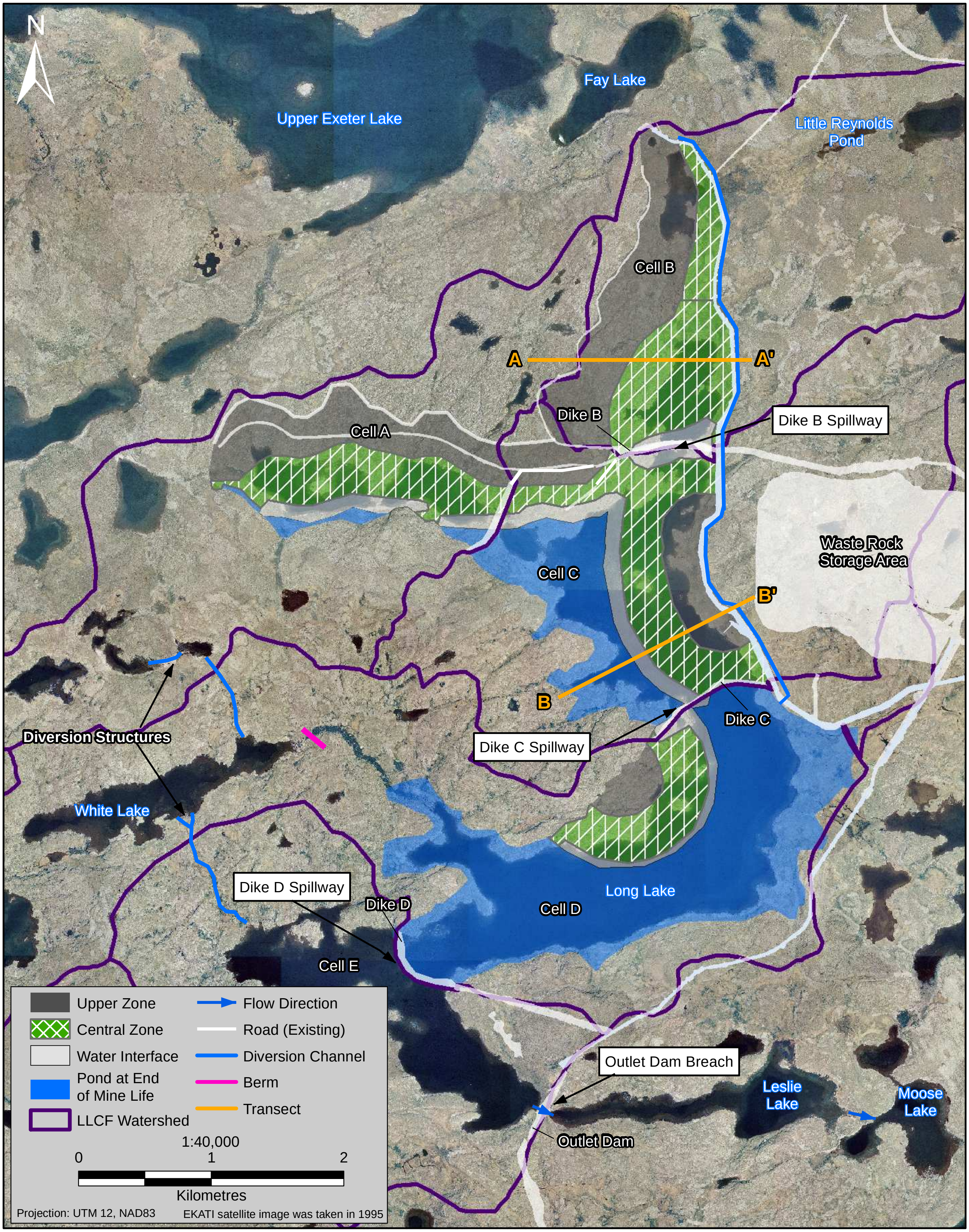
In order to address the concern of wind and water erosion, the closure plan for the LLCF will be to construct a cover over the exposed processed kimberlite to stabilize the surface. Observations on the Cell B surface at least 5 years after initial deposition indicated significant natural vegetation growth in the damper areas and good overall stability for the travel of wildlife. The selected cover is a combination of rock and vegetation. Figure 5.5-6 shows the proposed final landscape of the LLCF after the closure activities have been implemented. Two transect lines have been included in Figure 5.5-6 that are cross-sections of Cell B (Transect A) and Cell C (Transect B). These cross-sections are also shown in detail in Figures 5.1-2k and 5.1-2l of Appendix 5.1-2.

The final surface of the LLCF will be generally flat with a gentle downwards slope from the point of discharge, terminating at the opposite edge of the containment cell, or at the pond interface. Segregation of the processed kimberlite stream following discharge forms a beach-like deposit with the coarser kimberlite being deposited near the point of discharge and the finer silts and clays being carried down to the mid and lower slope position.

The physical segregation of the processed kimberlite which occurs during deposition presents challenges for re-vegetation and is the reason for dividing the surface of the LLCF cells into four zones for reclamation: an Upper Zone, a Central Zone, a Water Interface Zone and Ponds. These zones are discussed below and outlined in Figure 5.5-6.

<u>Upper Zone</u>

The Upper Zone includes the area beginning at the discharge points and extends down-gradient approximately 100 to 300 m. It has been recognized that this area will be difficult to vegetate due to the good drainage of the coarser sandy fine processed kimberlite and will be susceptible to water erosion. A cover consisting of 100% rock approximately 1.0 m thick is proposed. Construction of the rock cover in the Upper Zone will include standard rock placement techniques using large haul trucks end dumping material and a dozer spreading the material to achieve the desired thickness. The lower edge of the Upper Zone would be irregular, following the semi-circular outline of the alluvial fans resulting from processed kimberlite deposition from adjacent spigot points. The expected approximate total volume, and area of rock for each cell in this zone is provided in Table 5.5-6.



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Final Landscape of the LLCF

FIGURE 5.5-6

Rescan

Table 5.5-6. LLCF Surface Area and Volume Calculations

Areas at Mine Closure, Prior to Reclamation	Surface Area (m^2)					Design Thickness (m)	Volume (m^3)
	Cell A	Cell B	Cell C	Cell D	Total		
Exposed processed kimberlite surface	1,700,000	2,000,000	1,750,000	800,000			
Final water surface area	175,000	23,000	1,140,000	3,400,000	4,700,000		
Areas at Mine Closure, Following Reclamation	**Cell A**	**Cell B**	**Cell C**	**Cell D**	**Total**	**Design Thickness (m)**	**Volume (m^3)**
Upper Zone	900,000	1,000,000	500,000	150,0500	2,500,000		
Central Zone surface area (vegetation and rock cover berm)	650,000	1,000,000	1,000,000	500,000	3,000,000	-	
Rock cover berm footprint	-	-	-	-	700,000	0.6	400,000
Vegetation area	-	-	-	-	2,300,000	-	
Water Interface Zone	180,000	85,000	350,000	250,000	900,000	1.0	900,000

Central Zone

The Central Zone extends from the down-gradient edge of the Upper Zone to within 50 to 100 m of the pond water interface. The cover design within the Central Zone is a combination of rock and vegetation. The Central Zone will have waste rock placed in an irregular patterned fashion. The rock will be spread at a minimum thickness of 0.6 m in bands about 10 to 12 m wide. Spacing between bands will range between 50 to 100 m. Larger boulders will be pushed off to either side at random leaving the processed kimberlite covered with a more or less random pattern of rock and boulders. The methodology for the construction of the rock placed in this fashion will need to be confirmed by the pilot study referred to in Section 5.5.4.2. The exposed areas of fine processed kimberlite in the Central Zone will be vegetated. The expected approximate total volume, and area of rock and vegetation for each cell in the Central Zone is provided in Table 5.5-6.

The dimensions of the vegetation and rock cover in the Central Zone are conceptual at this time, based on reasonable expected areas for vegetation propagation techniques and expected widths for rock hauling equipment. The exact rock and vegetation cover dimensions together with methodology for the construction of the rock placed in this fashion and vegetation propagation techniques will need to be confirmed by the pilot study identified for 2013 in Section 5.5.4.2 and included in the Engineering Studies Plan (Appendix 5.1-5).

Water Interface Zone

The Water Interface Zone extends from the down-gradient edge of the Central Zone to the pond water interface and will be approximately 50 m in width. It is proposed that the water interface zone will also be covered with waste rock, spread in a thin layer approximately 1 m thick over the softer, finer-textured processed kimberlite. This zone is designed to provide shoreline protection from waves and freeze thaw action. The width of placement will vary depending upon width of extra fine processed kimberlite (Cells B and A) and seasonal fluctuations in the elevation of Cell C pond. Processed kimberlite is expected to push up through the rock as the rock settles down to become supported by permafrost, leaving this zone covered with a more or less uniform mixture of rock and kimberlite. With the assistance of vegetation, this combination of rock and kimberlite is expected to create a stable surface capable of transmitting surface drainage and withstanding wave action at the pond interface. The Water Interface Zone will likely be constructed in the winter months when the ponds' interface is frozen and the EFPK is more stable. Table 5.5-6 shows the expected approximate total volume, and area of rock for each cell in the water interface zone.

The dimensions of the vegetation and rock cover in the Central Zone are conceptual at this time, based on reasonable expected areas for vegetation propagation techniques and expected widths for rock hauling equipment. The exact rock and vegetation cover dimensions together with methodology for the construction of the rock placed in this fashion and vegetation propagation techniques will need to be confirmed through research and identified in Appendices 5.1.4 and 5.1-5, and in early pilot studies proposed for 2013 in Section 5.5.4.2.

<u>Ponds</u>

The final zone within the LLCF cover design is the ponds. Small permanent ponds will be located in each of Cells A and B, and connected to a larger pond in Cell C. The ponds will limit erosion of the processed kimberlite by preventing transport of fines into the lower watershed. They will also act as settling ponds for EFPK. Spillway structures in dikes downstream of the ponds will act as water level control structures for the upstream ponds.

5.5.5.3 LLCF Vegetation

Re-vegetation of the Central and Water Interface zones will be assisted with seeding and planting of suitable plant species. Grasses and sedges will provide the primary vegetation cover in both of these zones. A mixture of native-grass cultivars will be drill seeded in the Central Zone, prior to placement of the rock. Native grasses and sedges adapted to mesic to hydric moisture regimes will be broadcast seeded in the Water Interface Zone, after the placement of rock pavement. Fertilizer nutrients will be applied with the initial seed to quickly provide erosion controlling plant cover. The exact number of applications is unknown at this time, however, based on LLCF re-vegetation research at the Cell B plots, it is anticipated that fertilizer in the first 10 years will be applied at the time of the initial seeding followed by maintenance applications at the beginning of the third and eighth growing season. Reclamation Research Plan #16 will assist in identifying the number and type of fertilizer applications (Appendix 5.1-4). Actual timing of maintenance fertilization will be determined by the vigour and abundance of live plant cover.

Secondary vegetation establishment (*i.e.*, natural colonization by native species) will be aided by planting islands of native species such as dwarf birch, blueberry, fireweed, locoweed, Hedysarum and white dryad. Processed kimberlite in the upper portion of the Central Zone may be amended with organic matter to increase moisture and nutrient holding capacity and sustain acceptable plant cover. Willows, planted as stem cuttings, are expected to provide diversity to the grass-sedge vegetation in the Water Interface Zone. It is expected that the random rock and boulder placement in the Central Zone will assist with the establishment and long term sustainability of the vegetation cover through snow capture, wind protection, and topographic heterogeneity (which encourages plant community diversity).

The expected timeframe of plant colonization is unknown because of the lack of experience in re-vegetation of processed kimberlite in a low tundra environment. However, monitoring of the Cell B re-vegetation research plots from 2000 to 2005 indicates that natural colonization of species commonly found in the native plant community is already occurring. Numerous dwarf birch seedlings were found establishing under the protective grass mulch cover in the eighth growing season following initial revegetation (HMA 2007). Assuming colonization will continue at similar pace to that observed on other disturbed surfaces in the area, succession to a mature plant cover should be well underway after approximately two decades. The establishment of this secondary plant cover is likely to occur more quickly within the Central and Water Interface zones where soil moisture is more readily available.

Re-vegetation research on Cell B by HMA (2005) suggested that a plant cover of native grasses can be successfully established on processed kimberlite in the mid-slope position. Limited research within the lower slope and observation of natural colonization suggests that re-vegetation in this zone is also possible. Natural colonization, aided by wind, water and animal borne seed is expected to increase biodiversity in all zones. In time a plant community comprised of a mixture of native forbs, shrubs, grasses and sedges is expected to develop in the Central and Water Interface zones, with native-grass cultivars still present, but eventually only a minor component of the plant cover. Soil fines collecting amongst the rock in the upper zone rock cap are also expected to provide suitable sites for the establishment of non-vascular (*e.g.*, lichens and xeric mosses) and vascular plants (*e.g.*, grasses, fireweed, dwarf birch, locoweed), albeit a sparse, dispersed plant cover.

5.5.5.4 Wildlife Use of the LLCF

The final surface of rock and vegetation on the LLCF will be accessible by wildlife after closure. The wildlife that will likely use the facility are caribou, hare and migratory water fowl. Concern has been raised by communities of the safety of wildlife on the LLCF at mine closure. Monitoring programs through the WEMP will continue to study caribou movements through the facility. Results to date indicate that caribou have been using the facility with no adverse impacts from the physical environment (BHP Billiton 2006b). The cover material for the Upper, Central and Water Interface Zones will be designed so that the following conditions are met:

- Long-term stabilization of processed kimberlite; and
- Safety for people and wildlife.

Research studies and TK input from communities will be used to address how the LLCF final design can be created to ensure animal and human safety.

Metals bioaccumulation has been identified as a concern for grazers of the LLCF vegetation at mine closure. Further research on bioaccumulation to test the assumptions made in previous risk assessments will be conducted in the pilot study (Section 5.5.4.2), and the results from the research will also assist in determining the final design cover type for the LLCF.

5.5.5.5 Permafrost Development

Prior to processed kimberlite placement in Long Lake, a talik, or zone of unfrozen soil, existed under the lake as shown in Figure 5.5-7. The permafrost table above lake level roughly paralleled the ground surface and extended under the lake for a distance corresponding to the depth of water that froze to the lake bottom. Processed kimberlite placement in the LLCF will eventually shift the permafrost table and talik from its original location. The conceptual permafrost table and talik location at mine closure is shown in Figure 5.5-7. A talik will remain in those areas of the LLCF where a pond overlies the processed kimberlite. The permafrost table will eventually extend under the new pond limits for a distance corresponding to the depth of water that freezes annually to the pond bottom. Permafrost aggradation within the deposited processed kimberlite will occur via two scenarios. Where processed kimberlite is placed over what was originally exposed tundra (outside the original lake shore), permafrost aggradation will occur from above and below the processed kimberlite, as shown in Figure 5.5-7. Where processed kimberlite is placed over a former talik area, permafrost aggradation will occur from the top downward.

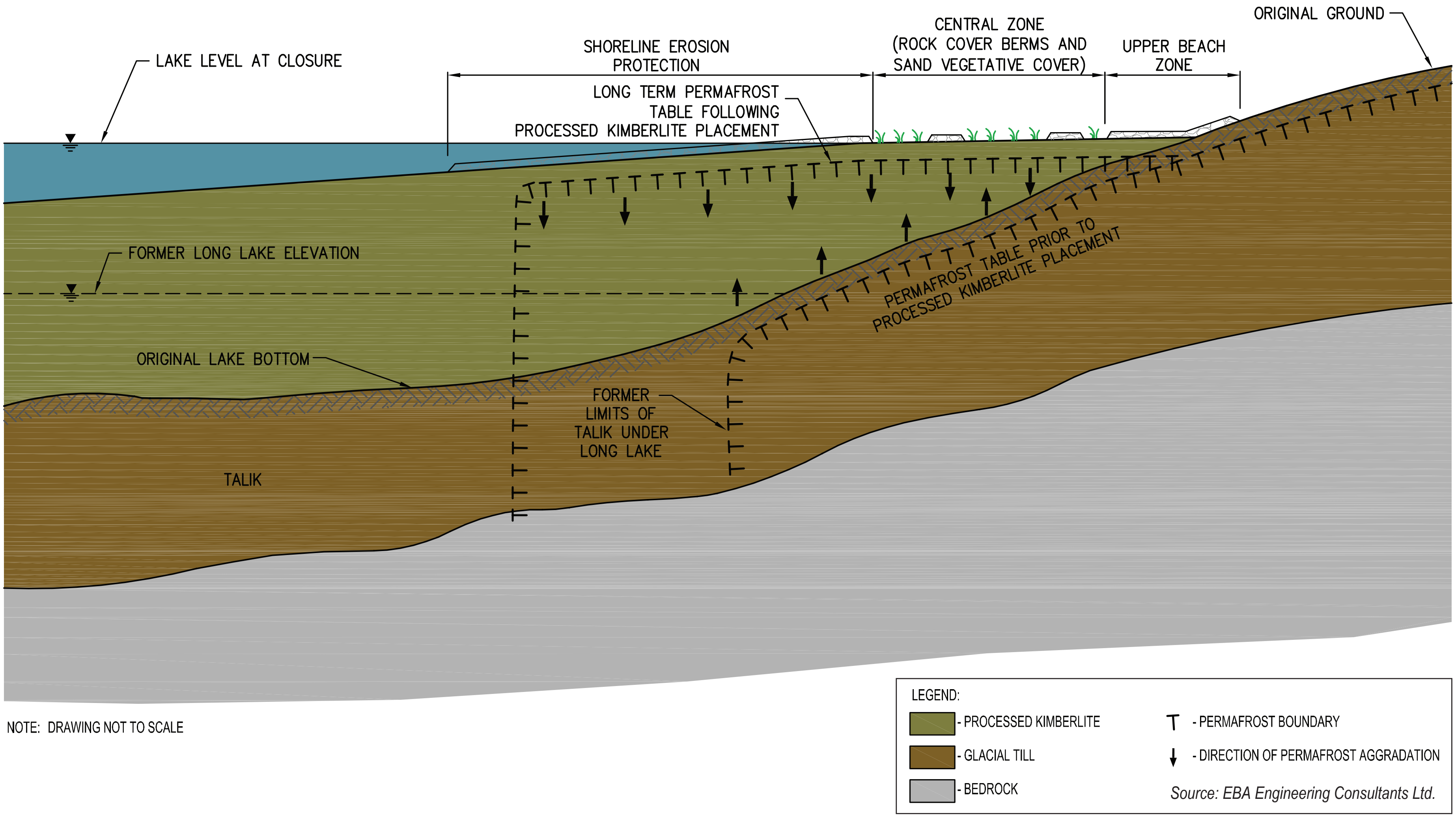


Figure 5.5-7

Conceptual Permafrost Development in LLCF

The seasonal active layer will act as a conduit for water, which will flow down-gradient either as shallow groundwater flow or report to the surface water. During freeze-up there will be minimal or no flow of shallow groundwater. The permafrost will act as a near-impermeable barrier for the shallow groundwater flow.

The migration of water is unlikely to be of concern during permafrost/talik formation because of the gradual and cyclical nature of permafrost development. The numerous freeze/thaw cycles that would occur over hundreds of years would gradually displace water or form karsts. In addition, water infiltrating the LLCF from the external catchment areas will ultimately be reduced and re-directed to the south end of the facility where it will flow into Leslie Lake. This process will occur while permafrost is developing and will continue once permafrost development has stabilized.

Except in those areas of the LLCF where taliks are expected, permafrost is expected to develop to an approximate thickness of 300 to 400 m, consistent with the natural permafrost regime at EKATI. Permafrost development has been measured in the LLCF with the use of ground temperature cables in Cells B and C. Site investigations have also been completed in the facility in 2001 and 2005 (EBA 2002a, 2005a).

The conceptual drainage plan for the LLCF accommodates surface drainage from catchment areas outside the LLCF. Processed kimberlite placement is not expected to inhibit water migration. As such, no issues with respect to permafrost development are anticipated.

The majority of the processed kimberlite surface area will be well-drained, sloping beach sediments. The high proportion of well drained beaches is expected to encourage rapid formation of permafrost from the surface downward (this has been observed in current upper and central beach zones). Water Interface Zones where the pond will freeze to the bottom sediments each winter are predicted to sustain permafrost but will have a thickened active layer. The permafrost distribution created by the revised deposition plan will be more predictable and will produce substantial improvements in long term stability of the landscape (BHP Billiton 2004a).

5.5.5.6 LLCF Water Management

Drainage in the LLCF after the facility has been reclaimed and closed will follow established permanent streambeds along predetermined routes, as shown in Figure 5.5-5. The revised operational drainage plan (*i.e.*, Option 3aM) has been summarised in Section 5.5.4.2. The remaining ponds in the LLCF will work as polishing and settling ponds for EFPK. External channels will convey surface water originating from the surrounding tundra as much as possible around the facility to reduce the potential for erosion and increased transport of kimberlite fines into the lower cells.

Streams in direct contact with Central or Water Interface zones will be restricted to short segments that interconnect the ponds. The water elevation in the residual ponds remaining in Cells B and C at mine closure will be controlled by spillways incorporated into Dikes B, C and D. Pond level fluctuations in Cells B and C will be monitored during operations, and will assist in determining flow points for these spillways. Conceptual cross-sections of external and internal diversions are provided in Figure 5.1-2n of Appendix 5.1-2. EFPK that collects in the ponds during operations will be confined to the pond bottoms where it will consolidate over time.

The dikes that now function as filter dikes will become water level control structures. They will be permanent features in the new landscape that control water elevation in the residual ponds and allow surface water to decant from one pond to the next within the basin. Over time processed kimberlite build up behind the filter dikes will reduce the permeability of the dikes, in essence “plugging” them. At which point most water will pass over rather than through the dikes. Evidence of plugging is currently seen where water levels in Cell B are higher than levels in Cell C requiring a culvert in Dike B as an overflow from Cell B to Cell C. The head difference between the two cells is larger than what would be expected if the dike were filtering at full capacity. This suggests some plugging of the filter dike as was expected in the design. Water quality in Cell C and downstream of Dikes C and D has been monitored during operations and reported in the Water Licence and Environmental Agreement Annual Report as SNP monitoring. The results from the monitoring to date indicate that the filter dikes are performing as designed (BHP Billiton 2007d).

The Outlet Dam will be decommissioned and breached at closure and regular flow to Leslie Lake will be restored. The final water level in Cell E will be 448 masl. The catchment area reporting to the Long Lake discharge will be similar to the pre-construction catchment; however, the lake surface area will be reduced from the original area. This may contribute to a reduction in evaporation losses in the Long Lake catchment area and a slight increase in the annual discharge when compared to pre-construction values. Expected final water balance and discharge volumes for the LLCF after completion of reclamation activities have not yet been completed. This information will be included in future updates of the ICRP. A cross-section drawing showing the conceptual Outlet Dam breach section is provided in Figure 5.1-2m of Appendix 5.1-2. Design characteristics for the breach such as channel slope and bank width will be provided in future updates of the ICRP. The breach will connect with existing flow channels that were in place prior to mine development where possible. Channel banks will be stabilized, if needed, through rock armouring and/or plant establishment to prevent erosion. The closure objective of ‘safe for fish passage’ as applied to the Outlet Dam breach means that fish should not have any more risk of physical injury than they would typically experience elsewhere in their natural range under similar circumstances, with similar natural flow conditions.

The East Dam, if constructed, would be required at closure only if water levels were maintained above 449 m or if processed kimberlite were discharged against it. The Spillway Dam, if constructed, would only be required during operations. At closure the dam would not impound water or processed kimberlite and therefore would no longer be required (EBA 1995).

The volume of expected EFPK at closure was estimated in 2005 through Plum Line Surveys in the LLCF, and water cap depths over EFPK were estimated for the LLCF in the 2007 Wastewater and Processed Kimberlite Management Plan (BHP Billiton 2007d). Based on the 2005 survey the final EFPK surface elevation in Cell C assumed for volume calculations is 456 m, and the final water surface elevation in Cell C will be 458 masl. In Cell D the EFPK final elevation is predicted at 437 m, with the final pond elevation at 455 masl. Uncertainty remains in the final volumes expected in the LLCF. A second round of surveys (Plum Line survey and LiDAR survey) was completed in 2008. Results from these surveys will be included in the next update of the ICRP. Research plans to address final expected EFPK volumes in the LLCF and the management of this material have been included in Appendix 5.1-5.

5.5.5.7 Water Quality

Water quality downstream of the LLCF following reclamation activities will be monitored as outlined in Appendix 5.1-6 (Post Closure Monitoring) for a period of 10 years to ensure water quality meets the closure objectives. It is expected that water quality downstream of LLCF will meet closure objectives, with the benefit of settlement ponds in the upper cells and capping of the processed kimberlite with rock and vegetation. A full discussion on the expected water quality from the LLCF during the post-closure period is presented in Section 7.6.

5.5.6 Designing for Closure

The review of operations and revisions adopted in 2005 as Option 3aM provides the opportunity to re-examine the performance and design of the facility so that it integrates with the long-term, post-closure landscape. The revised Wastewater and Processed Kimberlite Management Plan (BHP Billiton 2007d) seeks every practical opportunity to assist closure planning, and maximize progressive reclamation by adopting processed kimberlite deposition and runoff water management strategies that generate a stable landscape during the operating phase of the project.

The objective is to eliminate to the maximum extent possible any necessity to rework the new surface topography and to provide site drainage facilities that will be operational for the long-term early in the life of the facility.

The following is a summary of key opportunities where the LLCF has been designed to assist closure of the facility in regards to surface stability, erosion control, permafrost development, and water quality:

- Review and update of the processed kimberlite schedule and infrastructure to ensure maximum capacity of the upper cells in the LLCF is utilized for processed kimberlite deposition, allowing large areas for polishing ponds in the lower end of the facility (Cells D and E). By increasing the area of polishing and settling areas, the long-term water quality for the facility will be improved.
- Construction of external drainage channels to divert tundra surface drainage away from processed kimberlite.
- Construction of an internal drainage system and ponds to control erosion and encourage settlement of extra fine processed kimberlite.
- Conducting a pilot study during operations to look at vegetation growth, impacts from grazing, testing of constructability of the rock covers in each of the Upper, Central, and Water Interface Zones, and safety concerns for wildlife.

5.5.7 Closure Objectives and Criteria

Section 1.4 describes the Reclamation Goal, Closure Objectives and Closure Criteria, and Appendix 5.1-1D describes the comprehensive list of closure objectives and criteria for the PKCA mine component, with Actions/Measurements and linkages to reclamation research, engineering studies, and closure monitoring. The Closure Objectives that were developed for the PKCA mine components are:

- fugitive dust levels meet Canadian Ambient Air Quality Objectives;
- processed kimberlite surfaces are stabilized;
- remove (or cut to surface) surface infrastructure (i.e., buildings, pipelines, tanks, electrical);
- channel banks (including internal and external channels, and breach locations) are stabilized;
- removal/remediation of hydrocarbon contamination;
- native vegetation used for rehabilitation work;
- sites rehabilitated with plant cover have sufficient plant cover to stabilize land surfaces;
- surface drainage patterns are established to ensure runoff is channelled through the watershed;
- water quality for the LLCF and Phase 1 meets water licence criteria;
- surface of facilities is safe for wildlife use and travel;
- Cell E will be safe for fish passage;
- wildlife are using the EKATI Claim Block;

- surface of facilities, channels and remaining dike and dam infrastructure are safe for human use;
- appropriate safety control measures in place for reclamation activities associated with reclaiming PKCA;
- PKCA mine components are left in a healthy state that supports continuation of human land use activities;
- community land use expectations and TK have been considered in the closure planning;
- Transition Plan in place;
- compliance with legal, regulatory, and corporate obligations;
- appropriate documentation is in place for PKCA closure operations; and
- business procedures and policies in place for reclamation project development.

5.5.8 Reclamation Activities

The reclamation plan for the Phase 1 Pond is to cap the processed kimberlite in the Phase 1 Pond with granite rock. Closure options for control of drainage flow which are currently under review include a channel through the pond, or around the perimeter of the pond. Further details on the activities associated with reclamation work will be provided to the WLWB in a detailed final closure plan for the facility prior to commencement of reclamation work.

The closure plan for the LLCF is to construct a combination cover of granite waste rock and vegetation. Spillways will be constructed in the dikes to control upstream pond elevations in the containment cells, and the Outlet Dam will be breached and a spillway constructed between Cell E and Leslie Lake to allow flow from the facility.

Tables 5.5-7 and 5.5-8 summarize the engineering and environmental closure activities required for closure of Phase 1 and the LLCF.

Table 5.5-7. Phase 1 Reclamation Activities

Description	Processed Kimberlite Containment Area
Reclamation Method	(Preliminary design under review)
Start Reclamation Activities	2010
End Reclamation Activities	2012
Monitoring Period	2012-2022
Engineering Works: • Place rock cover on Phase 1 Pond. • Construct drainage channel. **Environmental Works:** • Control and monitor for erosion (wind and water) during rock cover construction period. • Monitor water quality discharge in receiving environment. • Conduct post closure monitoring.	

Table 5.5-8. LLCF Reclamation Activities

Description	Processed Kimberlite Containment Area
Closure Method	Combination rock and vegetation cover, with channels and weirs for a flow through system.
Start Closure Activities	2013 (Cell B Pilot Study)
End Closure Activities	2026
Monitoring Period	2026-2036
Engineering Works: • Construct weirs in all dikes. • Vegetate Central and Water Interface zones. • Place rock cover over Upper, Central, and Water Interface zones (winter construction), by hauling rock from the Panda/Koala/Beartooth WRSA. • Construct internal drainage channels in Cell C. • Remove thermistors from Outlet Dam and breach dam. • Construct drainage channel through Outlet Dam (refer to Figure 5.1-2n in Appendix 5.1-2) • Remove pumps and pipelines at Outlet Dam. **Environmental Works:** • Control and monitor for erosion (wind and water) during rock cover construction period. • Monitor water quality discharge in receiving environment. • Conduct post closure monitoring.	

5.5.9 Residual Effects

An assessment of potential negative residual effects which may remain in the PKCA mine component after reclamation work has been completed. No minor or higher residual effects were identified. Results from the environmental assessment which include the predicted potential negative effects during the reclamation period, the contingencies in place to control effects and the predicted residual effects after reclamation work is completed are included in Table 7.3-1. Research studies to address how residual effects in the PKCA mine component can be removed have been included in the Reclamation Research Plan (Appendix 5.1-4). Post-reclamation residual effects that were evaluated as negligible were:

- Phase 1 discharge water quality;
- LLCF discharge water quality;
- processed kimberlite erosion from LLCF;
- unstable landform at LLCF; and
- metals uptake from kimberlite and vegetation at LLCF.

Appendix 5.1-3 shows the results of a risk assessment on the preferred closure option for the PKCA mine components.

5.5.10 Reclamation Research

Reclamation research for the PKCA addresses uncertainties with LLCF water quality at mine closure, permafrost growth, stability of EFPK, wildlife safety when using the LLCF (grazing on vegetation and safe travel/use of the facility), and establishment of sustainable vegetation cover on the LLCF.

Research studies on water quality are used to predict the long term LLCF water quality after closure using numerical modeling tools and best current estimates of source terms and the LOM Plan.

Permafrost studies include modeling and field work to determine the condition of permafrost at mine closure. EFPK research addresses the behaviour of EFPK in the LLCF and the minimum necessary depth of fresh water cap over EFPK in the containment cells that ensures long term maintenance of water quality. Wildlife safety research seeks to identify and quantify the potential risks to wildlife ingesting metals from processed kimberlite from the LLCF post-closure, and any associated risks to humans consuming this wildlife. The surface stability on the LLCF after the vegetation cover and rock capping is also important in the long term use of the LLCF by wildlife. TK ideas that will assist reclamation of PKCA will also be incorporated into the reclamation research plans.

The following research studies for the PKCA mine components are included in the Reclamation Research Plan:

- long term LLCF water quality;
- permafrost growth in the LLCF;
- stabilization of EFPK in the LLCF to ensure no negative impacts on water quality and aquatic habitat;
- metal bioaccumulation in wildlife;
- establishment of self-sustaining plant communities;
- vegetation cover and surface stability;
- grazing impacts on LLCF vegetation cover sustainability;
- LLCF design cover; and
- incorporation of TK into reclamation planning.

The reclamation research objectives and work scope are provided in Appendix 5.1-4, and a schedule for completion of research studies is shown in Figure 5.1-4 of that appendix.

5.5.11 Engineering Questions

Identified engineering questions for the PKCA mine component include:

- stability of PKCA internal drainage channels;
- PKCA surface cover; and
- processed kimberlite weathering.

A summary of the engineering studies identified for the PKCA mine component is presented in Appendix 5.1-5.

5.5.12 Post-Closure Monitoring

The post closure monitoring program for the PKCA mine component proposes to use a combination of the current monitoring programs at EKATI adapted to suit specific closure needs, including to a large degree the AEMP, geotechnical and vegetation monitoring. The list of indicators for monitoring effectiveness of reclamation activities and to establish that closure objectives are meet for the PKCA mine component are listed below. Appendix 5.1-6 shows details of the proposed closure monitoring program, including the monitoring schedule.

The indicators selected for monitoring of the PKCA mine components, to establish when closure objectives have been met, are listed below:

- fugitive dust (monitored under general site Air Quality Monitoring);
- slope/surface stability;
- percent vegetation cover;
- stream flow;
- water quality;
- wildlife habitat movement, safety, abundance, mortalities, incidents, breeding, distribution, density, and diversity (monitored under general site WEMP);
- safe working procedures/practices;
- incorporation of TK into closure;
- archaeological sites; and
- operations, procedures and reporting.

5.6 DAMS, DIKES AND CHANNELS

5.6.1 Overview

There are a number of dams, dikes and channels currently in operation at EKATI as well as plans for future facilities in support of open pit development. Table 5.6-1 summarizes the current and projected dams, dikes and channels. The Outlet Dam, dikes and internal and external drainage channels associated with the LLCF have been discussed in Section 5.5.6.6 under Processed Kimberlite Containment Areas.

Table 5.6-1. EKATI Dams, Dikes and Channels and Associated Infrastructure

Location	Infrastructure
Sable	Two Rock Dam
	Two Rock Dike
	Two Rock Sedimentation Pond
Pigeon	Pigeon Stream Diversion
	Pigeon Stream Diversion Berm
Beartooth	Bearclaw Dam
	Bearclaw pipeline
	Bearclaw Intake Jetty
Main Camp	Panda Diversion Dam
	Panda Diversion Channel
Misery	King Pond Dam
	King Pond Settling Facility
	Waste Rock Dam
	East and West Coffer Dams

5.6.2 Pre-Disturbance Conditions

This section provides a description of the pre-disturbance conditions of sites where dams, dikes, channels, and sediment ponds have and will be constructed to assist mining operations.

5.6.2.1 Sable Dams, Dikes and Channels

Two Rock Dam, Two Rock Dike and the Two Rock Sedimentation Pond have not yet been constructed and are part of the future development of the Sable pipe. Rolling ground moraine composed of thick till (up to 15 m) surrounds most of the Two Rock Lake perimeter. The thickness of till is anticipated to be considerably lower in the vicinity of the easternmost tip of the lake. Bedrock, exposed as a cliff along a 120 m section of the north shore, is indicative of a somewhat thinner till cover east of the Two Rock Lake outlet. Patches of exposed bedrock and isolated boulder fields occur between the east end of Two Rock Lake and the southwest corner of Ulu Lake. Patterned ground, represented by well-defined frost boils, is widespread on the gently sloping surfaces around Two Rock Lake. Lacustrine and organic deposits that may contain excess ground ice underlie a poorly defined, elongated flat depression just south of Horseshoe Lake, to the north of the outlet of Two Rock Lake. The depression is vegetated with dwarf birch and willows. A few boulders are scattered across the surface of the depression, and a concentration of boulders is found at the outlet of Two Rock Lake. Environmental assessments were completed as part of the Sable, Pigeon and Beartooth Environmental Assessment in 2000, and a discussion on the water quality, sediment, phytoplankton and zooplankton assemblages, benthic communities, periphyton assemblages, fish population, lake habitat zones, and surface hydrology for Two Rock Lake can be found in detail in the above noted assessment report. Figure 5.6-1 shows a visual representation of the pre-disturbance conditions of Two Rock Lake. For reference, the outline of the proposed development features is shown on the figure.

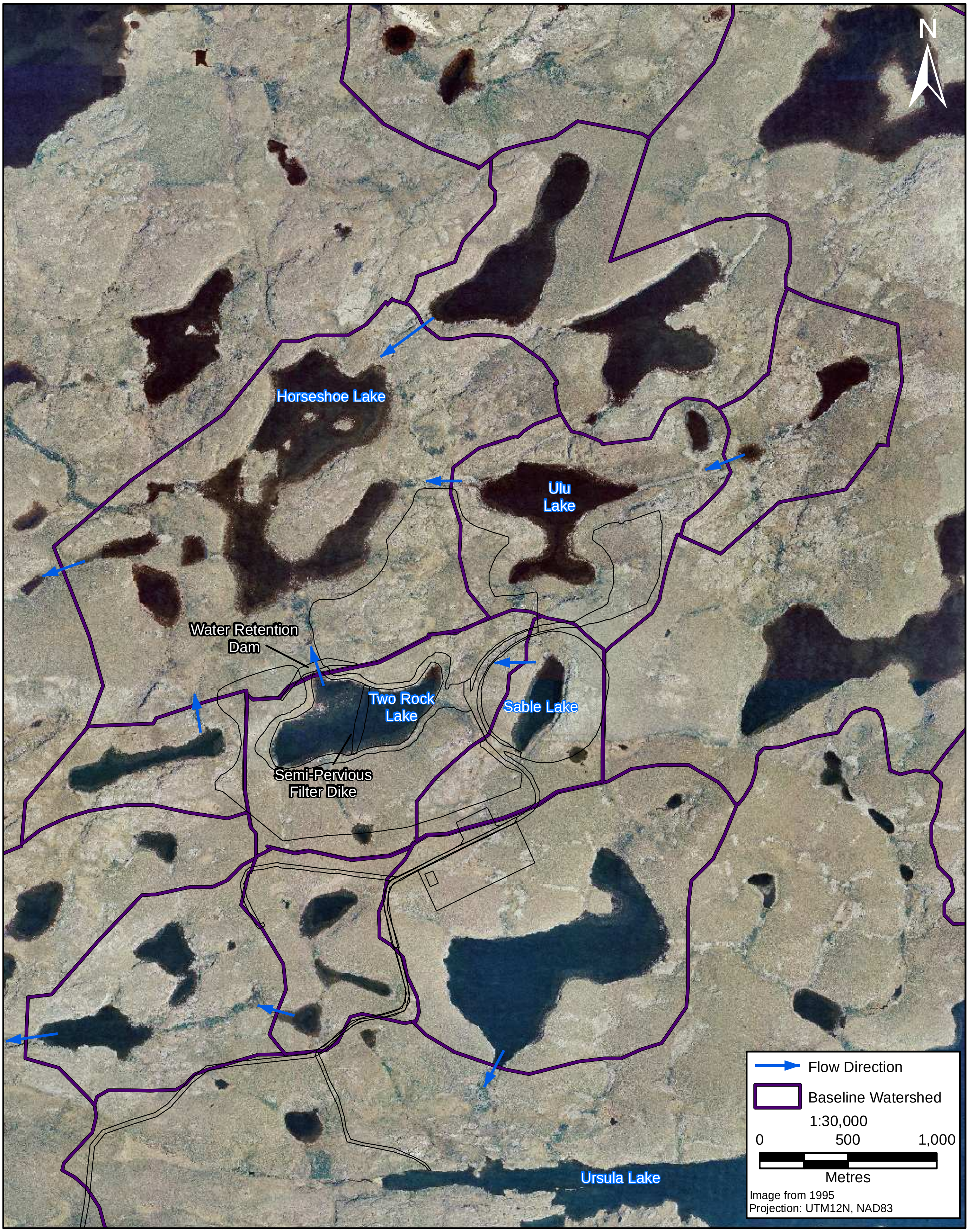
5.6.2.2 Pigeon Dams, Dikes and Channels

Pigeon Stream Diversion has not yet been constructed, but will be located within the vicinity of the current Pigeon stream, and is part of the future development of Pigeon Pit. The location of the future diversion is characterized by a large wetland area, with underlying bedrock topography. More detail on the surface characteristics of the Pigeon site is found in the pre-development description of the Pigeon Open Pit mine component in Section 5.2.2.2. Aquatic surveys, including fish and fish habitat sampling, were conducted in Pigeon Stream in 1999. Results from the survey, including fish populations and hydrology are covered in detail in the Sable, Pigeon and Beartooth 2000 Environmental Assessment report (BHP and Dia Met 2000).

Figure 5.6-2 shows visual representations of the pre-disturbance conditions of Pigeon Stream.

5.6.2.3 Panda/Koala/Beartooth Dams, Dikes and Channels

The Bearclaw Dam, Panda Diversion Dam, Panda Diversion Channel and Beartooth Diversion Pipeline are all located in close proximity to the Beartooth and Panda pit development areas. The Bearclaw Dam is located at the southern end of Bearclaw Lake. The Beartooth Diversion Pipeline is associated with the Bearclaw Dam and diverts water from Bearclaw Lake around the Beartooth pit and into Upper Panda Lake. The Bearclaw-Beartooth stream was 160 m long and had two distinct reaches. Habitat characteristics of each reach were assessed in Sable, Pigeon and Beartooth 2000 Environmental Assessment report (BHP and Dia Met 2000). It was unlikely that this stream provided habitat for fish because it was ephemeral, very shallow and had an average gradient of 11%.



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Pre-Disturbance Conditions of Two Rock Dam, Dike and Sedimentation Pond (1995)

FIGURE 5.6-1

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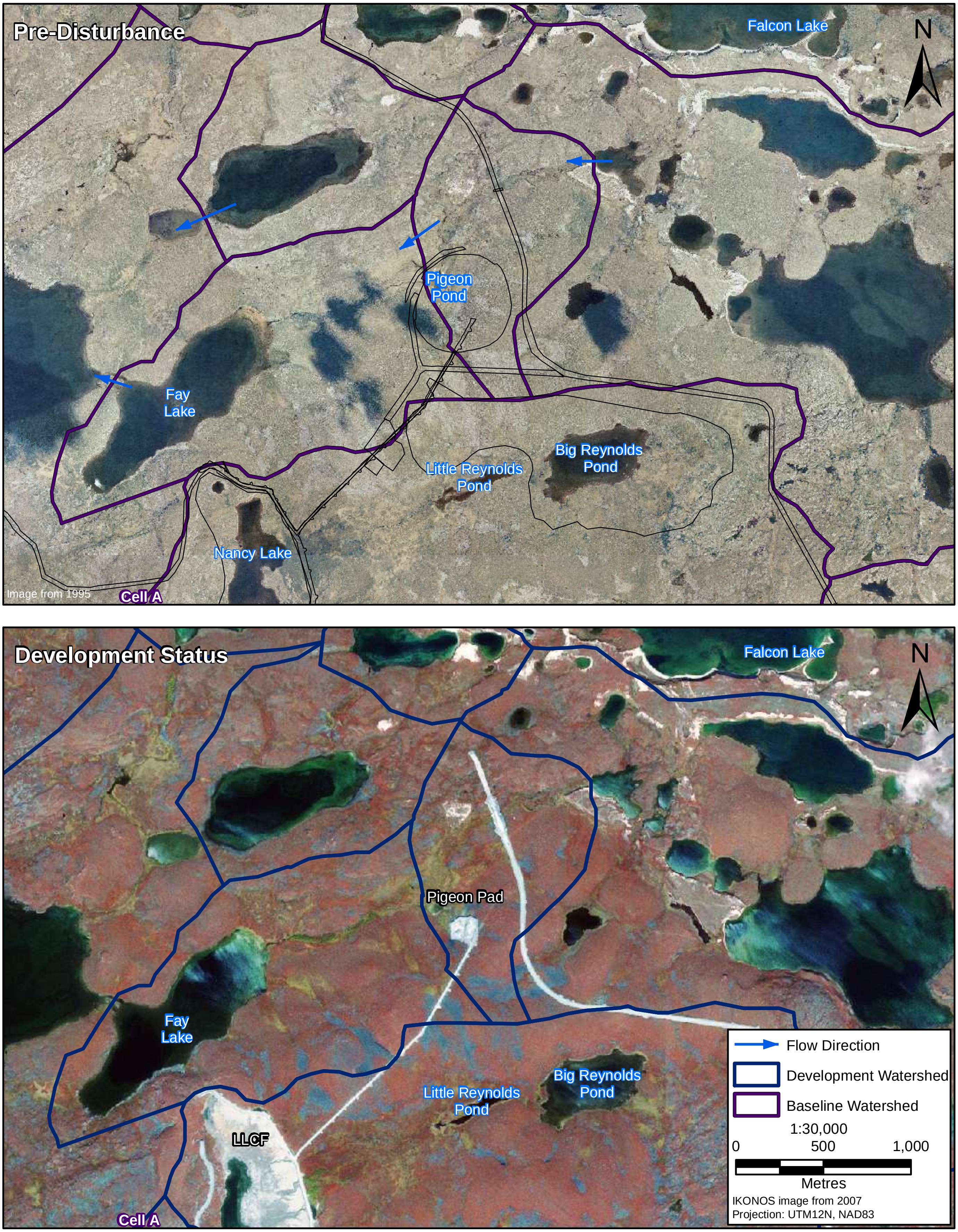

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FIGURE 5.6-2

Pre-Disturbance Conditions and Development Status of Pigeon Stream Diversion (1995 and 2007)

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The Panda Diversion Channel diverts water from Upper Panda Lake into Kodiak Lake. The Panda Diversion Dam has an integral part in the operation of the PDC and retains water from Upper Panda Lake and prevents overflow into Panda open pit. The pre-disturbance conditions of these areas are all similar to the conditions described for the Panda/Koala/Beartooth pits and WRSA. Figure 5.6-3 shows a pre-disturbance visual representation of the dams and diversion channels within the Panda/Beartooth development areas.

5.6.2.4 Grizzly Lake

Grizzly Lake is located approximately 3 km northeast of the EKATI Main Camp and within the Koala watershed. It is a headwater lake and discharge originally flowed from Grizzly Lake via the Grizzly Stream into Panda Lake. Grizzly Lake has been the source of potable water for EKATI since mine construction in April 1997. The lake is 650 ha in area with the northern two thirds occupied by a deep, circular basin and the southern third by a relatively shallow shelf with a maximum depth of about 9 m. The lake is recharged annually by snowmelt and precipitation runoff and direct precipitation. Grizzly Lake water discharges vigorously following spring freshet until a water level of approximately 468.1 m, determined by the natural outflow channel, is reached. Fluctuations of up to 0.15 m in this water level have occurred and will continue to occur throughout the late open water season as a result of precipitation and evaporation fluctuations.

5.6.2.5 Misery Dams, Dikes and Channels

The Misery area contains four separate dam structures: King Pond Dam, East and West Coffer Dams, Waste Rock Dam, and the King Pond Settling Facility. Pre-disturbance conditions for both the Misery Open Pit and WRSA area before development were described in Sections 5.2.2.5 and 5.4.2.5, respectively. Figure 5.6-4 shows the pre-disturbance conditions of the King Pond Dam, East and West Coffer Dams, and Waste Rock Dam.

King Pond was a small (29.1 ha), shallow (maximum depth of 2.5 m) water body located approximately 1.5 km north of Misery Lake. The pond was characteristic of oligotrophic Arctic tundra lakes, with winter conditions typically resulting in greater than 2 m of ice cover. Therefore, due to King Pond's overall shallow depth, the total area of the pond where ice cover would not be frozen to the bottom during the winter period was extremely limited, totalling less than 5% of the total pond area.

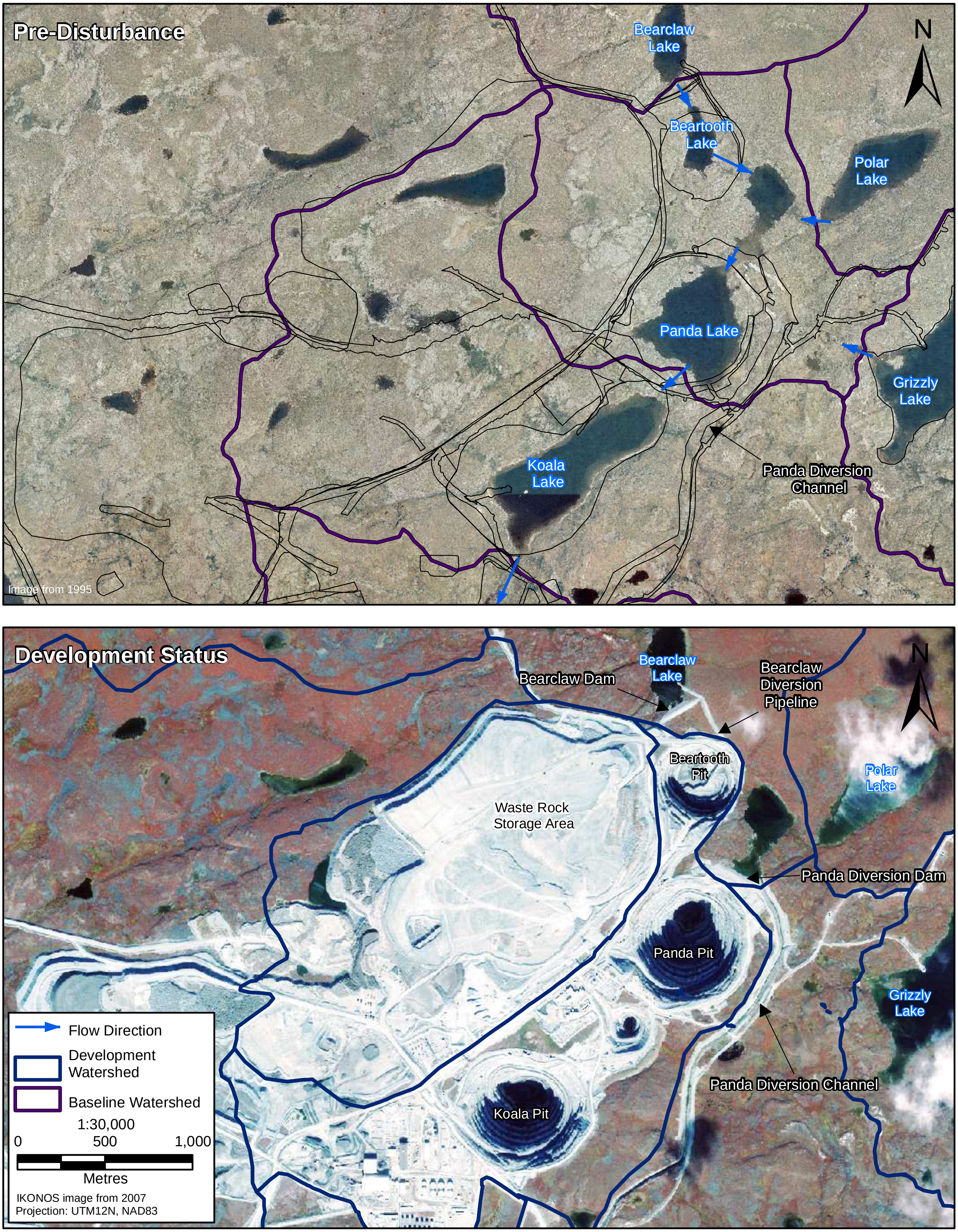
King Pond supported immature Arctic grayling when sampled in 1999 (Dillon 1999). No other species of fish, that could be captured using the sampling techniques used, were found within the pond. Sampling methodologies included the deployment of experimental gangs of gill nets and visual assessments of shoreline habitats. King Pond Outflow was found not to contain fish habitat. Other fish species that could potentially be found within King Pond and associated streams include slimy sculpin and ninespine stickleback.

5.6.3 Development Status

5.6.3.1 Dams and Dikes

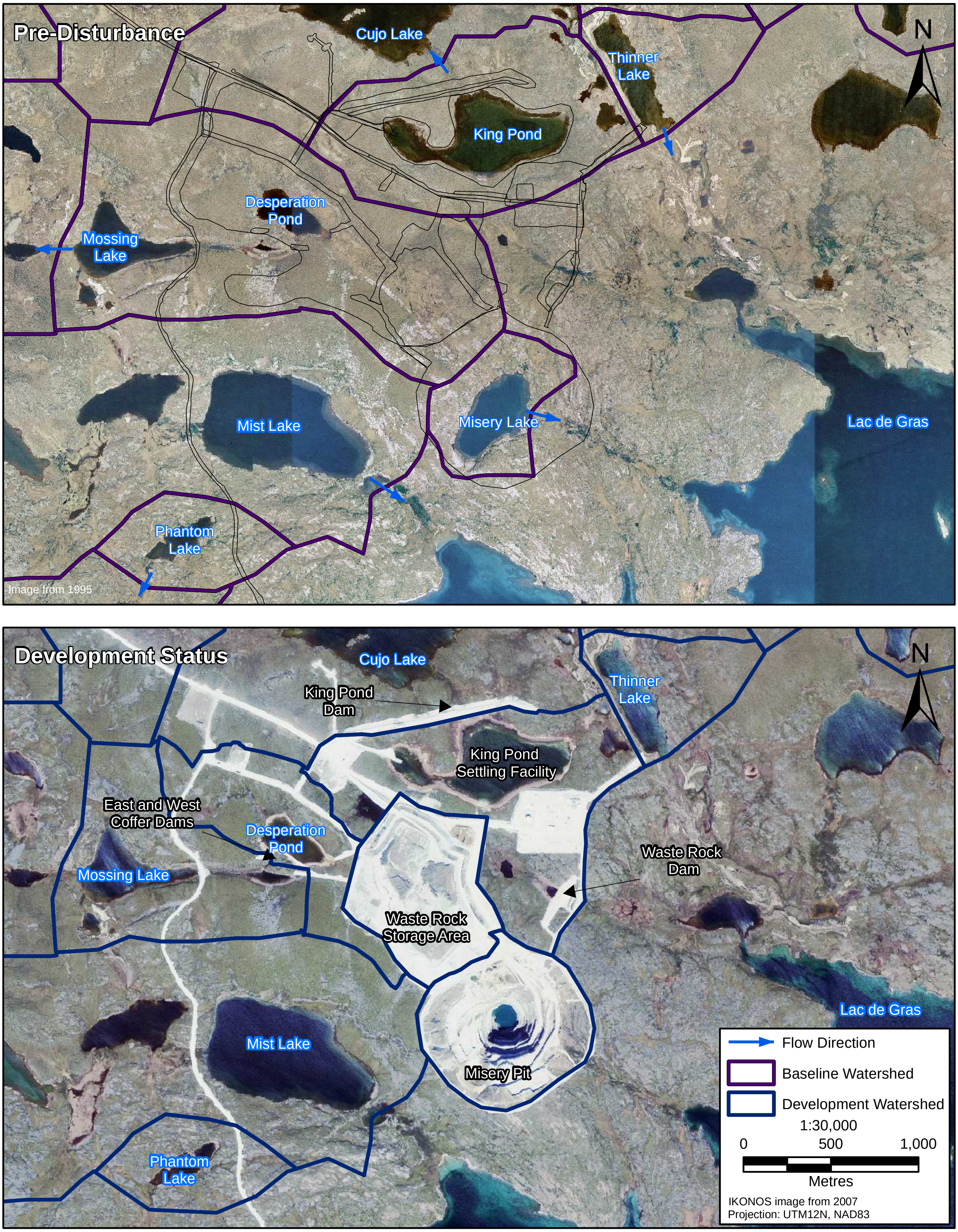
Five water-retention dams have been constructed to date at EKATI, as shown below:

- Bearclaw Dam;
- Panda Diversion Dam;
- Long Lake Outlet Dam (discussed in Section 5.5);
- King Pond Dam; and
- Waste Rock Dam.



Pre-Disturbance Conditions and Development Status -Panda and Beartooth Dams and Diversion Systems (1995 and 2007)

FIGURE 5.6-3



Pre-Disturbance Conditions and Development Status- Misery Dams (1995 and 2007)

FIGURE 5.6-4

Each is capable of sustaining a head of water against the frozen core without significant discharge continuously throughout the life of the mine.

All dams at EKATI have been constructed to comply with Canadian Dam Association Guidelines. Figure 5.6-5 shows the dams and dikes in the LOM Plan (excluding those associated with the LLCF).

The above listed dams are constructed with a frozen core, on permafrost foundations that would be thaw-unstable and/or permeable if they were allowed to thaw. They are constructed during the winter months, and are composed of frozen sand and gravel core protected by crushed transition rock and covered with run-of-mine rock. The dams are keyed into existing frozen ground. All dams have been designed to maintain the permafrost foundation at a defined maximum temperature to effectively act as an impermeable barrier to seepage. Thermosyphons are installed vertically through the dams into an area beneath the key trench to provide passive refrigeration and the means to freeze the soil in a talik (unfrozen) zone. These devices require no power or routine maintenance and have an expected, practical life span of 20 years. The resulting frozen core provides effective containment against leakage. Ground temperatures are monitored by instrumentation installed throughout and beneath the dams. All dams are subject to annual geotechnical inspections to ensure dams are continuing to meet design specifications. Table 5.1-2b of Appendix 5.1-2A summarizes the design specifications for the dams.

Four semi-pervious dikes have either been constructed or are included in future mine developments at EKATI. Dikes B, C and D in the LLCF are discussed in Section 5.5. The Two Rock Dike will be located in the Two Rock Sedimentation Pond at Sable and will divide the lake into two cells. The body of the dike will consist of waste rock with a sand, gravel and silt filter blanket constructed on the upstream side of the dike.

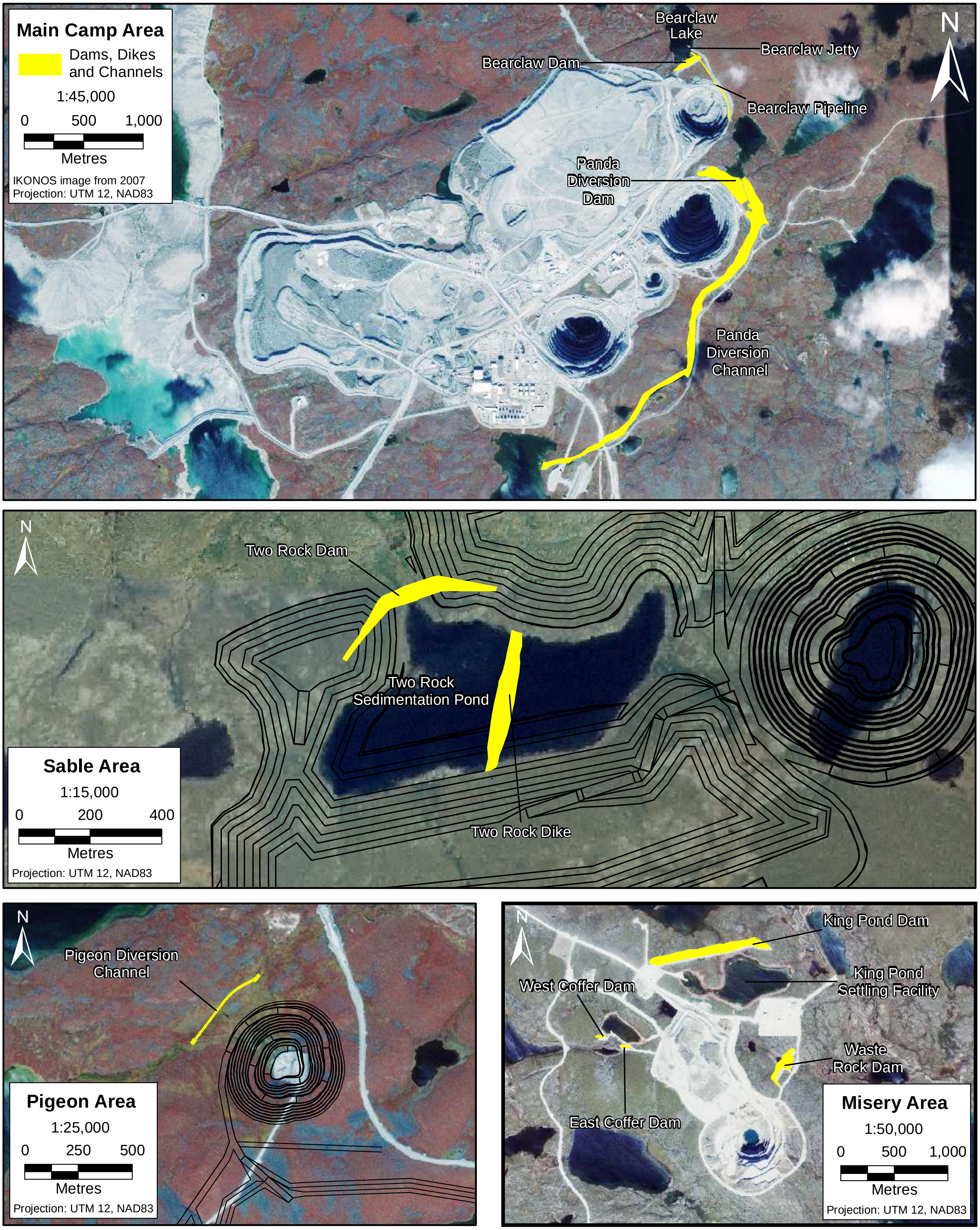
During pit development, mine water will be pumped into the upstream cell, allowing suspended solids to settle and filter from the water that seeps through the dike into the downstream cell.

<u>Bearclaw Dam</u>

Bearclaw Dam is a frozen core dam constructed at the outlet of Bearclaw Lake. It prevents runoff from the lake into Beartooth Pit during the operational phase of the pit. Water impounded behind Bearclaw Dam is routed around Beartooth Pit via the Bearclaw Pipeline into Upper Panda Lake. The dam is designed to retain up to 3 m of water. There are nine vertical and horizontal ground temperature cables and 12 survey monitoring points in Bearclaw Dam. The maximum recorded temperature at the base of the key trench ranges from -5ºC to -7ºC.

<u>Panda Diversion Dam</u>

Panda Diversion Dam separates Upper Panda Lake from the Panda and Koala pits and underground mine operations. Water from Upper Panda Lake is diverted around Panda and Koala pits and the underground mines through the Panda Diversion Channel. The dam is a low gravel and rockfill structure constructed across the narrows of Panda Lake. It retains the northern portion of the lake and allowed the southern portion to be dewatered for pit development. The dam sustains a normal operating head of only 1.3 m, retained by a core of winter constructed frozen sand and gravel overlying a foundation of permafrost sand. The core and foundation are thermally stabilized with a series of vertical thermosyphons (EBA 1997). It has been instrumented to record the progression of ground temperatures since it was constructed in 1997. Thirteen ground temperature cables have provided a record of dam performance that has been documented in the geotechnical annual inspection reports. The maximum recorded temperature at the base of the key trench ranges from -5ºC to -7ºC.



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Location of Dams, Dikes, and Channels

FIGURE 5.6-5

Rescan™

King Pond Dam

The King Pond Dam encloses the King Pond Settling Facility which holds mine water from Misery Pit. Water from the King Pond Settling Facility is piped to Cujo Lake when it meets Water Licence criteria. King Pond Dam is designed as a hybrid lined dam keyed into perennially-frozen soil. The dam and the settling facility were designed to retain all water for at least 1 year before releasing it to the downstream environment (BHP Billiton 2003c). There are eight vertical ground temperature cables and eight horizontal ground temperature cables installed in King Pond Dam. The maximum water surface elevation to date is 445.1 m, which is below the elevation of the access road constructed on the upstream side of the dam. The maximum recorded temperature at the base of the key trench ranges from -5ºC to -7ºC.

Waste Rock Dam

The Waste Rock Dam is located in the draw north of Misery Lake, and retains runoff from the Misery WRSA. Waste Rock Dam is designed as a hybrid lined dam keyed into perennially-frozen soil. There are seven vertical and seven horizontal ground temperature cables and 20 survey monitoring points constructed in Waste Rock Dam. The maximum water surface elevation to date is 439.75 m, which is up to 5.7 m head of water. The maximum recorded temperature at the base of the key trench ranges from -7ºC to -10ºC.

East and West Coffer Dams

These dams were located along the southwest shore of Desperation Pond to retain runoff from the Misery WRSA. They are not true frozen core dams because they have not been constructed into permafrost.

5.6.3.2 Diversion Systems

Bearclaw Pipeline

The Bearclaw Pipeline was constructed in 2003 to divert stream flow around Beartooth Pit from Bearclaw Lake to Upper Panda Lake. The pipeline is located north of Beartooth Pit and is installed on a granite crush bed. The pipeline is a temporary means of transferring natural runoff, and flow from Bearclaw Lake to Upper Panda Lake during Beartooth Pit operations.

Panda Diversion Channel

The Panda Diversion Channel (or PDC) was designed to divert flow from Upper Panda Lake, around Panda and Koala pits and underground operations, to Kodiak Lake, as well as to compensate for loss of fish habitat from all streams across the mine site that are affected by mining operations. The channel was designed and constructed from 1995 to 1997. Figures 5.1-2a and 5.1-2b in Appendix 5.1-2 provide a site plan of the PDC. It is 3.3 km long with bankfull width ranging from 4 to 16 m. Like all streams in the EKATI area, it freezes solid in the winter and is only used by fish in the open-water season. The channel was also designed to carry water flowing from Grizzly and Buster lakes, runoff from sub-basins adjacent to the channel, as well as fish passage to lakes upstream of Kodiak Lake (Rescan 2007b).

In summer 1998, aquatic grasses (*Arctophila fulva*) were transplanted in aquatic quiet-water areas along the base of the channel bank to create small, graminoid marshes. Channel banks with suitable substrate were also seeded with native forbs (*Epilobium* spp.) and legumes (*Hedysarum mackenzii*). Plantings of these species have continued annually through 2001 (ABR 2000a, 2000b, 2001, 2002). Natural colonization of the PDC has been better than expected, with 32 species of vascular plants and 6 species of non-vascular plants (*e.g.*, mosses and liverworts) observed in 2002. The most common vascular plants were horsetail, willow, shrub birch, bluejoint, cottongrass and other sedges. In addition, fish habitat enhancement features were constructed in the summers of 1998 and 1999 including meanders, pools, varying channel width, and topographic diversity of the bank slopes (Dillon 1999, 2000a, 2000b, 2001a, 2001b, 2002, 2003).

In 2006, the PDC had been in operation for 9 years and it is functioning much like any other stream in the region. Annual monitoring has shown that the PDC is an active fish passage route, that it provides spawning, rearing and foraging habitat for Arctic grayling (*Thymallus articus*) fry, slimy sculpin (*Cottus cognatus*) and lake chub (*Couesius plumbeus*). It also provides rearing habitat for juveniles and adults of species that spawn in lakes: burbot (Lota lota), lake trout (*Salvelinus namaycush*), longnose sucker (*Catostomus catostomus*) and round whitefish (*Prosopium cylindraceum*) (Rescan 2007b).

Annual observations and reporting of the channel performance since 2000 have noted two regions where channel wall stability is a potential threat to its future function (EBA 2005b). The section identified as the “Canyon Reach” is the deepest cut and it is entirely within granite rock. The rock is frost-fractured in the upper 2 to 3 m and is judged to be quasi-stable at the current time. There is a risk of rock fall into the channel bottom with potential consequences of interruption of fish passage. The potential for rock failure through this segment is currently a maintenance risk because there have not been any significant changes identified during the past 5 years. This segment of channel slope will need mitigation for long-term operation when annual maintenance is no longer available because the channel will remain open for perpetuity and fish passage will continue into the future.

Flow in the channel diminishes substantially as winter approaches. The channel freezes by January in an annual pattern typical of other streams in the region. The winter snow drifts into the channel, often reaching the top of the banks and impedes breakup in spring. It has been an operational practice since 1999 to clear sufficient snow from the channel during the weeks that precede breakup to encourage ice overflow water to enter the channel. The closure plan for the PDC will address this issue.

5.6.3.3 Settling Facilities

Desperation Pond

Desperation Pond currently collects seepage flow from the Misery WRSA. The Pond will eventually be encapsulated within the Misery WRSA as part of the planned, future pit enlargement. Figure 5.6-4 shows the location of Desperation Pond.

King Pond Settling Facility

At the Misery site, King Pond has been modified into a settling facility for use as a sedimentation pond and containment facility for mine water and other runoff associated with Misery Pit operations. Water that collects in the settling facility is only released into the receiving environment (*i.e.*, Cujo Lake) when it meets water quality requirements specified in EKATI’s Water Licence. The dam and the containment facility were designed to retain all water for at least 1 year before releasing it to the downstream environment (BHP Billiton 2003c).

5.6.3.4 Grizzly Lake

Grizzly Lake is the source of potable water for EKATI. The Grizzly Lake outflow stream that originally went to Panda Lake was intercepted by the Panda Diversion Channel and now forms a portion of the flow diverted past Panda and Koala pits directly into Kodiak Lake. A pump house with a water intake and a pipeline transfer potable water from the lake to a water storage facility at the EKATI Main Camp. Grizzly Lake Watershed contributes on average 1,100,000 m^3 or 25 to 30% of the total volume of 4,600,000 m^3 of water that flows annual into Kodiak Lake via the Panda Diversion Channel. The average water use per person has been calculated at 0.45 m^3/day. The maximum water use limit for Grizzly

Lake in the Water Licence MV2003L2-0013 is 200,000 m^3. Monthly and annual consumption rates for Grizzly Lake water are submitted annually in the Environmental Agreement and Water Licences Annual Report (BHP Billiton 2007b). The current accommodations capacity at EKATI is for 950 people. Although the EKATI mine site continues to evolve, the size of the camp is probably near its population peak. The largest portion of EKATI's fresh water needs will be required for the EKATI camp use.

5.6.4 Projected Development

5.6.4.1 Dams and Dikes

Two Rock Dam and Dike

At the future Sable site, the Two Rock Dam is expected to be constructed at the outlet of Two Rock Lake to contain the Two Rock Sedimentation Pond. A semi-pervious filter dike (Two Rock Dike) is proposed to divide Two Rock Lake into two cells, and to facilitate retention of suspended solids in the first cell (BHP and Dia Met 2000).

5.6.4.2 Diversion Systems

Pigeon Stream Diversion (PSD)

The Pigeon Stream Diversion (or PSD) has not yet been finally designed or constructed. The engineering design requires the approval of DFO and is currently under review by DFO.

Development of Pigeon Pit is expected to remove Pigeon Pond and part of Pigeon Stream. An approximately 440 m-long diversion channel is currently intended to be constructed to realign Pigeon Stream to maintain drainage and to allow for the seasonal passage of fish during the period of mine operations (BHP and Dia Met 2000). BHP Billiton will use the experience gained from developing the Panda Diversion Channel and will work closely with DFO to ensure that they are satisfied with the proposed enhancement features.

Panda Diversion Channel (PDC)

In 2005, BHP Billiton carried out a closure option assessment on maintaining the PDC for long-term use. The objective was to determine if it is feasible to sustain the diversion system in an environmentally acceptable manner in the long-term following mine closure. The risks of the channel not functioning as intended into the future without human oversight and maintenance would have to be equivalent to that of any other natural channel in the region.

Snow infilling was identified as the most significant risk to both the PDC and the dam. The risk of a rockfall blocking the channel is the other factor that would require mitigation by construction in order to provide reasonable assurance of long-term performance. Short-term overtopping of the channel may cause episodic flooding of lowlands, but there are no identified environmental consequences of such events that would be considered abnormal in natural local terrain. Two work projects have been proposed for the long-term use of the Panda Diversion Channel. The Panda spillway (previously discussed under Open Pits mine component) would be constructed as a mitigation to provide a safety release for water in those years when the PDC is slow to clear.

In addition to the spillway construction widening of the Panda Diversion Channel is also proposed. The steep rock slope through the canyon reach will be benched to eliminate the risk of a substantial rockfall. Figure 5.1-2e(a) in Appendix 5.1-2 shows the proposed design sections, and Figure 5.1-2e(b) shows the stabilization plan.

The maximum height of the slope would be reduced to approximately half its current value or to 6.5 m. Each side slope would be benched to provide an 18 m-wide catch bench for the fractured rock remaining in the upper half of the section. The wide benches would allow access for construction equipment and allow scaling (cleaning of loose material) of the remaining lower slope from each side. The conceptual design assumes the use of large haul trucks, thereby requiring a bench width of 18 m to meet Northwest Territories Mine Safety Act and Regulations, including the provision for a safety berm along the crest of the bench. The bottom of the channel would also be within reach for an excavator to remove boulders or snow from within the active channel.

The section of the channel within glacial till deposits, downstream of the canyon reach will be benched concurrent with stabilization of the canyon reach zone. The benched approach improves the overall stability while leaving the lower portion of the slope in its current condition, thus reducing the risk of releasing sediment into the channel. A waste rock fillet at a slope of 2H:1V is needed adjacent to the soil back wall due to the near vertical back slope as a result of blasting through the soil stabilization zone. Erosion protection will be placed over the bench protect exposed zones of potentially ice-rich material.

Access to the channel benching would likely be provided by ramps constructed from the channel crest on either side of the stabilization zone. Site access will be finalized during design.

5.6.4.3 Settling Facilities

Two Rock Sedimentation Pond

The Two Rock Sedimentation Pond is expected to be constructed in 2010 as part of the development of Sable Pit. Two Rock Lake will serve as a sedimentation pond for turbid water during the latter stages of lake dewatering and pit development.

King Pond Settling Facility

Although additional use will be made of the King Pond Settling Facility during the proposed Misery pushback, no change to the development of the mine component is expected until closure.

Desperation Pond

As part of the Misery pushback, Desperation Pond will be encapsulated within the footprint of the future Misery WRSA when Misery pushback operations commence, currently scheduled for 2012.

5.6.5 Final Landscape at Closure

5.6.5.1 Dams and Dikes

All dams and dikes (with the exception of the Panda Diversion Dam) will be breached at mine closure and their slopes will be stabilized with riprap where necessary. All thermosyphons, thermistors and associated instrumentation will be removed and the remaining thermosyphons and thermistors will be cut flush with the surface. Thermosyphon and thermistor material that is removed will be deposited in landfills because they are inert. Natural colonization will be the dominant process where lichens and mosses are the first plant groups expected to colonize these sites. Figure 5.1-2n in Appendix 5.1-2 shows conceptual level drawings of dam breach locations.

The Panda Diversion Dam will remain in place after mine closure. The Panda Spillway is planned to be constructed at mine closure to divert peak freshet flow from Upper Panda Lake into Panda Pit Lake after mine closure. The thermosyphons in the dam will be decommissioned (cut to surface). The long-term performance of the dam without thermosyphons requires analysis and has been identified in the

Engineering Studies Plan, however, it is expected that permafrost will persist in the Panda Diversion Dam for many years following decommissioning. Figures 5.1-2f(a) and 5.1-2f(b) in Appendix 5.1-2 show ground temperature history in the Panda Diversion Dam. If thaw were to occur in the dam, seepage would be initiated through the core, but the volumes would be low because of the low head across the granular material. The dam has proven to be a very robust structure than can reasonably be sustained after mine closure.

With the exception of the Panda Diversion Dam, (it is not yet determined whether or not Spillway Dam and East Dam will be constructed), all dams at EKATI will be breached at closure. All of the structures will be thaw stable and not be required to be maintained in a frozen condition. The King Pond Dam will be breached when water quality in the settling facility meets discharge criteria. The Waste Rock Dam will be breached when seepage from the Misery WRSA meets discharge criteria. The East and West Coffer Dams will eventually be decommissioned and encapsulated within the footprint of the future Misery WRSA when Misery pushback operations commence. Table 5.1-2a of Appendix 5.1-2 shows more information on post-closure dam function.

5.6.5.2 Diversion Systems

<u>Pigeon Stream Diversion</u>

When the Pigeon Pit ceases operation, the Pigeon Stream Diversion will remain in place for the long-term, and Pigeon Stream will continue to flow downstream to Fay Lake. The inflow from Pigeon Stream into Pigeon Pit Lake will not be re-established. The lessons learned from the construction and operation of the Panda Diversion Channel will be applied to the construction of the Pigeon Stream Diversion.

<u>Bearclaw Diversion Pipeline</u>

The Beartooth Diversion Pipeline will be removed and flows will be re-established from Bearclaw Lake to North Panda Lake via the Beartooth Pit Lake once water quality meets water quality criteria at the end of Beartooth Pit filling. The pumphouse at the Bearclaw jetty will be removed but the Bearclaw jetty will remain in place, as agreed to by DFO. The jetty was constructed in 2003 to the following specifications – clean granite crush was placed on the flanks of the jetty below the normal water level. It was placed as a thin surface cover on top of the run of mine material, such that some of the run of mine would remain exposed to leave some large larger voids in the surface. Fish were expected to colonize the jetty, and therefore removal of this infrastructure at closure would result in an impact to fish habitat.

<u>Panda Diversion Channel (PDC)</u>

The PDC will remain as a long-term diversion of watershed flow around Panda and Koala pit lakes, and as fish passage and fish habitat. Beginning in 2011 sections of the channel will be widened to alleviate operational risks and improve the long-term stability of the channel by benching. The details of the work and locations in the channel are further described in EBA Engineering Design Report (EBA 2010). Construction work will be monitored to mitigate impacts on the environment during construction and following. All the existing culverts will be removed from the channel when the mine is decommissioned and the slopes will be re-graded and appropriate erosion control measures applied.

5.6.5.3 Settling Facilities

<u>Two Rock Sedimentation Pond</u>

When mining operations cease at Sable Pit, flow from the Sable Pit Lake will be connected through a connecting channel from the pit lake into Two Rock Lake and through Horseshoe Lake. The facility will be reclaimed at closure to ensure sediments contained in the facility, deposited through the period of mining operations, have been stabilized and are not transportable to the downstream watershed. The Two Rock Dike and Dam will then be breached when water flow from Two Rock Lake meets water licence criteria (BHP Billiton 2000b).

The volume of sediments and water quality parameters in the settling pond will be reviewed midway through the Sable Pit operations, and a decision made on closure of the facility. It is unknown at this time whether or not sediments will be removed from the Two Rock Pond. Should they be removed a future location will be determined in consultation with DFO. One proposed location would be the bottom of Sable Pit. The destruction and loss of fish habitat in Two Rock Lake has been compensated for through *Fisheries Act Authorization* no. SC99037. This authorization states that compensation for fish habitat has been covered by the compensation provided by Leslie Lake (*Fisheries Act Authorization* no. SCA96021).

<u>King Pond Settling Facility</u>

The King Pond Settling Facility will be reclaimed as directed by *Fisheries Authorization* which requires a number of steps for closure that will be undertaken at Misery Mine closure. The work includes removing the sediments within King Pond that degrade the quality of or interfere with the enhancement of fish habitat, re-establishing the King Pond outflow channel, and enhancing the drainage and migration corridor between King Pond and Cujo Lake. Habitat construction work will increase Habitat Suitability Index scores (HSI) for King Pond from 10.75 (pre-development) to 13.39, and for King-Cujo streams from 0.04 (pre-development) to 0.11 (Dillon 2000b). Appendix 1.1-4 provides further detail on *Fisheries Act Authorization* number SC00028.

<u>Desperation Pond</u>

As part of the Misery pushback expansion, Desperation Pond will be encapsulated within the footprint of the future Misery WRSA when Misery pushback operations commence, currently scheduled for 2012. Fish habitat loss in both Desperation Pond and Carrie Stream has been authorized through *Fisheries Act Authorization* no. SC01111.

5.6.6 Closure Objectives and Criteria

Section 1.4 describes the Reclamation Goal, Closure Objectives and Closure Criteria, and Appendix 5.1-1E describes the comprehensive list of closure objectives and criteria for the Dams, Dikes and Channels mine component, with Actions/Measurements and linkages to reclamation research, engineering studies, and closure monitoring. The Closure Objectives that were developed for the Dams, Dikes and Channels mine component are:

- fugitive dust levels meet Canadian Ambient Air Quality Objectives;
- channel banks are stabilized;
- dams, dikes and channel remaining infrastructure are stabilized;
- remove (or cut to surface) surface infrastructure (i.e., buildings, pipelines, tanks, electrical);
- remaining operational, engineered structures meet appropriate design levels;
- removal/remediation of hydrocarbon contamination;
- native vegetation used for rehabilitation work;
- sites rehabilitated with plant cover have sufficient plant cover to stabilize land surfaces;
- surface drainage patterns are established to ensure runoff is channelled through the watershed;
- water quality in channels meets water licence criteria;

- water quality in settling ponds meets water licence criteria;
- remaining dam, dike and channel infrastructure are safe for wildlife use;
- fish access and habitat is in place in the PDC as required by Fisheries Act Authorizations;
- fish habitat reclamation work has been completed for Fisheries Act Authorizations at King Pond Settling Facility;
- wildlife are using the EKATI Claim Block;
- dams, dikes and channels mine components are left in a healthy state that supports continuation of human land use activities;
- appropriate safety control measures in place for reclamation activities associated with reclaiming dams, dikes and channels;
- community land use expectations and TK have been considered in the closure planning;
- archaeological sites are protected;
- Transition Plan in place;
- compliance with legal, regulatory, and corporate obligations; and
- appropriate documentation is maintained.

5.6.7 Reclamation Activities

All dams and dikes with the exception of the Panda Diversion Dam will be breached at mine closure, and their slopes stabilized with riprap. For those dams where sections will be breached to re-establish hydrologic flow, thermosyphons, thermistors and associated instrumentation will be removed. The PDC will remain operational for the long-term and used as fish passage and fish habitat. The King Pond Settling Facility will be re-established as fish habitat as agreed to through *Fisheries Authorizations* with DFO. Tables 5.6-2 to 5.6-8 summarize the engineering and environment work required to close the dams, dikes and diversion channels.

Table 5.6-2. Two Rock Dam, Dike and Sedimentation Pond Reclamation Activities

Description	Dam, DIKE and Settling Pond
Reclamation Method	Breach dam and dike, and create flow-through from Sable to Horseshoe Lake
Start Reclamation Activities	2019
End Reclamation Activities	2033
Monitoring Period	2033-2043
Engineering Works: • Breach dam and dike as per design drawing in Appendix 5.1-2. • Stabilize side slopes by placing rip rap on slopes as necessary. • Cut thermosyphons and thermistors off at ground surface. • Remove any remaining instrumentation. **Environmental Works:** • Control and monitor for erosion during rock cover construction period. • Natural colonization for re-vegetation on any exposed areas. • Complete post closure monitoring.	

Table 5.6-3. Pigeon Stream Diversion Reclamation Activities

Description	Diversion channel around Pigeon Pit during operations
Reclamation Method	Reconnect pit lake to Pigeon Stream
Start Reclamation Activities	2018
End Reclamation Activities	2019
Monitoring Period	2019-2029
Engineering Works: • Initial construction of channel to incorporate design criteria for long term use. • Lessons learned from Panda Diversion Channel will be used in design and construction of Pigeon Stream Diversion. • Breach outlet pit berm to reconnect flow to lower Pigeon Stream. • Leave channel in place long-term. **Environmental Works:** • Complete post-closure monitoring.	

Table 5.6-4. Bearclaw Dam and Diversion Reclamation Activities

Description	Pipeline to divert water around Beartooth Pit during operations
Reclamation Method	Remove and establish drainage flow through Beartooth Pit lake
Start Reclamation Activities	2020
End Reclamation Activities	2033
Monitoring Period	2033-2043
Engineering Works: • Remove pumphouse and equipment at Bearclaw jetty. • Leave jetty in place to provide fish habitat. • Remove Beartooth pipeline and landfill or salvage. • Breach Bearclaw Dam as per design drawing in Appendix 5.1-2. • Stabilize side slopes by placing rip rap on slopes as necessary. • Cut thermosyphons and thermistors off at ground surface. • Remove any remaining instrumentation. **Environmental Works:** • Complete post-closure monitoring.	

Table 5.6-5. Panda Diversion Channel Reclamation Activities

Description	PDC – diversion channel around Panda and Koala pit lakes
Reclamation Method	Stabilize for long-term use
Start Reclamation Activities	1998
End Reclamation Activities	2020
Monitoring Period	2020-2030
Engineering Works: • Stabilize side slopes in Canyon Reach Area as per design criteria in Appendix 5.1-2. • Selectively place rock armour on channel slopes downstream of the Canyon Reach Area. • Remove culverts and stabilize banks. • Construct spillway around frozen core dam and into Panda Pit. **Environmental Works:** • Control and monitor for erosion and suspended solids release during construction period. • Complete post-closure monitoring.	

Table 5.6-6. King Pond Dam Reclamation Activities

Description	Retains water in King Pond Settling Facility
Reclamation Method	Compliance with Fisheries Act Authorization no. SC00028
Start Reclamation Activities	2019
End Reclamation Activities	2024
Monitoring Period	2024-2034
Engineering Works: • Breach dam and dike as per design drawing in Appendix 5.1-2. • Construct fish migration corridor. • Stabilize side slopes by placing rip rap on slopes as necessary. • Cut thermosyphons and thermistors off at ground surface. • Remove any remaining instrumentation. **Environmental Works:** • Control and monitor for erosion during rock cover construction period. • Rely on natural colonization for re-vegetation. • Complete post-closure monitoring.	

Table 5.6-7. King Pond Settling Facility Reclamation Activities

Description	Settling facility for Misery mine water
Reclamation Method	Compliance with Fisheries Act Authorization no. SC00028
Start Reclamation Activities	2019
End Reclamation Activities	2024
Monitoring Period	2024-2034
Engineering Works: • Remove sediments (if required) accumulated within King Pond that degrade the quality of or interfere with the enhancement of fish habitat. • Re-establish King Pond outflow. • Enhance the drainage and migration corridor between King Pond and Cujo Lake. **Environmental Works:** • Enhance bathymetry within the King Pond to promote over-wintering habitat. • Complete post-closure monitoring.	

Table 5.6-8. Waste Rock Dam Reclamation Activities

Description	Retains water runoff from Misery WRSA
Reclamation Method	Breach dam
Start Reclamation Activities	2019
End Reclamation Activities	2022
Monitoring Period	2022-2032
Engineering Works: • Breach dam and dike as per design drawing in Appendix 5.1-2. • Stabilize side slopes by placing rip rap on slopes as necessary. • Cut thermosyphons and thermistors off at ground surface. • Remove any remaining instrumentation. **Environmental Works:** • Control and monitor for erosion during rock cover construction period. • Rely on natural colonization for re-vegetation. • Complete post closure monitoring.	

5.6.8 Residual Effects

An assessment of potential negative residual effects that may remain in the Dams, Dikes and Channels mine component after reclamation work has been completed. The assessment indicates that no residual effects would remain at closure for this mine component. Results from the environmental assessment which include the predicted potential negative effects during the reclamation period, the contingencies in place to control effects and the predicted residual effects after reclamation work is completed are included in Table 7.3-1. Appendix 5.1-3 shows the results of a risk assessment on the preferred closure option for the Dams, Dikes and Channels mine components.

5.6.9 Reclamation Research

Reclamation research planning for the Dams, Dikes and Channels mine components addresses King Pond Settling Facility reclamation which is based on *Fisheries Authorization* SC00028, Sections 6.2.1 through 6.2.3. Research plans also address the development of sustainable plant communities. The reclamation research objectives and work scope are provided in Appendix 5.1-4, and a schedule for completion of research studies is shown in Figure 5.1-4 of this appendix. Where possible, TK ideas that will assist reclamation of dams, dikes and channels will also be incorporated into the reclamation research plans.

Identified reclamation research studies for the Dams, Dikes and Channels mine components include:

- establishment of self-sustaining plant communities;
- vegetation cover and surface stability;
- fish migration corridor between Cujo Lake and King Pond Settling Facility;
- King Pond fish habitat; and
- incorporation of TK into reclamation planning.

5.6.10 Engineering Questions

Identified engineering questions for the Dams, Dikes and Channels mine component include:

- long term channel bank stability; and
- geotechnical stability of dam and dike infrastructure.

Appendix 5.1-5 summarizes the engineering studies identified for the Dams, Dikes and Channels mine component.

5.6.11 Post-Closure Monitoring

The post-closure monitoring program for the Dams, Dikes and Channels mine component proposes to use a combination of the current monitoring programs at EKATI adapted to suit specific closure needs, including to a large degree geotechnical surveys and vegetation monitoring. The indicators for monitoring effectiveness of reclamation activities and to establish that closure objectives are met for the Dams, Dikes and Channels mine component are listed below. Details of the proposed closure monitoring program, including monitoring schedules, QA/AC protocols for monitoring, and discussion on adaptive management are included in Appendix 5.1-6.

The indicators selected for monitoring of the Dams, Dikes and Channels mine components to establish when closure objectives have been met are listed below:

- fugitive dust (monitored under general site Air Quality Monitoring Program);

- slopes, drainages, surface stability;
- percent vegetation cover;
- stream flow;
- water quality;
- wildlife habitat movement, safety, abundance, mortalities, incidents, breeding, distribution, density, and diversity (monitored under general site WEMP);
- stream flow, water temperature, fish movement, grayling fry density, habitat complexity and nutrient inputs;
- safe working procedures/practices;
- incorporation of TK into closure;
- archaeological sites; and
- operations, procedures and reporting.

5.7 BUILDINGS AND INFRASTRUCTURE

5.7.1 Overview

The Buildings and Infrastructure mine area component includes all buildings (mobile and permanent), pipelines, pump stations, electrical systems, quarry site, Camp pads and laydowns, ore storage pads, roads, culverts and bridges, airstrip, helipad, mobile equipment and hydrocarbon contaminated sites. Table 5.7-1 summarizes the buildings and infrastructure in place at EKATI as well as future planned infrastructure.

Table 5.7-1. EKATI Buildings and Infrastructure

Infrastructure	Location
All Buildings (mobile and permanent)	Main Camp, Underground surface facilities, Satellite facilities, Exploration sites, Airport, Ammonia and Nitrate Storage, Explosives storage, Emulsion Plant.
Satellite Facilities	Old Camp.
Exploration Camps	Mark's Camp, Culvert Camp, and Boxcar.
Petroleum and Chemical Storage	Fuel storage at Sable, Main Camp, Fox, Misery Bulk Lube Facility at Main Camp. Glycol systems in the Main Camp and Underground surface facilities.
Pipelines and Pump Stations	Grizzly Lake, Bearclaw Lake, and other sites as required. Pit flooding pipelines and pump stations.
Electrical Systems	All sites.
Quarry	Airport Esker.
Camp Pads and Laydown Pads	All sites.
Ore Storage Pads	Sable, Panda/Koala/Beartooth and Misery.
Sumps and Collection Ponds	Associated with camp and laydown pads.
Roads	All haul roads and subsidiary roads.
Culverts and Bridges	All sites.
Airstrip and Helipad	EKATI Airport.
Mobile Equipment	All sites.
Hydrocarbon Contaminated Sites	All sites.
Waste Management and Recycling	All sites.

5.7.2 Pre-Disturbance Conditions

The majority of EKATI's buildings and infrastructure are located in the Main Camp and at the underground surface facilities location. The pre-disturbance terrain at these two sites is similar to the description given for the Panda/Koala/Beartooth WRSA. The area had a thin tundra vegetation cover over glacial till deposits, and mixed with sparse patches of granitic country rock outcrops. The topography consisted of low relief rolling hills with elevation variations of approximately 15 m. Figure 5.4-3 shows the pre-disturbance conditions of the buildings and infrastructure for the Main Camp and underground support facilities.

Sections 5.4.2.1 and 5.4.2.2 provide a description of the pre-disturbance conditions at the Sable and Pigeon sites, and Figures 5.4-1 and 5.4-2 show the pre-disturbance conditions of the Sable and Pigeon sites, respectively.

A small, stand-alone camp and support buildings and infrastructure are in place at Misery. These facilities are located adjacent to the Misery WRSA and therefore the pre-disturbance conditions for these facilities are similar to that described in Section 5.4.2.5 and Figure 5.4-5.

5.7.3 Development Status

5.7.3.1 Buildings and Infrastructure

Most of the large buildings at EKATI were built in the Main Camp area in the first years of mine construction. All of these buildings are permanent structures which have been designed with a compact arrangement in response to the remote location and extreme cold climate. The construction of most buildings at the Main Camp was founded on bedrock. The use of steel piles and layers of compacted gravel with insulation was also part of the foundation. To minimize concrete and fill requirements, the steel piles were anchored in bedrock. Major piping (*i.e.*, water, processed kimberlite, fuel, *etc.*) is above ground to minimize excavation requirements and to provide ease of disassembly.

Figure 5.7-1 shows the buildings at the Main Camp. They are listed in detail below:

- ***Main Accommodations Complex***. This consists of 940 sleeping accommodation rooms, dining, kitchen, and recreation areas, first aid station, emergency response/mine rescue stations and maintenance shops. A sewage treatment plant, water treatment facility and incinerator room also adjoin the eastern section of the main accommodations building.
- ***Power Plant***. This is EKATI's main power plant, consisting of seven 4.4 MW diesel generator sets. It provides power to the process operations, accommodations and truckshop/office complex. Waste heat from the power plant diesel engines is recovered by means of glycol heat exchangers. The recovered heat is used to heat buildings and process water.
- ***Process Plant***. Constructed primarily with structural steel sheathed with insulated steel panels and bolted construction on the main frame. The floors are concrete on insulated ground slabs or on metal deck-form work and have interior curbs for the containment of spills. A security fence surrounds the entire area.
- ***Bulk Sampling Plant***. This was moved from Old Camp in 2003 to the Main Camp Process Plant.

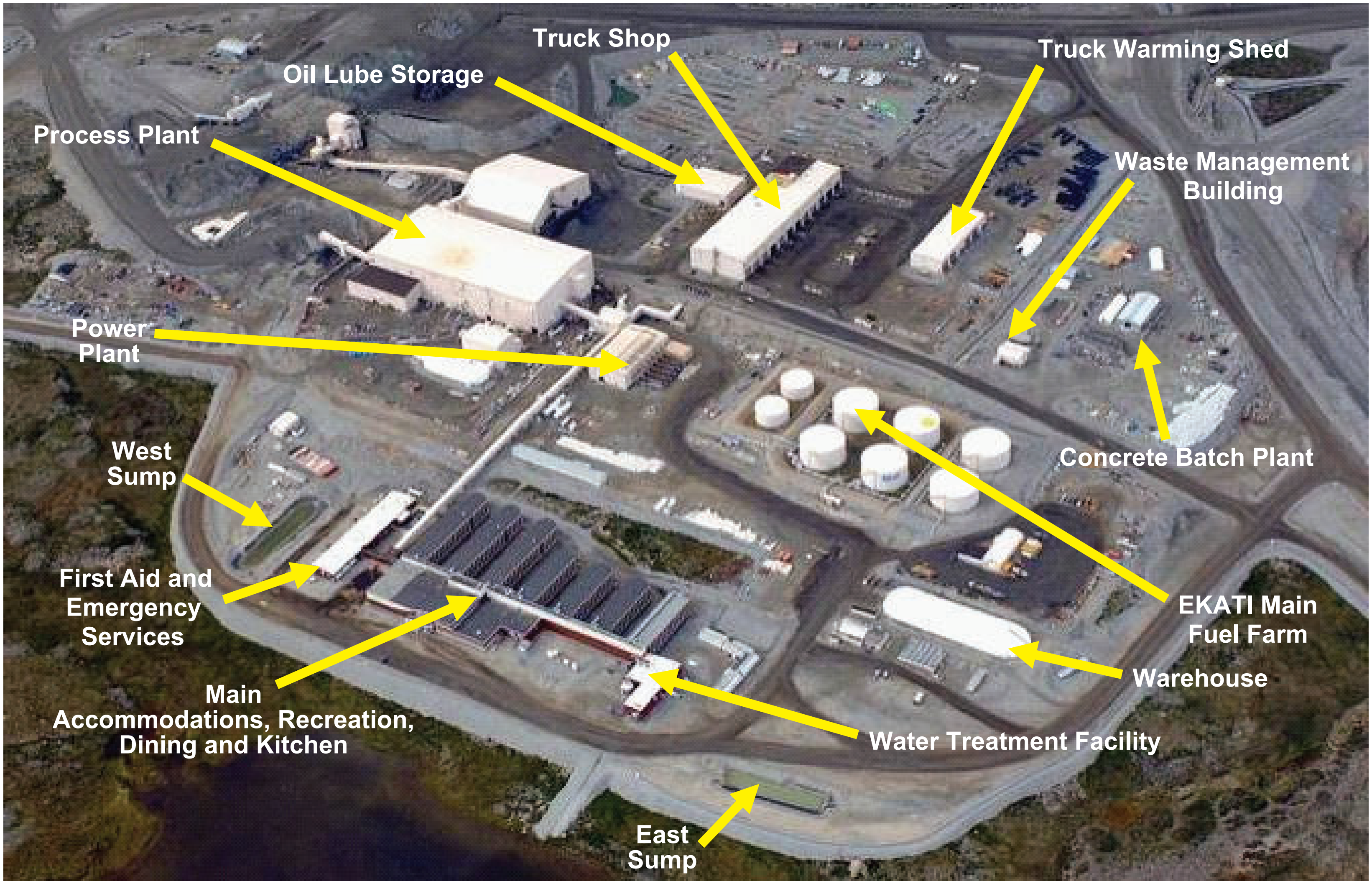

Figure 5.7-1

Main Camp Buildings and Infrastructure (2006)

- ***Truckshop/Offices/Warehouse Complex***. This provides for heavy and light vehicle maintenance, heated warehouse storage, change rooms, an environmental laboratory and administration offices. The truckshop and warehouse are on the bottom floor and include seven heavy equipment repair bays, three light vehicle repair bays, two tire-shop bays, one fabrication bay, one lube bay, one bucket welding bay and one vehicle wash bay. Dirty water from the vehicle washing bay is settled, filtered, and recycled in the wash system. A vacuum truck reclaims the skimmed oil and sludge. A warming shed facility adjacent to the truck shop has seven bays used for equipment storage.
- ***Bulk Lube Facility***. This was constructed adjacent to the Truckshop in 2002 to hold bulk lubricant and glycol.

Ancillary buildings that are located within the EKATI Main Camp area include:

- ***Ammonium Nitrate (AN) Storage Facility***. This is located southwest of the Main Camp, adjacent to Kodiak Lake. The original building accommodated up to 12,500 tonnes of AN. Expansion of the plant in 2003 increased the capacity to 16,500 tonnes.
- ***Emulsion Plant***. This is located 800 m to the north of the AN Building, as required by government regulation.
- ***Waste Management Building***. Wastes to be sent off site are prepared for transport at the Waste Management Building. Materials are collected and segregated into recyclable and hazardous wastes from operation areas on a daily basis. Wastes destined for off-site are stored in sealed barrels on pallets, and B-Train tanks holding bulk liquid wastes, in lined and bermed areas. Inventories of the wastes stored are kept at all times.
- ***Site Maintenance Shed and Sprung Facility***. This is used for shipping and receiving, during winter road operations and for aircraft freight. They also house mobile equipment used for general mine site maintenance.
- ***Airport Building***. This is located on the airport apron and is the control point for all EKATI flight operations both fixed wing and helicopter.
- ***Geology and Helicopter Facility***. Located on the Misery Road approximately 1 km from the Main Camp. There are a number of small structures on the Geology Laydown pad which support exploration drilling (Sprung structure), and helicopter flight operations (summer use trailers).

Surface facilities to support the Panda, Koala North and Koala underground operations include two maintenance shops, a warehouse, an office complex/change house, a compressor building and batch plant (for mixing concrete), a cold storage building, and a 1 million L fuel tank located within a bermed area (Figure 5.7-2).

5.7.3.2 Satellite Facilities

Old Camp was constructed in October 1993 to support exploration activities, and bulk sampling facilities, and later used to house employees during the construction of the EKATI Main Camp. Figure 5.7-3 shows the location of Old Camp. The camp was located at the south end of the present day EKATI Airstrip, adjacent to Larry Lake. The camp has been closed and is in the process of being reclaimed. The camp included a pilot process plant, tank farm, truck shop and equipment storage facilities, as well as office, accommodations and kitchen trailers and weather haven facilities.

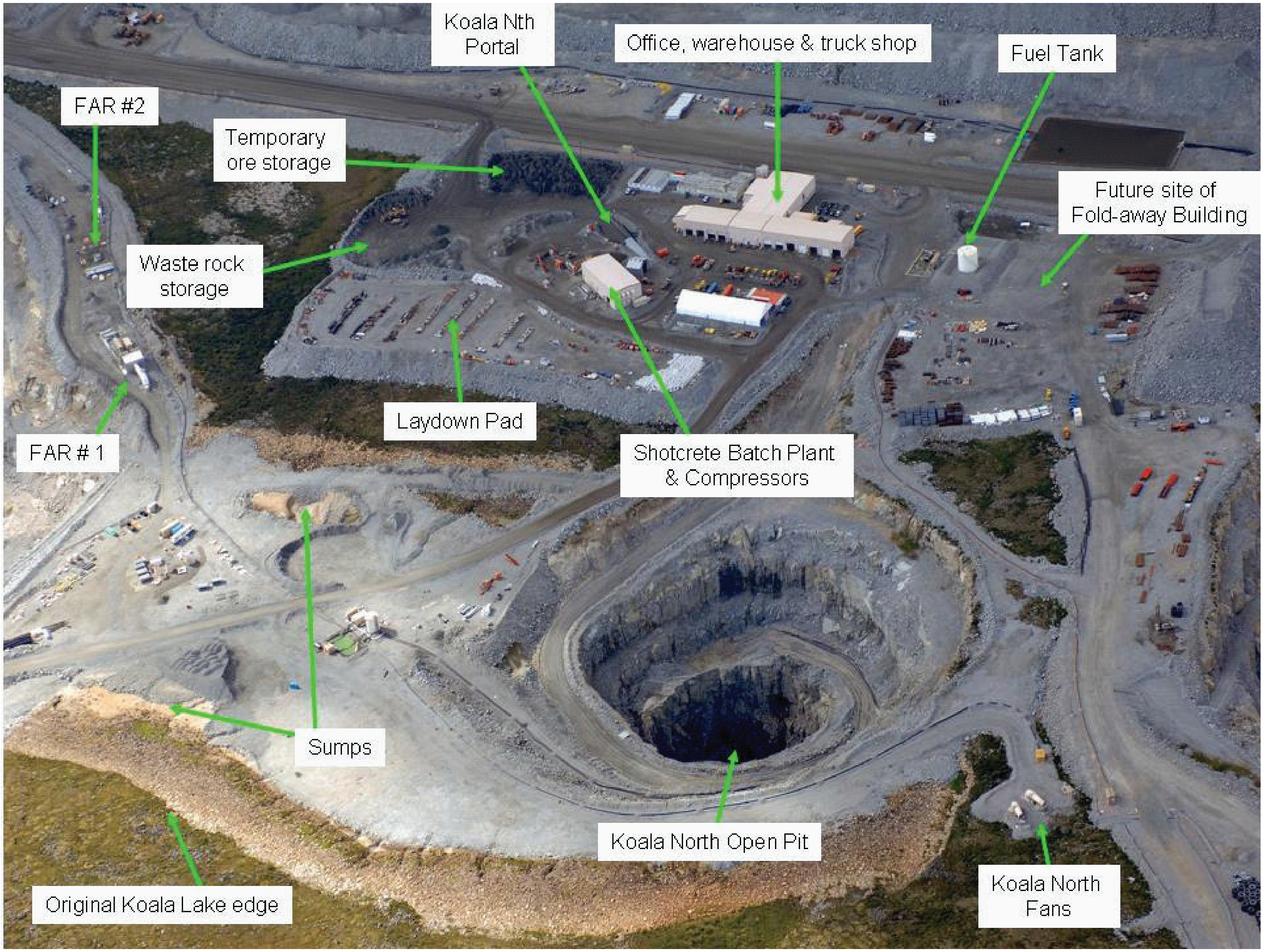

Figure 5.7-2

Underground Support Facilities (2006)

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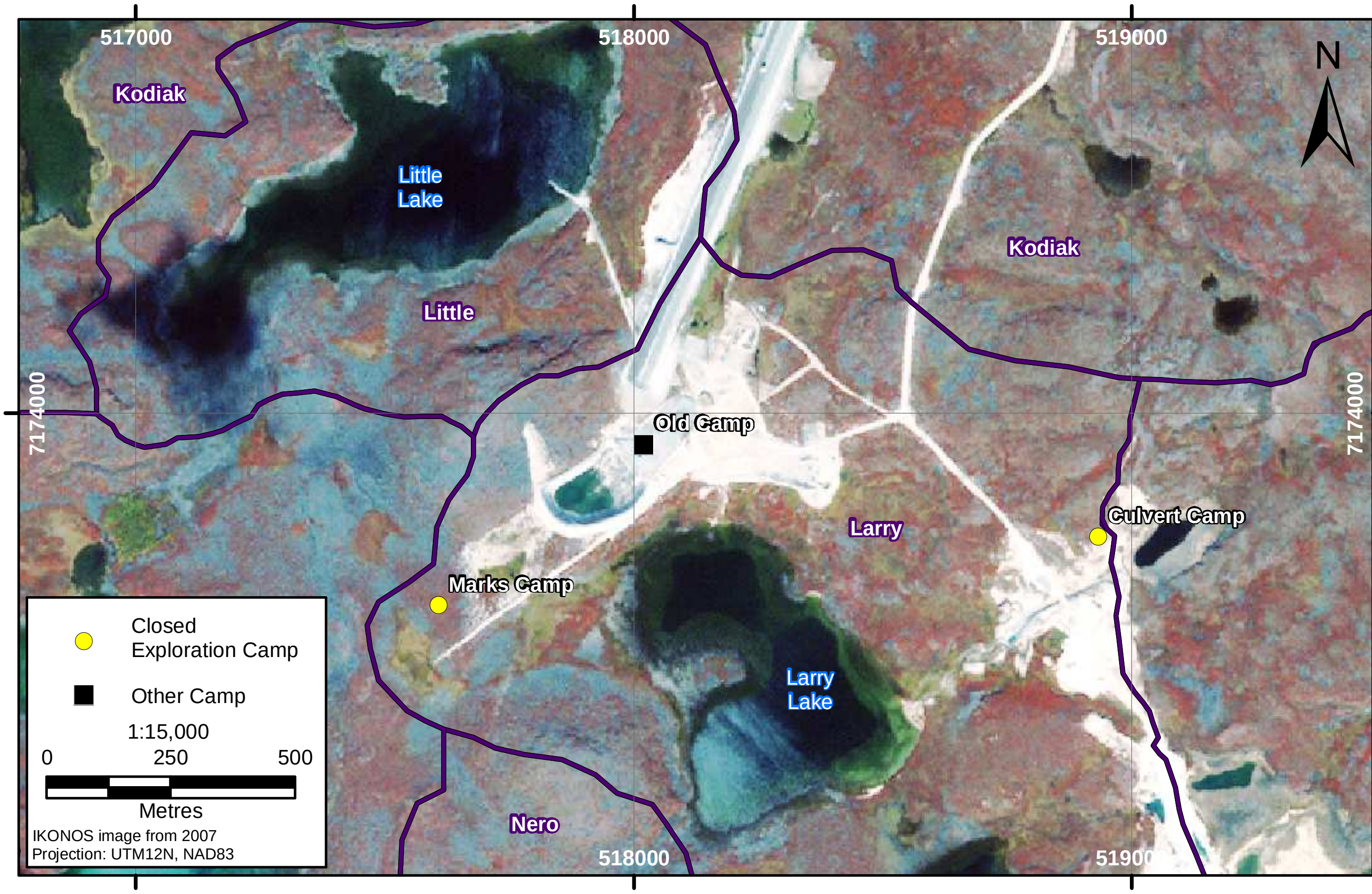

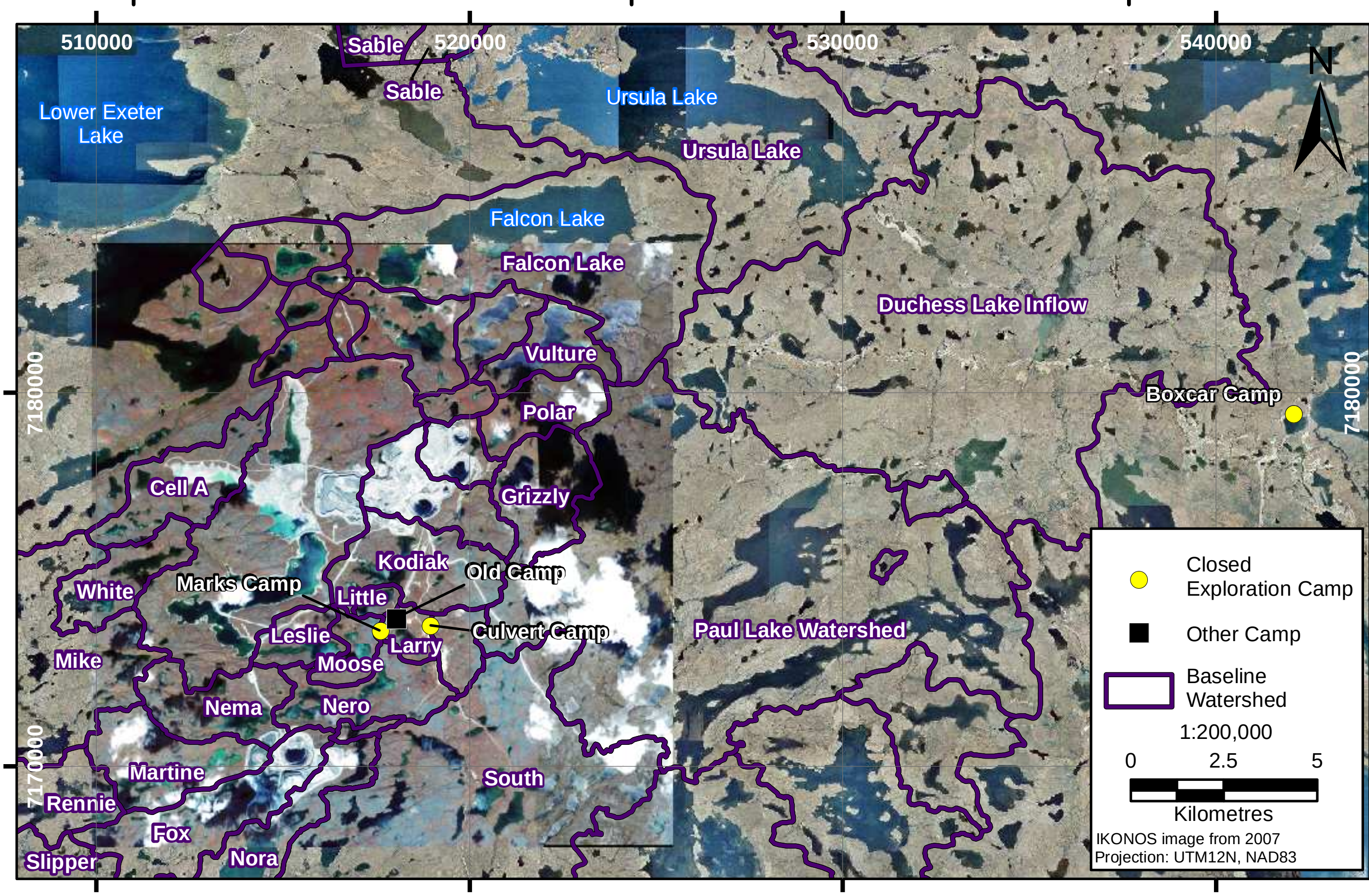

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Locations of Exploration Camps and Old Camp

FIGURE 5.7-3

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In 2000, decommissioning of the site began with the removal of some accommodations and office trailers. Salvageable structures were moved to Misery camp and the Main Camp, and damaged or non-useable structures were buried in a landfill at the Panda/Koala/Beartooth WRSA. Salvageable kitchen, bedding and office equipment were transported down the winter road to Yellowknife. Over 2001 and 2002, the remaining infrastructure, which included sea-cans, trailers, a pilot Process Plant, pipeline and fuel tanks were removed from the site. Over 2003 and 2004, an environmental site assessment was completed for the Old Camp pad. Remaining reclamation work for the site includes mitigation of remaining hydrocarbon contaminated material, landscaping and vegetation of the pad and reclamation of the Phase 1 Containment Area.

Facilities at the Fox Pit include two 9 million L fuel tanks, a truck line-up area (located on the WRSA), a dispatch trailer, and a temporary trailer complex which houses washrooms, lunchroom facilities, first aid station, and offices. Explosive magazine storage facilities for the Fox Pit are located north east of the LLCF Outlet Dam. There are no overnight accommodations at the Fox Pit site.

The facilities associated with the satellite operations at the Misery Pit were constructed on a smaller scale than those at the Main Camp. The original facilities where sized for 150 people, but this has now been down-sized to a 50 person camp which is used for winter exploration programs. The facilities include a small power plant, camp accommodations/offices for 50 people, first aid facilities, a small workshop and a 9 million L bulk fuel storage tank within a bermed area. Infrastructure for a Land Treatment and atomization system in place at Misery includes a water pumping station, an operating plant, approximately 1 km of 8 inch pipeline, and two 12 m high water atomization towers (EBA 2002b).

5.7.3.3 Exploration Camps

Mark's Camp was located about 0.5 km south of the Koala Camp (Old Camp), and was used as a temporary winter camp for exploratory drilling operations between 1993 and 1994. It was moved to the Old Camp location in 1994 and the site was reclaimed. Figure 5.7-3 shows the location of exploration camps.

Culvert Camp was a temporary camp constructed in the winter of 1997 to hold overflow from Old Camp, and included approximately six trailers and a 500 L fuel tank and was reclaimed in 1998.

Boxcar Camp was a mobile camp located on the shores of Paul Lake. The camp was operational during winter months for exploration. It contained 10 trailers on skids, a sea-can, water tank on skids, incinerator on skids, a couple of cold storage sheds, and a 77,000 L, self-bermed green tank with bermed fuel module. The infrastructure was removed on the 2005 winter road and the remainder of the site reclaimed in the summer of 2005.

To date Mark's Camp and Culvert Camp have been reclaimed under the requirements of the Land Use Permits (Appendix 1.1-4). The reclamation requirements of exploration camps are covered under Land Use Permits. Reclamation activities and successful completion of reclamation is monitored and signed off by the INAC Inspector under the requirements of these Land Use Permits. Norm's Camp (constructed in 1991) is located adjacent on the west shore of Upper Exeter Lake. The airstrip that supplied the camp was operational until 2001 when it was closed to all traffic and markers were placed to indicate that the airstrip was decommissioned. This camp was transferred in ownership in 2010, and is no longer part of the EKATI Land Use Permits.

5.7.3.4 Petroleum and Chemical Storage Areas

A central bulk fuel tank farm, which contains eight tanks and approximately 68 million L of diesel fuel is located at the Main Camp. Other fuel tank farms are currently located at the Misery, Fox and Koala North sites. Fuel storage facilities will also be constructed at the Sable and Pigeon pits. The fuel tanks are double lined and housed within bermed areas on an impervious liner. The fuel tank farm at the former Old Camp was removed in late 2002.

A bulk lube storage facility at the Main Camp houses bulk antifreeze, engine oil, hydraulic oil, transmission oil, gear oil, glycol and waste oil. A list of all tanks used for storage of petroleum and chemicals, their locations and capacity is maintained at the mine site. For an inventory of specific fuel and lubricant storage type and location please refer to the EKATI Diamond Mine Spill Contingency Plan (BHP Billiton 2006a).

5.7.3.5 Pipelines and Pump Stations

Pipelines and pump stations support a variety of operations at EKATI. The following list provides the main pipelines and pump stations in current operation at the mine site:

- ***Central Dewatering System***. Mine water from Panda Underground and Koala Pit are pumped through a central dewatering system which bypasses the Process Plant and uses an in-line flocculent/coagulant treatment plant for in-line treatment of suspended solids.
- ***Mine Water***. The Misery Pit is under a temporary suspension of operations. During operations, and as required while in suspension, water from Misery Pit is pumped to the King Pond Settling Facility. The pipeline from Misery Pit to King Pond has an in-line treatment plant where flocculants and coagulants can be injected as required. Mine water from Fox Pit is pumped via the existing pipeline from Fox Pit through an in-line flocculent/coagulant treatment plant and discharged to an established location in Cell D of the LLCF.
- ***Process Plant Pipelines***. Processed kimberlite is carried in heat-traced pipeline as a slurry to the LLCF. The Process Plant operations only use recycled water from the LLCF. The water is pumped from a heated and insulated pump house through a heat-traced pipeline to the raw water storage tank at the Process Plant.
- ***Potable Water***. Potable water for domestic consumption is drawn from Grizzly Lake. Water is pumped through a 3.3 km-long insulated and heat-traced pipeline to a water treatment module at the Main Camp. Fresh water use for underground operations is piped from a split in the Grizzly pipeline. At present, the piped water for the underground is used for mixing cement.
- ***Pit Flooding Pipelines***. Pipelines for pit flooding will be constructed from Ursula Lake to Sable Open Pit, from Upper Exeter Lake to Pigeon Open Pit, from Lac de Gras (at the Paul Lake Bridge) to the Beartooth, Panda, Koala, and Fox Pits. Misery Pit will be flooded directly from Lac de Gras. Dependent on pit flooding timing, pipeline will be reused for the various pits.

5.7.3.6 Electrical Systems

The power plant uses a diesel generator system to provide electricity. There are six generators, each capable of delivering 4.4 MW at 4,160 V (3-phase). The present average load is approximately 16 to 17 MW, with daily and seasonal fluctuations. Waste heat from the Power Plant diesel engines is recovered by means of glycol heat exchangers. The recovered heat is used to heat buildings and process water.

5.7.3.7 Quarry Sites

The Airport Esker was the main source of granular material during Old Camp operations and in the early years of the EKATI Mine site construction. It is a prominent north-south oriented ridge located approximately 1 km southeast of the Old Camp. It contains high quality material and is located relatively close to construction and underground mining activities. Materials from this esker were used for construction of the Old Camp Pad, the airstrip, and some local roads. Quarry material from the esker was recently used for shotcrete (sprayed concrete) construction in the Koala North and Panda Undergrounds.

All well-bonded permafrost material obtained to date from the Airport Esker has been excavated using a progressive thaw and strip operation. The west side of the esker deposit slopes gently towards several natural drainage channels. During summer, warm air temperatures thaw the exposed surficial layer of the esker. As the gravel thaws, the material is scraped with a bulldozer and turned over to continuously expose a fresh surface to the summer heat. Continued extraction from the Airport Esker requires the excavation of material that impounds an adjacent waterbody (Airstrip Lake), which was dewatered in summer 1997. This allows further excavation of granular material while forming two sediment settling ponds in the basin of Airstrip Lake. The sediment settling ponds effectively protect against erosion of exposed lake sediments. Ground ice occurs in the core of the Airport Esker, which can be a long-term hazard to landscape stability. To maximize the rate of thaw of frozen material and minimize the formation of deep thaw pockets in the pit, positive drainage is maintained.

In recent years crushed granite rock has replaced esker material for use on roads, dams, dikes and camp and laydown pad construction. Crush is also used for resurfacing of the airstrip and for road traction during winter. Crusher equipment and storage areas are located on the Panda/Koala/ Beartooth and Fox WRSA.

5.7.3.8 Camp Pads and Laydowns

There are three major camp pads located at EKATI: the Main Camp, the Underground support facilities and Misery camp (Figure 5.7-4). They are used for infrastructure and materials storage.

5.7.3.9 Ore Storage Pads

The Main Camp kimberlite ore storage pad is located north of the Process Plant primary crusher. This site holds all ore from the open pits and underground operations. Throughout the mine life, the kimberlite ore storage area at the Main Camp will accommodate any surges in ore production and allow for a constant feed of ore directly into the primary crusher as the Process Plant requires. The storage area is approximately 50 m north of the primary crusher and has a capacity of 200,000 tonnes. By the end of the mining operation, all of the stored ore will have been processed.

There is also a temporary kimberlite ore storage pad at the Misery site adjacent to Misery Road. The ore material on this pad was removed to the Process Plant during Misery operations suspension.

5.7.3.10 Sumps and Collection Ponds

Rain and snowmelt water falls on and collects around roads, camp pads, waste rock piles, and related infrastructure around the mine. This water follows natural flow paths and, where possible, must be collected and managed. There is a potential for this water to become turbid.

Snowmelt and rainwater runoff from areas with high vehicular traffic and in the vicinity of existing infrastructure at the EKATI Main Camp site are collected in ditches and sumps. Collected surface runoff that does not meet licence discharge criteria is pumped or trucked to an approved water containment facility (*e.g.*, various cells of the LLCF including Cells A, B, C, and/or D, and King Pond Settling Facility). Water that meets licence discharge criteria may be discharged to the receiving environment.

Figure 5.7-4

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Misery Camp Pad (2006)

Figure 5.7-4

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Drainage from the northern portion of the main EKATI site, where the coarse ore stockpiles are located, is contained and captured by sumps and diversion ditches before it reaches the Panda and/or Koala Pits. The sumps and diversion ditches are located on the edge of the pit and are part of the surface water management system for the pit area. The collected surface water is pumped to various cells of the LLCF including Cells A, B, C, and/or D. Surface water flow cannot be allowed into the pits where it could cause flooding in the underground.

Runoff from the coarse kimberlite ore rejects surge pile is directed to the surge pile sump where the water is cycled into the Process Plant. Runoff from the southern portion of the plant site is diverted into a sump by a perimeter berm and swale located along the south edge of the plant site. Two collection/retention ponds (east and west) are used to capture this surface flow. The collection/retention ponds have been constructed with geomembrane liners to minimize seepage losses. The water from the collection/retention ponds is pumped to the various cells of the LLCF including Cells A, B, C, and/or D.

Misery site drainage is collected by a series of containment structures/sumps and the Misery Pit. Water collected in the sumps and the pit is pumped to the King Pond Settling Facility prior to discharge to the environment each summer season following confirmation that the water meets water licence requirements.

Drainage and runoff that flows toward the Fox Pit is captured before it reaches the pit by a surface water management system (*e.g.,* sumps and diversion ditches, *etc.*) and is pumped to the LLCF. An in-line flocculent treatment plant may be utilized, depending on water quality, before the water is discharged to the LLCF.

5.7.3.11 Roads, Culverts, Bridges and Airport

<u>Roads</u>

Roads within the mine area are constructed at two different widths, depending on whether they are access roads or haul roads. Access roads support light-duty trucks, and include plant site and service roads. Haul roads support large haul trucks and mining equipment and include those roads in mine pits, to and on WRSA, for ore haulage to the coarse ore handling at the plant site, and the Misery and Sable roads. Both types of roads have been constructed primarily from waste rock excavated during mining.

Access roads are constructed with 10 m-wide surfaces to accommodate two-way traffic. The roads are built on fill where required to insulate the underlying permafrost. Safety berms (2 m wide) are added wherever the drop-off exceeds 3 m, and slots are cut periodically to permit snow removal and accommodate wildlife crossing. Culverts are placed where the roads intersect major natural drainages. In recent years a number of specific caribou crossings have been constructed on the EKATI roads in areas of caribou migration. This will continue as required during closure.

Haul roads, with the exception of the Misery road, and the future Sable road are approximately 30 m wide at the crest (Northwest Territories Mine Health and Safety Regulations require a haul road width of 20 to 30 m) and are constructed to a standard that will allow safe and efficient operation of large mining trucks. Many of these roads are within the footprint of the open pits and WRSA. Shoulder berms are constructed wherever the drop-off exceeds 3 m. Breaks are incorporated at intervals along the road to allow for drainage and snow clearance.

The Misery road averages 21 m wide and is constructed with a minimum fill thickness of 1.8 m (2 m on average). The side slope ratio negates the requirement for safety berms. A 40 m-long, single-span bridge with 2 m clearance was constructed during winter 1997 to cross the stream that connects Paul

Lake and Lac de Gras (referred to as the Paul Lake Bridge). Twelve caribou crossings were also strategically placed on the Misery road. The Sable road is expected to be a similar construction to the Misery road with an emphasis on maintaining a low profile to reduce fill heights.

Culverts and Bridges

Culverts have been placed in roadways, under the EKATI Airstrip and in the Panda Diversion Channel to divert water through mine infrastructure. There are at least 70 culverts located throughout the EKATI mine site and these will be progressively removed at closure. The Paul Lake Bridge is located approximately 14 km south of the Main Camp, on the Misery Road. The Nema-Nero Bridge is located on the Fox haul road, south of the LLCF Outlet Dam.

Airport

To support various size aircraft (*e.g.*, Hercules C130 and Boeing 727/737 jets), a 1,950 m-long airstrip was constructed using esker sand and granite waste rock as the base and compacted crush gravel for the surface. Other gravel-filled areas constructed to support the airstrip include a parking area, loading and service areas, an access road, and an aircraft control building, which are all located at the north end of the airstrip. The airport is also equipped with runway lighting and approach system, navigational aids, radio transmitters and weather observation equipment. Both the airstrip and access road had culverts placed where appropriate. A helicopter pad with accommodation for three helicopters is located on the Geology Laydown pad adjacent to Misery Road, and approximately 1 km from the Main Camp.

5.7.3.12 Mobile Equipment

EKATI uses a multitude of mobile equipment to support both open pit and underground operations. The mobile fleet is a combination of track mounted (*i.e.*, dozers) and rubber tire mounted (*i.e.*, trucks) equipment. The majority of all mobile equipment is diesel powered. The open pit and underground support equipment is standard to most mining operations in the north as well as around the world.

Other mobile equipment includes drill rigs, loaders, shovels and dozers, underground haul trucks, and ancillary equipment such as graders used in both the open pits and the underground operations. It also includes all the emergency and light vehicles used across the site.

5.7.4 Hydrocarbon Contaminated Sites

Hydrocarbon impacted materials at EKATI are managed under the Hydrocarbon Impacted Soils Management Plan (BHP Billiton 2007c). The following material disposal locations are in operation at EKATI:

- Contaminated Snow Containment Facility (hydrocarbon-impacted snow and ice);
- Landfarm (rock and soil <4 cm);
- Zone S (rock and soil >4 cm);
- Long Lake Containment Facility (sump water, underground spills); and
- Waste Management Building (used oil filters and fuel filters, oil-based paint cans, empty containers with hydrocarbon residue).

All spills are recorded at EKATI. Spilled material and liquids are removed by spill pads and excavation. BHP Billiton has in place a Spill Contingency Plan (BHP Billiton 2006a) that outlines Spill Prevention, Spill Response, Spill Training and Reporting Procedures. A 'First Priority' database is used to record the type, volume and location of all spills at EKATI.

5.7.5 Waste Management

Waste streams at EKATI are divided into eight major categories:

- ***Incinerator waste***. Food and office waste are collected from various locations at site and taken to the Accommodations Complex for incineration. Numerous containers labelled “Incinerator Waste” exist across the site to capture these wastes where they are generated. Waste management crews inspect the contents regularly, empty them as required and take the material away for incineration. Ash generated as a result of incineration operations is allowed to cool and is then trucked to the landfill for disposal. Remaining liquids are transported to an approved facility.
- ***Aerosol cans***. These are sorted at the source and placed into dedicated containers that are monitored and emptied as required. Waste aerosol cans are taken to the Waste Management Building where they are punctured, drained and incinerated. The burnt cans are disposed at the landfill.
- ***Landfill waste***. There are a number of “roll off” type industrial bins dispersed across EKATI that are labelled as to the acceptable waste stream (e.g., plastic, glass, steel). These are large waste bins that are designed to be loaded onto the deck of a large truck designed for this purpose, and driven to the landfill, emptied and returned and unloaded at the same location. These bins are monitored by Waste Management and Environment to ensure that only approved wastes are disposed in these units. Once full, they are taken to the landfill, emptied and returned.
- ***Batteries***. Automotive batteries are collected at the Waste Management Building where they are placed into suitable containers for shipping from site to an approved disposal/recycling facility outside the Northwest Territories. Small disposable batteries (e.g., “AA’s”, “C’s”) are collected in dedicated containers at source generation points. The containers are monitored, emptied as required and the batteries are taken to Waste Management. There, they are placed into a larger container and shipped from site for recycling and disposal.
- ***Biohazardous material***. EKATI has dedicated containers dispersed across site for these wastes (e.g., razors, syringes). They are handled by the site medical contractor who collects and ships the wastes from site for proper disposal.
- ***Oily rags***. These are collected at source generation location in dedicated containers. The containers are monitored, emptied as required and the rags incinerated at the Waste Management Building.
- ***Oil and filters***. Waste oils are collected at source generation locations across the site in labelled containers. They are then stored in larger tanks on site and reused as fuel in furnaces that supply warm air to underground operations. Oil filters are drained to remove the contents and the filters are transferred to dedicated containers at source generation locations. They are collected from these locations, taken to Waste Management and shipped from site for recycling/disposal purposes.
- ***Waste grease***. Waste grease generated from the kitchen is incinerated at the Accommodations Complex. Waste grease generated at vehicle servicing locations is collected into suitable containers and is shipped from site to an appropriate facility.

Waste glycol generated from equipment servicing is collected in dedicated containers and shipped from site for recycling at an approved facility. Air filters generated at site are deposited in the landfill.

BHP Billiton supports and encourages waste minimization by recycling. Where wastes can be recycled without additional transport, these receive preference. Materials shipped off-site for recycling or disposal in the NT are forwarded to facilities registered with the Government of the Northwest Territories. Material shipped outside the territory for recycling or disposal is forwarded only to those facilities approved by applicable government bodies for acceptance of waste. BHP Billiton confirms the manner of recycling and waste disposal prior to entering into an arrangement. The selected facility is audited and is required to provide certification of recycling/disposal. Waste management procedures and products that are recycled during mining operations are provided in EKATI Waste Management Plan (BHP Billiton 2003c). Table 5.7-2 is a list of products that are recycled during mining operations.

Table 5.7-2. Recycled Products at EKATI

Product	Recycled Use
Lead-Acid Batteries	Transported off site for recycling of lead core and plastic casing.
Used oil filters	Transported off site for recycling of metals and residue oils.
Used Oil	Transported off site for recycling. Also used on site.
Lumber (large pieces)	Salvageable lumber recycled on site.
Plastic petroleum pails	Transported off site for recycling of plastic.
Oil based paints	Transported off site for recycling.
Scrap metal	Salvageable product recycled for site use or buried in landfills.
Used or damaged auto parts	Salvageable parts returned to supplier for refund.
Waste Glycol	Transported off site for recycling.
Empty Drums	Returned to manufacturers for credit.
Alkaline Batteries	Sent to secure landfill.

5.7.6 Projected Development

5.7.6.1 Overview

Planned support facilities for Sable Pit include a small warehouse, field office complex (lunch room, washrooms, first aid room and emergency accommodations), fuel storage, truck line-up area, and an explosives magazine. Mine water from Sable Pit is planned to be pumped to Two Rock Sedimentation Pond.

The Sable road will be approximately 18 km long (from Pigeon) and up to 24 m wide. The road will be constructed as a low profile road that minimizes fill heights to as great a degree as practical. This will build on the positive experiences gained from the Misery Road. Two types of culverts will be used: an arch culvert at the Pigeon Stream crossing, and round culverts at three other stream crossings. Falcon road, which will run from Falcon Lake to Sable road, will be used for road watering access during Sable Pit operations. The road width will be 14 m and length will be 0.5 km.

Pigeon Pit will be connected to the Main Camp by an all-weather road and the planned facilities include a temporary emergency shelter and supplies. Mine water from Pigeon Pit will be pumped to the drainage basin of Little Reynolds Pond. Water from this pond has a natural outflow stream that discharges directly to the north end of Cell B of the LLCF.

5.7.7 Final Landscape at Closure

5.7.7.1 Buildings and Infrastructure

At closure all buildings and surface support infrastructure will be decommission and removed. Depressions where buried infrastructure will have been excavated and removed will be filled in with granite waste rock. All piles will be cut off at surface and concrete foundations will be capped with waste rock. Where surface stabilizing work is required these sites will have a granite cover or will be vegetated with native vegetation. Surface drainage will be re-established where necessary. An assessment of remaining surfaces will be conducted and selected sites will be landscaped to encourage natural vegetation through trenching and boulder placement to create depressions for snow capture and plant colonizes to collect and propagate. Those areas with potential for erosion (wind or water) will be stabilized with rock or vegetation cover, with the use of salvaged topsoil in places where vegetation will have the best opportunity for establishment. Research studies for the Buildings and Infrastructure mine component are underway to determine the best methods for establishment of plant communities, and the most effective used of salvaged topsoil to create landscapes that best ensure sustainability of plant communities that will be compatible with surround tundra ecosystems (Reclamation Research Plans #24 and 25 of Appendix 5.1-4).

A diverse vegetation cover comprised of shrubs, herbs, grasses, mosses and lichens is expected to develop on areas of topsoil cover, while the roughened pad will provide habitat for the more xeric vegetation such as dwarf birch, crowberry, willow, grasses, sedges, lichens and xeric mosses. The left-hand panel of Figure 5.7-5 shows natural colonization of dwarf birch and grasses at the Airport Esker. The middle panel shows the Tercon laydown area which was landscaped in 2000. In the following year it was helicopter-seeded with a uniform but sparse cover of native-grass cultivars (EBA 2003). The right-hand panel illustrates the results of long-term colonization of a granular pad at Lupin Mine where a diverse vegetation cover has developed within a period of 17 years. This work has enhanced conditions for plant colonization from the adjacent tundra.

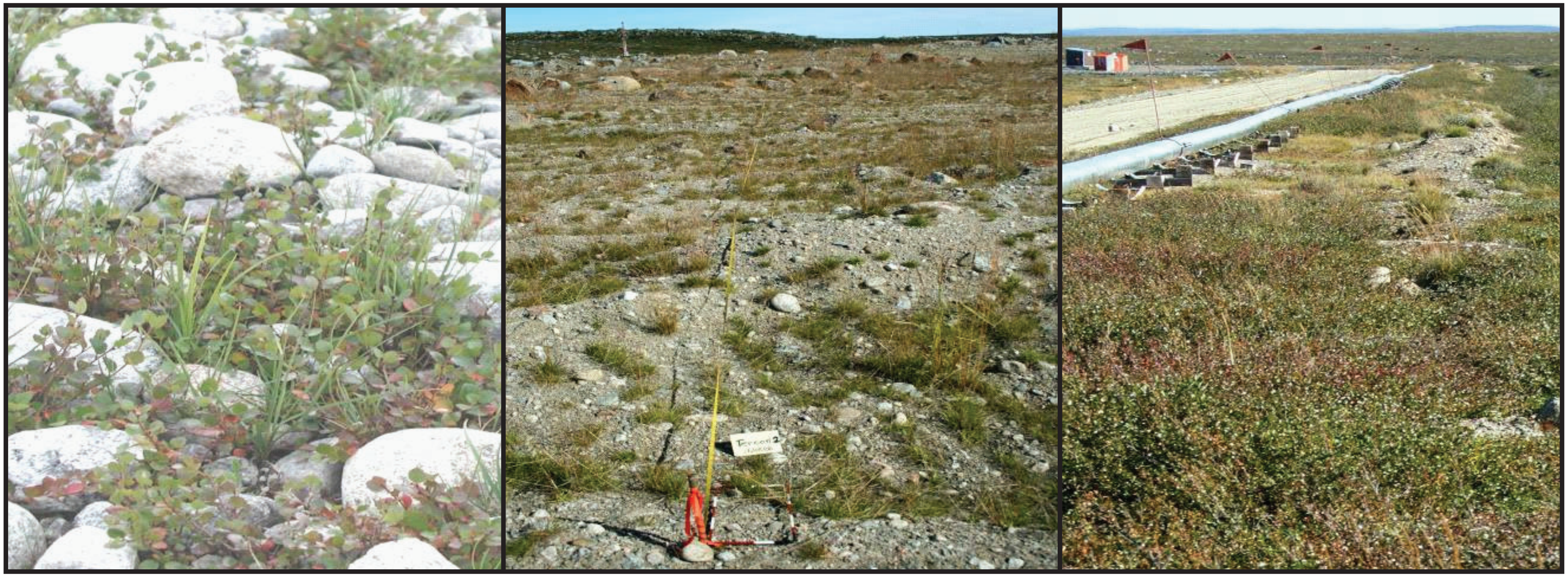
Small ponds that form on the esker as a result of thermokarst erosion from quarrying will be considered part of the final landscape unless there are potential negative impacts to nearby productive waterbodies. The residual ponds will be stabilized at a new and final water surface elevation. Re-vegetation efforts may include seeding and fertilization in selected areas to promote surface stabilization, and transplanting of aquatic species in ponded areas to create wetland communities. The final landscape will depend on the extent of re-vegetation efforts, but will probably include barren patches interspersed with stands of xeric grasses and forbs. Ponds may contain stands of Arctic pendant grass and sedges along their margins.

Natural colonization is expected to be the principal means for vegetation recovery on the roads and airstrip. These areas will serve as travel corridors and insect relief habitat for caribou. Many roads, such as the Fox, Misery and future Sable Road with low profiles which allow easy access and egress by wildlife will continue to be used by caribou, and as evidenced through WEMP monitoring are not expected to restrict migration routes through and around EKATI.

5.7.7.2 Designing for Closure

Examples of designing for closure for the buildings and infrastructure include:

- Buildings are located on bedrock and stable ground to minimize the need for excavation and additional disturbance of the terrain. This reduces the amount of disturbance that needs to be reclaimed at the end of the mine life.
- Facilities are designed and constructed to avoid degradation of the permafrost.
- Waste material used for pads is inert to ensure it does not become a source of contamination long-term after closure.
- Arctic corridors reduce the amount of excavation required to bury the supply lines and reduce the amount of work to reclaim and close these facilities. Arctic corridors also prevent the degradation of permafrost.



Examples of Natural Colonization

Figure 5.7-5

- Containment systems around fuel and chemical storage areas prevent the release of hazardous materials and therefore reduce and eliminate areas of hydrocarbon-contaminated soils.

5.7.8 Closure Objectives and Criteria

Section 1.4 describes the Reclamation Goal, Closure Objectives and Closure Criteria, and Appendix 5.1-1F shows a comprehensive list of closure objectives and criteria for the Buildings and Infrastructure mine component, with Actions/Measurements and linkages to reclamation research, engineering studies and closure monitoring. The Closure Objectives that were developed for the Buildings and Infrastructure mine component and are:

- fugitive dust levels meet Canadian Ambient Air Quality Objectives;
- remove (or cut to surface) surface infrastructure (i.e., buildings, pipelines, tanks, bridges, culverts, electrical);
- all demolition material has been removed;
- hydrocarbon storage sites are decommissioned;
- removal/remediation of hydrocarbon contamination;
- removal of hazardous materials (ammonium nitrate, batteries, etc.);
- native vegetation used for rehabilitation work;
- sites rehabilitated with plant cover have sufficient plant cover to stabilize land surfaces;
- camp pads, laydown areas, sumps, roads and airstrip are stabilized;
- quarry sites are stabilized to prevent permafrost degradation;
- EKATI Airstrip is decommissioned;
- surface drainage patterns are established to ensure runoff is channelled through the watershed;
- water quality downstream of ore storage pads is maintained;
- remaining surface areas are safe for wildlife use;
- wildlife are using the EKATI claim block;
- Buildings and Infrastructure mine components are left in a healthy state that support continuation of human land use activities;
- appropriate safety control measures in place for reclamation activities associated with reclaiming Buildings and Infrastructure;
- community land use expectations and TK have been considered in the closure planning;
- archaeological sites are protected;
- Transition Plan in place;
- compliance with legal, regulatory, and corporate obligations;
- appropriate documentation is maintained for closure operations of Buildings and Infrastructure;
- sumps and collection ponds are safe for human use; and
- business procedures and policies in place for reclamation project development.

5.7.9 Reclamation Activities

5.7.9.1 Buildings and Infrastructure

The closure and reclamation of buildings and infrastructure will consist of removal of all site facilities no longer required for long-term monitoring or those facilities that have no potential alternative and sustainable use at the site. Decommissioning will begin with removal of the Process Plant and other infrastructure no longer required for mine operations. This will include buildings, electrical and heating supply infrastructure, and fuel and bulk lube storage facilities. Some buildings and infrastructure such as fuel tanks may be kept in operation during the period of mine reclamation and monitoring. Fences around the Process Plant will be removed.

The steel piles used to support buildings will be cut off and capped at ground level for safety reasons. Any concrete foundation will be left intact and capped with waste rock. Items that have a salvage value will be sold for potential use at other operations in the North. Infrastructure for the Land Treatment Project at Misery will be dismantled and buried in a landfill.

Surface facilities that support underground operations located on the Koala North Pad as well as temporary structures at Sable, Pigeon, Fox and Misery pits will be treated in the same manner as detailed for buildings at the Main Camp.

Remaining fuel will be drained from the fuel tanks and the tanks removed. Hazardous materials will be shipped off site, and inert materials that are damaged, unsafe or have no salvage value will be disposed of in an on-site landfill designated for demolition material. The location for the landfill will be finalized closer to final closure. The options for storage of inert demolition material include the WRSA and exhausted open pits. The landfill will be layered and backfilled with waste rock.

5.7.9.2 Satellite Facilities

All of the buildings, fuel tanks and equipment were removed from Old Camp by the end of October 2002 (BHB Billiton 2003a). Remaining reclamation work for the Old Camp Pad includes removing any remaining contaminated soils, landscaping the pad to provide topographic heterogeneity, which is important for successional re-vegetation, and then fertilization and seeding with native grass cultivars, legumes and shrubs.

5.7.9.3 Petroleum and Chemical Storage

At closure, most fuel and bulk supplies will have been used during de-commissioning since most fuel orders are for 12 months of operation. Some fuel, lubricant and glycol storage will be required at EKATI during the demolition, reclamation and pit flooding period, and therefore any re-supply will be based on the closure schedule. At the end of the reclamation period, any surplus fuels, ammonium nitrate, lubricants and other bulk supplies will be backhauled for use at another site, returned to the supplier or sent for proper disposal (if contaminated). Upon completion, all fuel tanks and bulk lubricant and glycol tanks will be removed. Any hydrocarbon-contaminated soils will be placed in an on-site landfarm and/or kiln-treated. Any remaining fuel sludge in fuel tanks will be removed from the site, the tanks will be cleaned, broken down and buried in a landfill.

5.7.9.4 Pipelines and Pump Stations

All water, processed kimberlite, sewage, and fuel lines will be dismantled and removed off-site for salvage, re-used at other operations, or disposed of at the on-site landfill or underground mine workings. The timbers to support the processed kimberlite pipelines will be removed and buried in a landfill or reused for the pit flooding program. The disturbed areas along the water lines will be re-contoured with the adjacent road. The crushed gravel used to support the lines can serve as surface substrate. Field observations to date indicate that low shrubs such as birch are establishing well on areas of fine crush material.

All water pump houses will be dismantled. The Grizzly Lake causeway constructed at the pump house will be left in place to prevent disturbance of the lake.

5.7.9.5 Quarry Sites

Reclamation activities will include stabilization of the remaining landform and the exposed portion of the lake sediments of Airstrip Lake. All worked areas will be cleaned of all debris. Positive drainage will be established. All culverts will be removed and the respective areas will be stabilized to prevent erosion.

The north end of the Airport Esker has been contoured and a drainage channel lined with riprap was constructed in summer 1997. A few locations showed evidence of subsidence 1 year after the area was contoured, which was expected. Seeding of erosion-sensitive areas with native-grass cultivars was completed in fall 1997. Initial plant establishment was successful. Additional seeding and fertilizer application was completed in fall 1998 in new areas and re-disturbed areas. Arctic hares were observed feeding in the area. Reclamation of the south end of the Airport Esker began in 1999 because it was no longer needed as a source of quarry materials (ABR 2002). Heavy equipment, construction debris and hydrocarbon-contaminated soils were removed, and the area was re-contoured to create shallow depressions and to scatter large boulders over the area to enhance surface roughness. Most of the area was barren, but small pockets of vegetation (*e.g.*, shrub birch, crowberry, polargrass, purple reedgrass and horsetail) were present in depressions. In August 2002, 7.4 ha of this re-contoured area was divided into 12 treatment blocks for planting with native forbs, native-grass cultivars, native wetland species, and birch (ABR 2002). The success of the reclamation of this area of the Airport Esker Quarry will be extended to the rest of the quarry at closure.

Fred’s Channel runs along the southern edge of the old Culvert Camp, crosses the Airport Esker and then empties into Larry Lake (ABR 2002). Reclamation work at Fred’s Channel is important because this site has been quarried in the past and the channel itself is an engineered structure. Ground ice has been exposed at this site and reclamation work is intended to help stabilize this area to prevent potential erosion. Remedial earthwork was performed in 2000 and 2001 to manage surface runoff and reduce thawing (ABR 2001). Re-vegetation efforts have focused on creating riparian habitats; between 1999 and 2001 this included planting willow cuttings, bundles and mats and transplanting Arctic pendant grass sprigs. Survival of these plants was low, but this was attributed to changes in temperature, precipitation, hydrology and erosion. The soil consists of gravel and sand, with low organic content and concentrations of nitrogen and phosphorus. The lower end of Fred’s Channel provides habitat for birds and caribou.

5.7.9.6 Camp Pads and Laydowns

Landscaping and re-vegetation work on the laydown and camp pads will be completed after the above-ground structures have been removed, and an environmental site assessment has been completed. Areas such as those with exposed bedrock or large boulder sites are not expected to support vegetation for at least several decades, due to the poor physical properties for supporting plants. Initial colonizers in these locations will be lichens and xeric mosses. Other areas with physical characteristics suitable to establish and support vegetation will be scarified and seeded to create conditions more conducive to plant colonization. Stored topsoil will be used for covering those sites that require amendment additions that would encourage re-vegetation.

Conditions for native plant colonization and establishment will be enhanced using a variety of techniques including:

- Deep ripping of the surface to relieve surface compaction and create depressions and microsites for the collection of soil fines and soil moisture. This will enhance conditions for establishment of seed via natural colonization and/or assisted re-vegetation.
- Construction of topsoil islands planted and seeded with a variety of native species including herbs, grasses and shrubs for the primary re-vegetation of strategic locations and to provide additional sources for native seed dispersal. Topsoil is limited at EKATI and judgment will be required to determine the best use of this material at closure.
- Establishment of a sparse cover of seeded native-grass cultivars over the area to further improve the microenvironment for plant colonization and to initiate soil biological processes.
- Application of fertilizer to boost soil nutrients for plant establishment and growth.
- Scattering of large boulders over the surface of the pad to collect snow, enhance wildlife habitat and provide a more natural landscape.

5.7.9.7 Ore Storage Pads

Ore will be removed from ore storage areas at Sable, Misery and the Main Camp and the pads will be re-contoured and scarified as necessary. As with the WRSA, natural re-vegetation is expected to establish slowly, with cover consisting mainly of lichens and mosses.

5.7.9.8 Sumps and Collection Ponds

Surface water collection areas that are within pit perimeters with water that does not meet licence discharge criteria will have water pumped or trucked to the LLCF. Their liners will be removed and buried in a landfill. Sumps and collection ponds located on camp pads will also be pumped to the LLCF if water licence criteria are not met. All sumps will have their liners removed and those will be buried in a landfill. Materials under the liners will be assessed for contaminants and if necessary managed as outlined in the Hydrocarbon Contaminated Materials Management Plan (BHP Billiton 2007c). Clean granite will be used to backfill the remaining depressions. It is expected that there would be no water quality concerns if any residual contaminated materials located below the liner have been managed, or from the waste rock used to fill these sump areas.

5.7.9.9 Roads

At closure some roads will be required for monitoring and to allow access to the reclaimed sites. These roads will have their safety berms, culverts and stream crossings (bridges) removed when access around the site is no longer required (Refer to Section 5.7.9.10 for reclamation at stream crossings). Natural colonization will be relied upon in these areas.

Roads not required during closure and monitoring are expected to be reclaimed by scarifying the surface and by removing culverts and safety berms.

Except in those sections of road considered hazardous to wildlife, shoulder berms will be knocked down and contoured to provide access for wildlife. Hazardous areas will be evaluated more closely at the time of reclamation activities. Potential areas may be locations where culverts or bridges have been removed, or steep roadsides where access is deterred by road berms.

5.7.9.10 Culverts and Bridges

Culverts will be removed from roadways and drainage channels will be re-established. Some drainages may need to be stabilized with riprap to prevent erosion and this will be considered on a case by case basis. The bridges at the Paul Lake Bridge on the Misery road and Nema Nero Bridge on the Fox road will be dismantled and deposited in the landfill site. Any concrete structures will be left intact to minimize disturbance of the existing stream crossing. The area around the channel will be contoured to match the natural topography.

5.7.9.11 Airport

After mine closure, and following the post-closure monitoring period, the airstrip will be decommissioned as per government regulations for unused airstrips. The culvert will be removed, and the channel through the airstrip stabilized and seeded. All airstrip navigational equipment such as runway lighting will be removed, as will buildings and other structures. If this equipment and infrastructure is deemed salvageable at the time of mine closure, then it will be shipped to Yellowknife or Edmonton; otherwise it will be placed in the landfill.

The side slopes of the airstrip were contoured and graded in 1996, and various sections around the runway were seeded with native-grass cultivars in summer/fall 1996 to minimize erosion (ABR 2001). The seeded grass and forb cover appears to be promoting establishment of a diverse and self-sustaining plant community in this area (ABR 2001), and field observations to date indicate that natural re-colonization is also occurring. Monitoring of the airport reclamation sites in 2007 indicated the following:

- Research results in 2001 indicated that mean total vascular plant cover in the seeded areas was similar between 1998 (32.8%) and 2001(40.6%), but taxonomic richness was considerably higher (ABR 2001). Plant cover was dominated by graminoids, mainly polar grass (Arctogrosrostis latifolia), and in the recently re-graded area at the south end of the airstrip, by northern alkali grass (Puccinellia borealis). Natural colonizers included a variety of forbs, shrubs, and willows. Many of the forbs were commonly found on eskers in the mine area.
- Research in 2007 found that species diversity of the shrubs increased and that of the forbs decreased, compared with 2001 (ABR 2001). Highest plant cover was found along the east side and north end of the airstrip where soils and moisture conditions were more favourable. The reduction in vascular plant cover since 2001 is attributed to the reduction in graminoids, likely as a result of low soil nutrient levels. Native nonvasculars increased slightly since the last monitoring, to 12.8% from 10.4% (HMA 2007).

The monitoring results from the vegetation research help inform the specific revegetation research on Buildings and Infrastructure Mine Component sites found in Reclamation Research Plans #24 and 25 (Appendix 5.1-4).

5.7.9.12 Mobile Equipment

Mobile equipment from surface and underground operations will be salvaged and transported off site if this equipment is of further use. Other equipment will be cleaned of hydrocarbons and hazardous materials and buried in a landfill.

5.7.9.13 Hydrocarbon Contaminated Sites

Environmental Site Assessments will be conducted to determine the type and extent of contaminated soils and the contaminated material will be left for in-situ remediation, buried in a landfill or volatized. Soil remediation standards for hydrocarbons will follow CCME guidelines. The numerical remediation criteria will be derived for the Final Closure and Reclamation Plan based on a site assessment using the Tier 1, 2 or 3 approaches, as described in the CCME documentation that is in effect at that time. At this time, and based on the current CCME guidelines, agricultural land use classification is the most representative surrogate for the desired future land use of "wildlands", described in the 1995 EIS as “*productive use of land, with wildlife designated as the principal land user, in additional to limited use of cultural and natural resources of the area by Aboriginals.*”. BHP Billiton will continue to cleanup and report hydrocarbon spills at the mine site, followed up by INAC inspection.

5.7.9.14 Waste Management

Waste management procedures have been discussed in detail in Section 5.7.5 along with the waste stream (type of waste and final destination). Expected materials and equipment that will be salvaged at mine closure would be pump stations, buildings with bottled structure, conveyor belts, mobile equipment, kitchen and dormitory equipment. An initial assessment of salvageable products will be completed at end of the mining operations prior to main demolition, and again at the end of the monitoring period, when remaining buildings and equipment will no longer be required. The estimated volume of demolition material at mine closure that will report to the landfill is 2.4 million m^3. This is volume is based on a conceptual estimate completed for the 2001 Liability Estimate for the mine site. BHP Billiton will be refining this estimate for the next update of the ICRP.

Tables 5.7-3 to 5.7-10 summarize the engineering and environment work required to decommission the buildings and infrastructure.

Table 5.7-3. Buildings and Underground Support Facilities Reclamation Activities

Description	Typical steel buildings
Reclamation Method	Dismantle, cover concrete slab
Start Reclamation Activities	2020
End Reclamation Activities	2050
Monitoring Period	2050-2060
Engineering Works: • Dismantle steel buildings and salvage any material with value and backhaul it down winter road. Material without salvage value buried either in bottom of open pit, landfill or underground. • Break concrete footings to the ground or slab level. • Cover and cap concrete slab with waste rock. • Contour concrete cover material and re-establish surface drainage. **Environmental Works:** • Clean up and dispose of any debris and garbage. • Remove and properly dispose of any hazardous material remaining in building. • Complete environmental site assessment for hydrocarbon contaminated soils. • Remove and remediate any hydrocarbon contaminated soils. • Prepare final as-built drawings, including any remaining buried utilities and location of buried concrete slabs. • Conduct post-closure monitoring.	

5.7.10 Residual Effects

An assessment has been conducted on potential negative residual effects which may remain in the Buildings and Infrastructure mine component after reclamation work has been completed. No minor or higher residual effects were identified. Table 7.3-1 shows results from the environmental assessment which includes the predicted potential negative effects during the reclamation period, the contingencies in place to control effects and the predicted residual effects after reclamation work is completed. Research studies to address how residual effects in the buildings and infrastructure mine component can be removed have been included in the Reclamation Research Plan (Appendix 5.1-4). Post reclamation residual effects that were evaluated as negligible were wildlife access and use of roads.

Table 5.7-4. Satellite Facilities Reclamation Activities

Description	Satellite facilities and modular buildings
Reclamation Method	Dismantle and Reclaim
Start Reclamation Activities	2020
End Reclamation Activities	2022
Monitoring Period	2022-2032

Engineering Works:
- Salvage any modular buildings that have salvage value.
- Dismantle and bury either in bottom of open pit, landfill or underground.
- Break concrete footings to the ground or slab level.
- Cover and cap concrete slab with waste rock.
- Contour concrete cover material and re-establish surface drainage.

Environmental Works:
- Clean up and dispose of any debris and garbage.
- Remove and properly dispose of any hazardous material remaining in building.
- Complete environmental site assessment for hydrocarbon contaminated soils.
- Remove and remediate any hydrocarbon contaminated soils.
- Prepare final as-built drawings, including any remaining buried utilities and location of buried concrete slabs.
- Conduct post-closure monitoring.

Table 5.7-5. Chemical and Fuel Storage Reclamation Activities

Description	Storage facilities for chemical and fuel storage
Reclamation Method	Decommission and remove
Start Reclamation Activities	2020
End Reclamation Activities	2050
Monitoring Period	2050-2060

Engineering Works:
- Remove any remaining fuel and product in storage tanks.
- Dismantle storage tanks.
- Clean tanks of residual material, cut up and bury in bottom of open pit, landfill or underground.
- Contour storage locations and re-establish surface drainage.

Environmental Works:
- Complete environmental site assessment for hydrocarbon contaminated soils.
- Remove containment liner and remediate any contaminated soil.
- Conduct post closure monitoring.

Table 5.7-6. Quarry Sites Reclamation Activities

Description	Source for construction aggregate material
Reclamation Method	Re-contour and natural colonization
Start Reclamation Activities	2009
End Reclamation Activities	2015
Monitoring Period	2015-2025

Engineering Works:
- Selectively place rock armour in areas as necessary for stabilization.
- Rely on natural colonization for re-vegetation.

Environmental Works:
- Complete environmental site assessment.
- Complete post-closure monitoring.

Table 5.7-7. Laydown and Camp Pads Reclamation Activities

Description	Laydown sites for materials storage, and Camp pads
Reclamation Method	Remove infrastructure and stabilize site
Start Reclamation Activities	2020
End Reclamation Activities	2050
Monitoring Period	2050-2060
Engineering Works: • Contour the edges of the pads to blend into the surrounding terrain and prevent surface erosion. • Remove all debris. • Grade to remove topographic irregularities or steep banks. • Seed and fertilize where necessary. **Environmental Works:** • Complete environmental site assessment. • Complete post-closure monitoring.	

Table 5.7-8. Ore Storage Pads Reclamation Activities

Description	Temporary storage area for kimberlite ore
Reclamation Method	Remove kimberlite ore and stabilize site
Start Reclamation Activities	2020
End Reclamation Activities	2020
Monitoring Period	2020-2030
Engineering Works: • Contour the edges of the pads to blend into the surrounding terrain and prevent surface erosion. • Remove all debris. • Grade to remove topographic irregularities or steep banks. • Seed and fertilize where necessary. **Environmental Works:** • Conduct post-closure monitoring.	

Table 5.7-9. Roads Reclamation Activities

Description	Main access and haulage roads
Reclamation Option	Remove culverts, knock down berms and natural colonization
Start Reclamation Activities	2020
End Reclamation Activities	2050
Monitoring Period	2050-2060
Engineering Works: • Remove culverts and break down berms. • Remove bridges. • Leave concrete structures/abutments intact to minimize disturbance of the existing stream crossing. • The area around the channel will be contoured to match the natural topography. • Rely on natural colonization for re-vegetation. Environmental Works: • Conduct post-closure monitoring.	

Table 5.7-10. Airstrip Reclamation Activities

Description	Airstrip
Reclamation Method	Remove buildings, culverts, and natural colonization
Start Reclamation Activities	2061
End Reclamation Activities	2055
Monitoring Period	2055-2065
Engineering Works: • Remove culverts and knock down berms. • Remove airport buildings. • Rely on natural colonization for re-vegetation. **Environmental Works:** • Complete environmental site assessment for hydrocarbon contaminated soils. • Conduct post-closure monitoring.	

Appendix 5.1-3 shows the results of a risk assessment on the preferred closure option for the Buildings and Infrastructure mine components.

5.7.11 Reclamation Research

Reclamation research planning for the Buildings and Infrastructure mine components addresses the establishment of sustainable plant communities, and construction of stable surface covers. TK ideas that will assist reclamation of buildings and infrastructure at EKATI will also be incorporated into the reclamation research plans. Appendix 5.1-4 provides the reclamation research objectives and work scope, and Figure 5.1-4 shows a schedule for completion of research studies.

Identified reclamation research studies for the Buildings and Infrastructure mine component include:

- establishment of self-sustaining plant communities;
- vegetation cover and surface stability; and
- incorporation of TK into reclamation planning.

5.7.12 Engineering Questions

Identified engineering questions for the Buildings and Infrastructure mine component include:

- geotechnical stability of quarry sites; and
- camp pad surface stability.

Appendix 5.1-5 summarizes the engineering studies identified for the Buildings and Infrastructure mine component.

5.7.13 Post-Closure Monitoring

The post-closure monitoring program for the Buildings and Infrastructure mine component proposes to use a combination of the current monitoring programs at EKATI adapted to suit specific closure needs. The list of indicators for monitoring effectiveness of reclamation activities and to establish that closure objectives are met for the Buildings and Infrastructure mine component are listed below:

- fugitive dust (monitored under general site Air Quality Monitoring Program);

- o surface stability at camp pads/laydown pads;
- o surface stability at quarry sites;
- o percent vegetation cover;
- o water quality;
- o wildlife movement and safety (monitored under general site WEMP);
- o safe working procedures/practices;
- o incorporation of TK into closure;
- o archaeological sites; and
- o operations, procedures and reporting.

Appendix 5.1-6 shows details of the proposed closure monitoring program, including monitoring schedules, QA/AC protocols for monitoring and discussion on adaptive management.

6. Temporary Closure Measures

6. Temporary Closure Measures

6.1 TEMPORARY CLOSURE MEASURES

There are a number of factors, both internal and external, that may influence a decision to shut down mining operations. These include market conditions, economics of ore recovery, ore reserves, regulatory requirements and ongoing exploration programs. The strategies outlined below are dependent on the duration of the shutdown.

A temporary shutdown is a halt of mining and processing operations for economic, operational or regulatory reasons. These shutdowns are generally of short-term duration and full operation will resume when the cause of the shutdown has been remedied. By its nature, a temporary closure assumes that reopening of full scale mining and processing operations will occur in the near future. During a period of temporary closure, the only mining activities that occur are equipment and site maintenance. However, all environmental monitoring and administrative duties continue as part of licensing and permitting agreements.

With respect to closure measures conducted under a temporary closure event, activities will be focused on maintaining the stability and integrity of existing facilities and structures. Because the closure is assumed to be temporary in nature, no final closure of the major mine area components would be completed. For example, pump flooding of an active open pit would not be initiated nor would removal and demolition of any building or infrastructure begin. If progressive reclamation of a mine area component(s) was in progress during a temporary closure, then these activities would continue. The following level of activity would continue during a period of temporary closure:

- All environmental monitoring required to maintain licences and permits would continue.
- Maintenance of all facilities would continue to prevent any degradation of the facilities as well as prevent any adverse environmental effects.
- Management of water diversion structures would continue to ensure they operate as designed.
- Access to the property would continue and the airstrip would be maintained.
- Water management and release of water that meets water licence criteria from Cell E of the LLCF would continue.
- Adequate maintenance staff will continue on site to ensure critical equipment such as pumps and generators are maintained in operating condition.
- Adequate management, engineering, technical and environmental staff will continue to support the operation and ensure all environmental compliance conditions are met.

In addition to the level of activity during a temporary closure, a number of active measures will be implemented to protect human, wildlife and the environment. These measures are consistent with the *Northwest Territory Reclamation Guidelines* and include:

- Access to the site and buildings will be restricted to authorized personnel only.
- Mine openings will be either temporarily guarded or blocked to prevent unauthorized access.
- Waste management locations and landfills will be secured and continued to be monitored.

- The inventory program in place will continue including inventory of chemicals, reagents, petroleum products and any other hazardous materials. These products will continue to be secured.
- All WRSA, ore stockpiles, dams, dikes and diversion structures will be maintained and inspected to ensure physical stability.

Water diversions and pipelines will continue to be maintained as necessary to ensure its performance until final closure measures are implemented.

6.2 SAFETY, SECURITY AND ACCESS

BHP Billiton has in place a HSEC program and ISO 14001. Safety is the number one priority at EKATI. There are several initiatives and programs within HSEC to manage and promote safety improvement and a safe working environment. These initiatives include:

- Hearing Conservation and Noise Level Reduction Program;
- "Ask the Nurse" Health Promotion Program;
- Safety Suggestion Feedback Program;
- Return to Work Program; and
- Operation Zero Harm Safety Recognition Program.

To ensure a healthy and safe work environment, the use of controlled substances including alcohol and drugs are prohibited at the mine site.

7. Environmental Assessment

7. Environmental Assessment

7.1 OVERVIEW

The environmental assessment section examines the residual environmental effects at EKATI from mining operations and reclamation activities. It takes a structured approach by reviewing the past and current closure plans for major mine components, considers predicted residual effects of mining after operations have ceased, and discusses effects on water quality and on terrestrial and wildlife resources. The environmental assessment includes the following:

- An outline of the previous and current closure plans for the mine components.
- A comparison of post decommissioning residual effects as outlined in the 1995 Environmental Impact Statement with post-reclamation residual risks identified in the 2006 Interim Closure Plan risk assessment (Appendix 5.1-3).
- Water quality modeling results for the pit lakes, LLCF and WRSA seepages.
- Predicted impacts on source lakes for pit flooding, including flow regime and fish habitat at source lakes.
- Short- and long-term pit lakes loadings from external source water used to fill pits, groundwater and surface runoff, WRSA seepage and pit wall runoff.
- Pit lake stability modeling.
- Predicted environmental effects on terrestrial and wildlife resources.
- Impacts to other resource users.
- Environmental impacts.

Table 7.1-1 shows the activities required to close the EKATI mine components. Activities are broken out into those outlined in the Environmental Impact Statement (BHP and Dia Met 1995), the 2000 approved Interim Abandonment and Restoration Plan, the Sable, Pigeon and Beartooth Environmental Assessment (BHP and Dia Met 2000) and the current Interim Closure and Reclamation Plan.

Table 7.1-1. Previous and Current Closure Plan Activities for Mine Components

Mine Component	EIS (1995)	2000 A&R Plan	EA[1] (2000)	2011 ICRP
Open Pits	Natural filling of Koala, Fox and Misery pits PK into Panda Pit	Natural filling of Koala, Fox and Misery pits PK into Panda Pit	Pump flood Sable and Pigeon pits PK into Beartooth Pit	Pump flood all open pits. PK into Panda and Beartooth pits and alternate option.
WRSA	Sloped sides, Vegetation communities on side slopes.	Lifts and benches. Irregular topography on top surface	Stabilized and contoured, access ramps.	Lifts and benches, access ramps, no vegetation.
LLCF	Cap with layered sequence coarse tails, waste rock and lake sediment.	Cap with layered sequence coarse tails, waste rock and lake sediment.	N/A	Combination rock and vegetation cover, breach dikes and dam.

(continued)

Table 7.1-1. Previous and Current Closure Plan Activities for Mine Components (completed)

Mine Component	EIS (1995)	2000 A&R Plan	EA[1] (2000)	2011 ICRP
Dam, Dikes and Channels	Panda Diversion Channel left in as-built condition.	Panda Diversion Channel remains open and Panda Diversion Dam breached.	Pigeon Stream Diversion remains operational into perpetuity.	Panda Diversion Channel and Pigeon Stream Diversion remain open and operational.
Buildings and Infrastructure	All buildings removed. Roads remain in place.	All buildings removed. Roads remain in place.	All buildings removed. Roads remain in place.	All buildings removed. Roads remain in place.

1. Sable, Pigeon and Beartooth Environmental Agreement.

7.2 EFFECTS COMPARISON

BHP Billiton submitted an Environmental Impact Report (BHP Billiton 2006b) to DIAND, the Government of the Northwest Territories, and the IEMA which outlined the results from environmental monitoring conducted between 2003 and 2005. The report focused on residual effects for Valued Ecosystem Components (VECs). It concluded that there are currently no major, adverse residual effects on the environment resulting from mining operations at EKATI. The Environmental Impact Report is a requirement of the Environmental Agreement, to be submitted every 3 years until full and final reclamation of the project site has been completed. Further information on current environmental conditions at EKATI can be found in the 2006 Environmental Impact Report.

The 1995 EIS predicted that 1,738 ha of land would be disturbed by mining and processing operations. This was based on a mine plan which completed mining operations in 2021 and which included Leslie Pit, but not Sable, Pigeon and Beartooth pits. To date, mining development has occurred in 0.58% (or approximately 2,070 ha) of the EKATI claim block, primarily in the Koala and King-Cujo watersheds. The total expected footprint of the mining operation (which does not include Leslie pit, but includes Sable, Pigeon and Beartooth pits) based on the current LOM Plan is 2,980 ha. This number includes land where infrastructure has and will be developed, lakes over pits, and lakes associated with Long Lake Watershed.

Mining activities at EKATI have also altered water routing and water balance during the operations period. The following are some of the changes which have and/or are expected to occur over the period of mining operations:

- Water pumped from underground operations, a component of the operational water balance, was introduced through mine development. Between 2003 and 2006, an average of 368,000 m^3/year of underground connate water has reported to the LLCF.
- The flow paths for areas near the pit developments have changed compared to their pre-development configuration. Currently, all water collected in open pits and underground sumps reports to the LLCF. This has at least temporarily reduced inflow to Upper Panda and Kodiak lakes.
- As mine and site waters report to the LLCF, the effective watershed of the LLCF has increased compared to pre-development conditions. The timing and quantity of water release from the LLCF is controlled by pumps located near the Outlet Dam. On an annual timescale, the management of this facility can impact both the site and downstream water balance.
- The flow paths directly downstream of Kodiak Lake (Kodiak Lake to Little Lake and then to Moose Lake) and the LLCF (LLCF to Leslie Lake and then to Moose Lake) are unchanged

compared to the original, pre-development configuration. However, because the flow paths upstream of Kodiak Lake and the LLCF have changed, the volumes entering these lakes have altered.

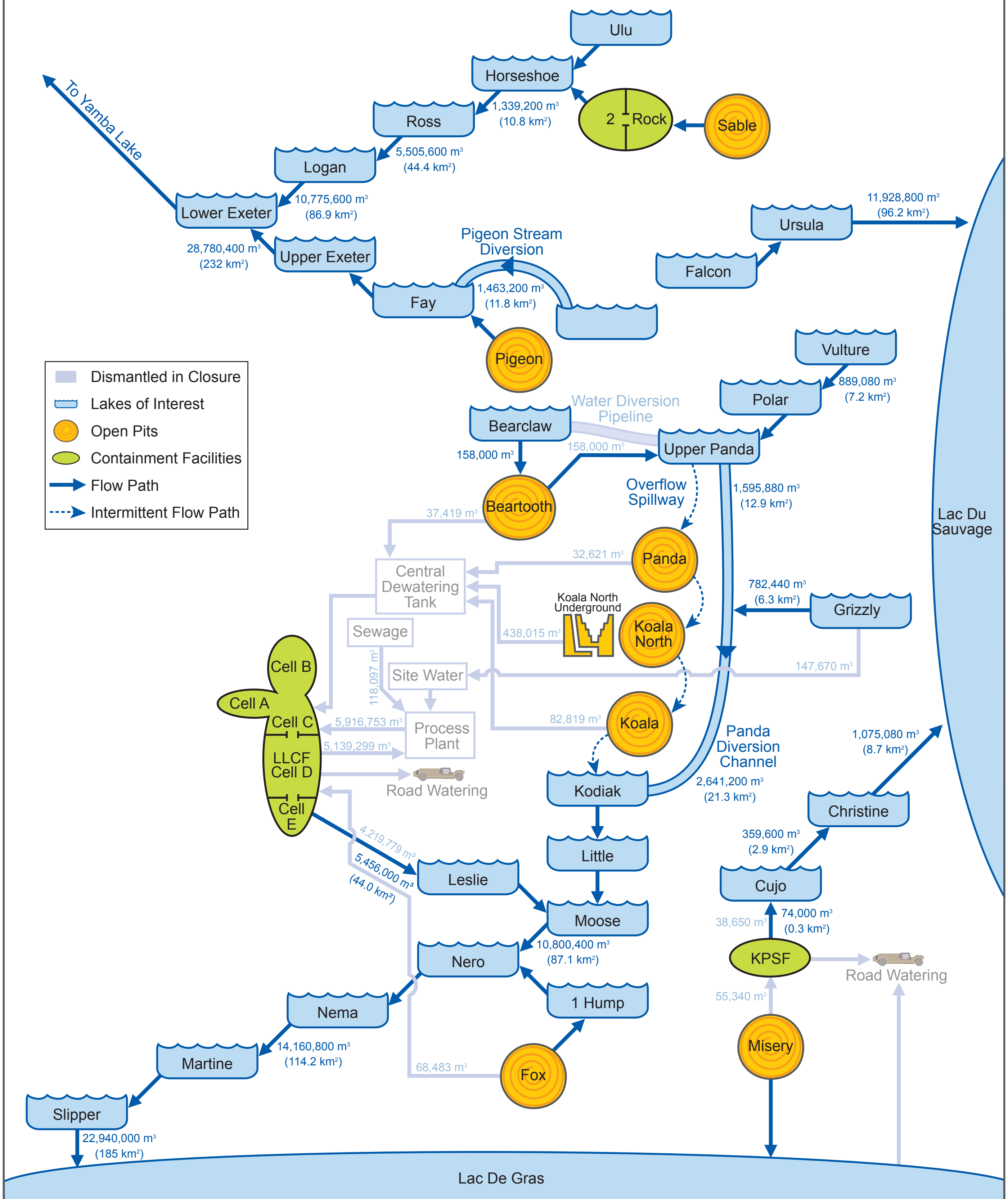
- The amount of evaporation expected on an annual basis is directly proportional to the surface area covered by water. The conversion of lakes to open pits reduced the amount of water available for evaporation. Approximately 1,300,000 m2 of lake surface area was lost through pit dewatering. On average, this equates to approximately 416,000 m3/year of water that does not evaporate.
- Placement of processed kimberlite in the LLCF will also result in increased water surface area and an increase in evaporation. The surface area of the LLCF increases as processed kimberlite is deposited.
- The quantity of water that is accounted for in the water balance by groundwater and reduced evaporation is small compared to the outflow of Slipper Lake (which averages 30,812,000 m^3/year). Despite the changes to the pre-development water balance during operation, no change in average outflow volumes has been observed at Slipper Outflow. This is due in part to the long chain of lakes between the mine site and the outflow of the Koala Watershed at Slipper Lake. This chain of lakes offers a large attenuation capacity to changes in water flows due to mining activities.

Figure 7.2-1 shows the conceptual and simplified site-wide water balance. Current (operational) average annual flow volumes are included, along with operations and closure flow directions. The closure configuration illustrated for mine components are based on EKATI's current LOM Plan.

7.3 PREDICTED POST-RECLAMATION RESIDUAL EFFECTS

In 2006, BHP Billiton completed an internal risk assessment of the proposed 2007 ICRP Working Draft. It was conducted on reclamation activities associated with each of the mine components and outlined the risks identified for HSEC based on VEC's, Operations and current impact studies from the 2006 Environmental Impact Report. Risks were assessed on the basis of environmental, social, legal and cost considerations. Two types of risks were identified: those risks which could be controlled or eliminated through the application of mitigations proposed in the ICRP, and residual risks which cannot be prevented or fully remediated through the application of mitigations proposed in the ICRP, and that are predicted to remain after the post-closure period. The post-closure period is that time after all physical reclamation activities and monitoring have been completed, and closure criteria (based on the closure objectives outlined in Appendix 5.1-1) have been fully met.

Table 7.3-1 lists the predicted residual environmental effects postulated for the post-decommissioning period in the EIS (BHP and Dia Met 1995) versus the predicted residual effects at post-closure, as assessed in the 2006 Risk Assessment. The table also lists the proposed contingencies to mitigate/remove these risks in the Working Draft ICRP, and the remaining residual risks after all reclamation work has been completed. The assessment showed there were no minor, moderate or major residual risks after reclamation. The residual risks which remain after closure are all negligible and are mostly associated with water and wildlife interacting with a safe, stable landscape.



Note: Volumes based on pumping data from 2005.
Volumes based on watershed area, 2005 precipitation data (248 mm) and an assumed runoff coefficient of 0.50.

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Figure 7.2-1

Conceptual and Simplified Schematic
Site-Wide Water Balance for EKATI at Closure

Rescan Engineers & Scientists

Table 7.3-1. Environmental Assessment Summary

VEC	Effect	Predicted Effect for Post Decommissioning EIS (1995)	2007 ICRP Working Draft Potential Residual Environmental Effects		
			Potential Effect During Reclamation Period 2007 ICRP	Contingencies during Reclamation Period	Residual Effect Post Reclamation 2007 ICRP
AIR					
Air Quality	Wind erosion / dust generation	Negligible	Negligible	N/A	N/A
	Greenhouse gas emissions		Minor	N/A	N/A
LAND					
	LLCF processed kimberlite erosion		Negligible	Vegetation and rock cover	N/A
	Failure of LLCF rock cover (isolated areas)		Negligible	Additional capping if required	N/A
	Discovery of unidentified buried materials		Negligible	Removal to designated landfill and/or encapsulation with waste rock	N/A
	Incorrect material buried during decommissioning		Negligible	Decommissioning and Salvage Plan. Encapsulation with waste rock.	Negligible
	Erosion at quarry sites		Negligible	Armouring and/or vegetation cover	N/A
Permafrost	Degradation of permafrost in WRSA		Negligible	Flat surface, Gradation of material on side slopes to encourage super-cooling.	N/A
Vegetation	Failure/setback of LLCF Vegetation cover		Negligible	Progressive reclamation, pilot study. Rock capping	N/A
	Failure/setback of vegetation over camp pads and laydowns		Negligible	Progressive reclamation.	N/A
Archaeological			N/A	Archaeological sites have been identified and recorded during mining operations.	N/A

(continued)

Table 7.3-1. Environmental Assessment Summary (continued)

VEC	Effect	Predicted Effect for Post Decommissioning EIS (1995)	2007 Working Draft ICRP Potential Residual Environmental Effects: Potential Effect During Reclamation Period 2007 ICRP	Contingencies during Reclamation Period	Residual Effect Post Reclamation 2007 ICRP
WATER					
Water Quality	Drainage from waste rock dumps	Negligible	Negligible	Freeze encapsulation, toe berms	Negligible
	Pit lake water discharge		Minor	Water Treatment during reclamation period	N/A
	Downstream water volume effect from LLCF water withdrawal		Moderate	Use alternate sources	N/A
	Pump systems failure - diesel spills		Minor	Environmental Site Assessment during reclamation period	N/A
	Nutrient sink in pit lakes		Negligible	Biomass Improvement Plan	Negligible
	Drawdown effects at source lakes during pit flooding		Negligible	Longer closure period. Hydrologic regime re-establishes after pumping.	N/A
	Sable natural hydrocarbons degrades water quality		Negligible	Monitor during operations and reclamation period to determine if further steps are necessary.	N/A
	Pit wall runoff effects pit lake water quality		Negligible	Monitor during operations reclamation period to determine if further steps are necessary.	N/A
	Longer pit/s fill times - exposing wall rock to air for longer than anticipated.		Negligible	Monitor during operations reclamation period to determine if further steps are necessary.	N/A

(continued)

Table 7.3-1. Environmental Assessment Summary (continued)

VEC	Effect	Predicted Effect for Post Decommissioning EIS (1995)	2007 ICRP Working Draft Potential Residual Environmental Effects: Potential Effect During Reclamation Period 2007 ICRP	Contingencies during Reclamation Period	Residual Effect Post Reclamation 2007 ICRP
WATER (continued)					
Water Quality (continued)	Failure of Panda/Koala underground plug - leakage of processed kimberlite into bottom of Koala pit lake, and drop in Panda pit lake elevation.		Negligible	Full supervision of design and construction by qualified engineer.	Negligible
	Underground impacts pit lake water quality		Negligible	Water Treatment during reclamation period	Negligible
	LLCF discharge water quality		Minor	Water Treatment if necessary during reclamation period	Negligible
	Phase 1 discharge water quality		Negligible	N/A	Negligible
	Long term contamination from landfarm, landfill sites		Negligible	Collect and treat if necessary during operations	Negligible
	Downstream water quality affected during bridge/culvert removal		Negligible	Erosion control in place	N/A
	Surface water contamination at Laydown pads, ore storage, camp pads		Negligible	Removal of contaminated material	N/A
	Hydrocarbon contamination at Exploration Camps		Negligible	Removal of contaminated material or remediate in place	N/A
	Larger volume of hydrocarbon contaminated material than expected		Negligible	Collect, remediate, encapsulate	N/A
Fish/Aquatic Habitat	Inadequate outflow from Sable/Fox/Misery pits once pits are flooded, causing downstream effects on fish habitat		Negligible	Research studies to better understand potential hydrologic regime of headwater pit lakes.	Negligible

(continued)

Table 7.3-1. Environmental Assessment Summary (continued)

VEC	Effect	Predicted Effect for Post Decommissioning EIS (1995)	2007 ICRP Working Draft Potential Residual Environmental Effects: Potential Effect During Reclamation Period 2007 ICRP	Contingencies during Reclamation Period	Residual Effect Post Reclamation 2007 ICRP
WATER (continued)					
Fish/Aquatic Habitat (continued)	Effect on natural source lake and catchment areas fish habitat during pit flooding		Negligible	Longer closure period to reduce volume pumped	N/A
	Processed kimberlite erosion from LLCF		Negligible	Rock and vegetation cover to stabilize kimberlite, engineered drainage channels, settling ponds in Cells C,D and E.	Negligible
	Fish migration into upper cells of LLCF		Negligible	Fish barrier in place at LLCF outlet	Negligible
	Sediment release from Panda DC during stabilization work		Moderate	Proper winter construction methods, monitoring, silt curtains, construction in winter	N/A
	Fish enter Panda pit lake via spillway		Negligible	Fish barrier in place	Negligible
	Sediment release from dam construction		Negligible	Sediment control in place, winter construction	N/A
	Fish habitat compensations do not meet DFO expectations		Negligible	Habitat construction as per Compensation Agreements	N/A
Hydrology	Filling of pits	Positive impact			
	Panda DC fails to perform over long term		Negligible	Panda DC stabilization	N/A
	Pigeon DC fails to perform over long term		Negligible	Pigeon DC stabilization	N/A
	Additional water from Grizzly Lakes flows into Panda DC at cessation of operations		Negligible	Panda DC designed to take future flow regime from Grizzly	N/A
	Poor performance with flow rate after dams breached		Negligible	Outflow regime included in breach design	N/A

(continued)

Table 7.3-1. Environmental Assessment Summary (continued)

VEC	Effect	Predicted Effect for Post Decommissioning EIS (1995)	2007 ICRP Working Draft Potential Residual Environmental Effects: Potential Effect During Reclamation Period 2007 ICRP	Contingencies during Reclamation Period	Residual Effect Post Reclamation 2007 ICRP
WATER (continued)					
Hydrology (continued)	Overtopping of Panda Diversion Dam		Minor	Spillway design for 100yr event	N/A
	Cumulative effects from Diavik and EKATI water extraction		Negligible	Water extracted from Lac de Gras for EKATI pits in years when DDMI not flooding.	N/A
Groundwater			N/A	N/A	N/A
WILDLIFE					
	Remaining highwall leads to wildlife falling into pit lakes (fatality or injury)		Negligible	Wildlife berms constructed around pit perimeter. Reshape pit edges to reduce rapid transitions.	Negligible
	Migratory birds landing on pit lake		Negligible		Negligible
	Failure of underground access seals		Negligible	Geotechnical inspection prior to completion of closure criteria	Negligible
	Unstable landform at LLCF		Negligible	Rock cover ensures safe wildlife passage	Negligible
	Metals uptake from kimberlite and vegetation at LLCF		Negligible	Plant vegetation that is not attractant for wildlife. Risk Assessment of vegetation.	Negligible
	Noise		Negligible	Monitor wildlife reactions and adjust noise accordingly	N/A
	Wildlife access/use of roads		Negligible	Wildlife access ramps, berms & culverts removed.	Negligible

(continued)

Table 7.3-1. Environmental Assessment Summary (completed)

VEC	Effect	Predicted Effect for Post Decommissioning EIS (1995)	2007 ICRP Working Draft Potential Residual Environmental Effects: Potential Effect During Reclamation Period 2007 ICRP	Contingencies during Reclamation Period	Residual Effect Post Reclamation 2007 ICRP
WILDLIFE (continued)					
Wilderness	Landscape alteration	Negligible	Negligible	Progressive reclamation. Return of mine site to safe, stable and productive wildlife habitat.	N/A
CLIMATE					
	Climate	Unknown			
	Degradation of permafrost in WRSA		Negligible	Continued modeling / material management.	Negligible

The rating system for the 2007 Predicted Residual Effect for Post Reclamation follows the same rating system for the risk assessment rating outlined in Appendix 5.1-3, and summarized below.

Significance	Physical	Biological	Key
Negligible	Variable affected in a localized area during a short time period	A specific group of individuals in a localized area affected during a short time period	
Minor	Variable affected during less than one decade	A specific group of individuals affected during less than one generation	
Moderate	Variable affected for one or more decades	Portion of population affected over one or more generations	
Major	Variable affected for several decades	Whole stock or population affected over several generations	

Source. EKATI Diamond Mine Environmental Impact Report, 2006.

7.4 PIT LAKE STUDIES

Water Licence MV2001L2-0008 required BHP Billiton to submit a Terms of Reference for studies to address the potential of converting the mined-out kimberlite pipes (Sable, Pigeon and Beartooth pits) into pit lakes. This was based on the Sable, Pigeon and Beartooth EIS (BHP and Dia Met 2000), which proposed that these lakes would be pump flooded at closure. The Terms of Reference were delivered to the MVLWB in October 2004 (BHP Billiton 2004c). At the time of this ICRP two of the ten tasks within the Terms of Reference had been completed and delivered to the MVLWB. These are:

- Task 1 - Review of the State of Knowledge of Pit Lakes, delivered to the MVLWB in December 2005 (Rescan 2005b).
- Task 2 – Review of Data Requirements: Available Data and Data Gaps, delivered to the MVLWB in December 2005 (Rescan 2005c).

The remaining tasks will be developed and submitted after the delivery of the ICRP, so the following sections provide only a summary of the remaining tasks for this pit lake study. Summary comments are based on the best available knowledge at the time of the development of the ICRP. The summary in the 2011 ICRP includes all of the open pits in the current 2005 LOM Plan (Panda, Koala, Fox and Misery) since in the most recent plan these pits will also be pump flooded at closure. BHP Billiton intends to consider all of the EKATI pits as a part of the Pit Lake Study. These comprehensive tasks will be completed and delivered to the WLWB separate from the ICRP, but will ultimately be integrated into a later rendition of the ICRP. The following sections are summaries of pit lake water quality and stability modeling.

7.4.1 Pit Lake Load Balance Models Inputs

Pit lake water quality will be governed by initial loadings during the pit flooding and by loadings that will continue over the long term. Loads that will be introduced during pit filling include:

- ***Source lake water***, which will comprise the majority of the volume of each pit lake.
- ***Connate water***. All pits and undergrounds that have been developed to date have experienced some input of saline connate water, which has increased concentrations of major ions as compared to surface water quality.
- ***Metal leaching of reactive metasediments*** in the walls of Misery and Pigeon pits caused by oxidation between the completion of mining and inundation of the pit.

Loads that will continue over the long term, past the end of the mine life include:

- ***Surface run-off***. Peak run-off flows occur during freshet as a result of snow melt. Run-off water quality will likely be similar to background concentrations in the Koala Watershed which are typically clear, soft and have very low concentrations of nutrients and metals.
- ***Pit Wall Geochemistry***. As has been observed in other closed pit lakes, pit wall seepages can have elevated concentrations of some parameters. However, no pit wall seeps have been observed at EKATI, and therefore the potential water quality from this source has not been quantified.

In addition to the loads that are described above, there are processes that could impact pit lake water quality that would be included in a load balance model:

- ***Suspension of fine material***. Turbulent mixing during flooding could result in the re-suspension of fine material promoting metal leaching and high turbidity.

- *Salt exclusion from ice*. During winter at EKATI, ice can form with a thickness of up to 2 m. As ice forms, up to 97% of salts can be excluded from the ice into underlying fresh water (Eicken 2003). This process can transport salt from the surface into lower layers and enhance (or inhibit) meromixis, and freshen the top layer that is purged during freshet. Salt exclusion could significant influence the pit lake load balances.

7.4.2 Water Quality of Pit Lakes

The relative impact of the factors identified above is based primarily on volume. The source lakes will make up the bulk of the pit lake volume, thereby offering a high capacity for dilution of water from other sources. Inputs from connate water, metasediments in the pit walls of Misery and Pigeon pits, or highly weathered kimberlite on the bottom of pits could affect buffering capacity at flooding. These risks could be reduced by completing more studies on the geochemistry, and progressive reclamation, which ensures that inputs volumes are kept small and they are exposed for only a short time before flooding.

As was seen in Misery Pit in 2005, a delay in flooding pits after the end of mining could result in pits partially filling with water, having relatively high concentrations of total dissolved solids. An estimate of this potential load can be made based on measured sump water volume quality. In 2005, the total volume of water pumped from each pit sump over the year was on average 0.19 ± 0.04% of their respective proposed pit lake volumes. The highest concentrations of TDS in source lake water and sump water are 8 mg/L and 800 mg/L, respectively. If 0.19% of the pit lake filled with water of similar quality to sump water and the remaining volume was taken from a source lake, then the resulting water would have a TDS concentration of 9.54 mg/L. As the concentrations used in this estimate are conservative (*i.e.,* they are the highest measured TDS concentrations from each source), the initial loadings to the pit lakes are expected to be very low.

After closure, watershed run-off will likely be the source of greatest volume of water recharging pit lakes. Watershed run-off typical of surrounding un-affected watersheds has very low concentrations of nutrients and metals and will contribute very little to the total pit lake loads.

Permafrost in the WRSA and CRSA will likely capture most seepage water originating in these storage areas and therefore the seepage loads from these areas are expected to be small. In any case, to date no seeps have been identified flowing into the existing pit areas.

Pit lake salinity and the dynamics created by salt exclusion from ice to underlying water can have an impact on vertical physical stability of the pit lakes. Although they are not a source of loadings, these factors are important in determining the transport of loads in the pit lake systems.

The Terms of Reference for this ICRP specified the requirement for a “site-wide predictive water quality model.” However, BHP Billiton and their consultants have reviewed this reference section and believe the development of a site wide model is neither technically appropriate or required, practical, nor reasonably manageable. Rather than developing a site-wide water quality model, BHP Billiton has developed a set of modeling tools to address water balance and water quality at EKATI. These have included published work on LLCF water balance, mass balance and water quality predictions (e.g. Rescan 2008a, 2008b), hydrodynamic modeling of downstream lakes (e.g. Rescan 2007a), and unpublished modeling work on water quality downstream of the LLCF. Ongoing work is in development to predict the water quality of EKATI pit lakes using a set of modeling tools. The nature of the water quality work undertaken for the EKATI site does not lend itself to a single unified site-wide model. Such a unified modeling approach would severely limit the applicability of the model by not allowing the most appropriate modeling tools to be used given the nature of the question being addressed and the available data. BHP Billiton believes its approach to water quality modeling at EKATI is more technically sound than using a single site-wide model.

7.4.3 Pit Lakes Stability Model

Following implementation of the closure plan the pits will become pit lakes through active pump flooding. Mine pit lakes differ from most natural lakes because they are deep relative to their surface area, receive less direct wind turbulence due to their restricted surface area and remaining high-walls, and are often slightly saline due to ground-water, ore and waste rock geo-chemistry. As with natural lakes in the Lac de Gras region, the proposed future pit lakes at EKATI would be ice-covered during the winter. The development of winter ice cover will promote the exclusion of salts in the top few meters of the lake as it freezes. The more saline dense water that will develop at the surface will eventually mix downward into the lake. These characteristics suggest that the proposed pit lakes may become meromictic. That is they will not seasonally turn over or even mix entirely due to seasonal temperature changes and wind action.

It is important to know whether or not a pit lake will be meromictic because this can determine the fate of dissolved materials entering the lake and therefore, its water quality at different depths. Meromictic conditions are desirable in pit lakes because dissolved metals and ions in the bottom of lakes can become isolated from the lake surface and can be stored without posing risks to the more biologically active environment in the surface layer of the lake.

In general, meromixis should not be taken to imply complete isolation of deep water. There may be a small degree of transfer along the thermocline or chemocline between the surface and deep water each year, driven, for example, by plunging saline boundary flows caused by physical processes such as freeze clarification in the upper layer and much more slowly by diffusion of fresh ground water upwards. Some mixing may also occur every few years as a result, for example, of deep water cooling from heat transfer to the surrounding permafrost. Neither should the absence of meromixis be taken to indicate complete mixing of surface and deep water. Natural lakes do not always completely turn over every year. Pressure dependence of the temperature of maximum density may also inhibit mixing in deep (>150 m) lakes.

The semi-analytic model discussed by Lawrence and Pieters (2003a, 2003b) was used to identify the key influences on lake stability and meromixis of the proposed pit lakes. An 'analytic' solution is an exact mathematical solution to a set of model equations; exact solutions are rare. A 'semi-analytic' model has a solution that is partially analytic and partially numerical. 'Semi-analytic' should not be confused with 'semi-empirical' or 'qualitative'.

The two primary factors affecting whether a pit lake will be meromictic are its depth and its salinity or TDS (typically important are chloride, sulphate, calcium, carbonate and sodium). Exclusion of salt from the ice in winter, along with spring snow melt and freshet runoff, can create a salinity contrast between the surface and deep water. This salinity contrast provides stability against effects of fall wind and subsequent winter salt exclusion. Thus the salinity of the proposed pit lakes is fundamental to understanding their stability.

The source water for proposed pit lake flooding has very low concentrations of TDS (≤11 mg/L). This suggests that, at one extreme, the pit lakes could have water with very low concentrations of TDS – similar to surrounding un-affected lakes. The other extreme comes from the example of Misery Pit. Between September 2004 and September 2005, Misery Pit filled with 58,800 m^3 (0.2% of ultimate volume) of water with TDS concentrations ranging from 685 to 785 mg/L. Sump water from Beartooth, Koala and Koala North, and Fox pits showed a range of TDS concentrations between 48 mg/L and 800 mg/L

(Table 7.4-1). This elevated salinity may result from the dissolution of residual blasting material or from inflow of saline water from under the permafrost. Should flooding be delayed after the end of mining, pits could partially fill with water of the same source as sump water which would contribute to a higher initial salinity in the pit lake and may ultimately affect the buffering capacity of the lake.

Table 7.4-1. Summary of Potential Loads to Pit Lakes

Pit Lake	Source Lake	Source Lake TDP (mg/L)	Range of Sump Water TDS Concentration (mg/L)
Sable	Ursula	4.5	-
Pigeon	Upper Exeter	8	-
Beartooth	Lac de Gras	7	48-64
Panda	Lac de Gras	7	-
Koala and Koala North	Lac de Gras	7	360
Fox	Lac de Gras	7	670 - 800
Misery	Lac de Gras	7	685 - 785

Dashes indicate no data were available.

Meromixis occurs if the energy required to mix a stratified water body is greater than the energy available for mixing. The amount of energy (in units of Joules) needed to mix an entire lake is usually divided by the area of the lake (in units of m^2) to be comparable among lakes of different size. This variable is called the salinity stability or St*, and it has units of J/m^2 (Wetzel, 2001).

Another way of thinking about the concept of salinity stability is to envision what happens to a stratified lake when it mixes. The surface layer is less dense and the deep water is denser. When the entire lake is mixed, the dense deep water is lifted and mixed throughout the lake. This raises the center of mass of the water in the lake, thereby doing work against gravity. The salinity stability is the amount of work that must be done against gravity.

Calculations of St* presented here assume constant temperature throughout the lake's depth (*i.e.*, isothermal) and a stratified (*i.e.*, two-layer) salinity profile at the end of the summer. St* is also dependent on maximum winter ice thickness. The depth of the end-of-summer mixed surface layer was based on equations published by Gorham and Boyce (1989) and was calculated for BHP Billiton using EKATI-specific data.

In the middle of summer, the pit lakes will be stratified in both temperature and salinity. However, just before freeze up, the lake will have cooled and temperature will no longer contribute significantly to stability. In the fall, only the salinity stratification will maintain the stratification.

To determine the stability in the fall, we start with the salinity stability at maximum heat content in summer, St*. The salinity stability is the stability of the pit lake due to salinity alone and is computed by setting the temperature to a constant (4ºC) in the calculation of density. In effect, St* excludes the large and changing effect of temperature. The salinity stability in summer, St*, is then compared to typical changes of salinity stability over the fall, ΔSt, observed at other sites. If St* >> ΔSt, then meromixis is likely and if St* ~ ΔSt then meromixis is unlikely.

The formula for computing the stability of a water body is given by

$$St = \left(\frac{g}{A(0)}\right)\int_{0}^{H} A(z)(p(z) - \overline{p})zdz(Jm^{-2})$$

where z is the depth from the surface, $p(z)$ is the density, $\overline{p}$ is the mean density, $A(z)$ is the area of the pit, H is the total depth and g is gravity.

Meromixis is most vulnerable to breakdown during fall cooling, and one way of determining whether or not meromixis will breakdown during fall cooling is to examine the change in salinity stability during the fall. First, using a box model, the stability of the pit lake is computed for the start of fall cooling; in Figure 7.4-1 this is chosen to be the end of August. This model predicts that the salinity stability at the start of fall, St*, will increase both with salinity and with increased ice-cover during the previous winter. This salinity stability will resist fall overturn as the pit cools.

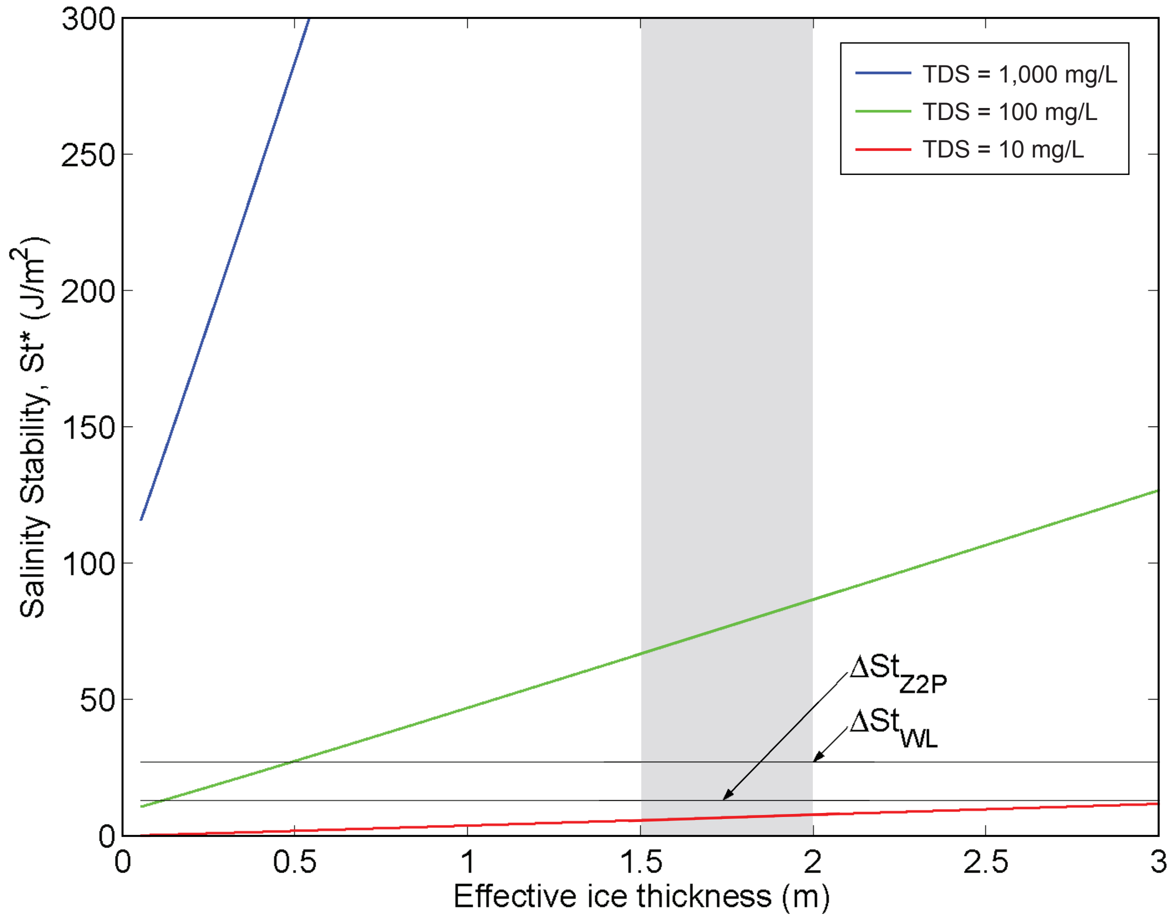
Figure 7.4-1 also compares the salinity stability of the proposed EKATI Fox pit lake at the start of fall cooling, St*, to the decrease in salinity stability, ΔSt, that was observed at the Colomac Zone 2 and Equity Waterline pit lakes. If the initial August stability at Fox, St*, is less than the decrease in salinity stability, ΔSt, observed at other pit-lakes, then meromixis is unlikely.

It is the work done by wind and convection to change the salinity stability that is important in the Zone 2 and Waterline pit lakes. For this example, it was assumed the same work was done by wind and convection at all three sites; and the intent is to quantify the differences between sites.

The total mass of dissolved salts available to the pit lakes during flooding is not known and the ultimate salinity of the pit lakes is, at present difficult to predict. If the final salinity of a flooded pit is close to that of the water from the source lakes identified in Table 7.4-1, then meromixis is unlikely. However, higher salinities are likely given the presence of sump water with salinities of order of 1,000 mg/L. If this is the case, then comparison with already existing pit lakes indicates that meromixis is a possibility (Table 7.4-2).

Table 7.4-2. Characteristics of Existing Pit Lakes at Other Mine Sites

Mine Site	Pit Lake	Depth (m)	TDS Concentration (mg/L)	Meromixis	Surface Mixed Layer Depth in Fall (m)	Comments
Anvil	Faro	~90	1,000	Yes	18	-
Equity	Waterline	40	1,100	Yes	10	Groundwater to depth through adits
Equity	Main Zone	110	1,800	No	N/A	Mixing due to sludge inflow.
Anvil	Grum	~50	700	Weak	10	Mixing due to creeping wall of till.
Anvil	Vangorda	~50	1,500	Weak	15-20	Mixing (small residence time, mixing likely results from water transfers).
Colomac	Zone 2 Pit	110	800	Weak	22	Mixing by groundwater inflow.



Notes: Grey band indicates typical maximum ice thickness for lakes at EKATI.
$\triangle$St is the reduction in salinity stability over the cooling period (autumn).
Z2P = Zone 2 Pit Lake at Colomac Mine.
WL = Waterline Pit Lake at Equity Mine.

Estimated Salinity Stability for Fox Pit Lake for a Range of Possible Salinities

Figure 7.4-1

As a result of uncertainty about the salinities of the flooded pits, the potential circulation of the largest pit lake, Fox, was examined assuming three salinities spanning the likely range: S = 10, 100 and 1,000 mg/L. In order to determine the likelihood of meromixis, St* estimated for varying ice thicknesses for Fox Pit Lake was compared with the reduction in salinity stability during the cooling period ΔSt. Figure 7.4-1 compares the estimated salinity stability for Fox Pit Lake for the three salinities identified above, to the potential for destratification, ΔSt, that was observed at two pit lakes from other sites.

For TDS of 1,000 mg/L, St* is much greater than the observed ΔSt, suggesting meromixis in Fox Pit Lake. For TDS of 10 mg/L, St* is unlikely to be high enough to maintain meromixis. Note that the values of St* are compared to ΔSt observed in pit lakes that have TDS concentrations. The 1,000 mg/L used as the approximate upper limit of potential TDS concentration in EKATI pit lakes was derived based on the levels of TDS observed during the temporary flooding of Misery Pit. St* is also a function of the pit lake depth and, for the shallower pit lakes (such as the proposed Panda Pit Lake should it be partially infilled with processed kimberlite), St* will be less and meromixis will be less likely.

The exclusion of salt from ice as it forms can both inhibit and contribute to meromixis. Excluded salt can inhibit meromixis by inducing mixing of the surface layer with the deeper water. On the other hand, excluded salt can enhance meromixis if it flows down the sides of the pit and increases the deep salinity. The mixing regime expected in each of the EKATI pit lakes requires a more thorough analysis. It should be noted that other processes can prevent or weaken meromixis that have not been included in this analysis (*e.g.*, groundwater inflows, failure of the pit walls and mixing due to water transfers).

These preliminary analyses suggest that meromixis is possible in all the proposed EKATI pit lakes. Before any reliable assessment can be made, further understanding of the potential salinity of the resulting pit lakes must be developed.

7.4.4 Predicted Effects of Extraction Rates on Source Lake Elevation

A preliminary assessment has been conducted on aquatic effects that might occur in source lakes as a result of pumping to flood open pits. The assessment was based on the existing EKATI meteorological dataset and data collected since 2001, specifically as part of the pit lakes studies. These unpublished data include at least 2 years of gauged outflow monitoring data and lake level data for Upper Exeter and Ursula lakes. Assumed natural annual and seasonal variation was estimated from this dataset.

A reduction in water elevation caused by water extraction was predicted to cause a minor temporary loss of littoral habitat in the source lakes and possibly in downstream water courses. For the low-flow period of October, the pumping rates represent a reduction from the ‘natural’ water surface elevation of 0.05 to 0.08 m for Upper Exeter Lake and 0.04 to 0.08 m for Ursula Lake. These losses are small relative to the 1.2 m-wide range of littoral zone habitat measured in August 2006. Since littoral zone habitat is essentially uniform over this depth range (*i.e.*, there is no structuring by depth), there will be no loss of unique or special habitat in source lakes due to pump flooding the open pits. It is also important to recognize that the natural seasonal ranges of elevations for both lakes (35 cm for Upper Exeter Lake and 40 cm for Ursula Lake) are an order of magnitude greater than the pumping losses.

After pumping ceases, the lakes will require time to rebound to their natural elevations. Ursula Lake will take nearly 3 years and Upper Exeter Lake is predicted to rebound within 1 year after the end of pumping. This analysis assumes pumping begins on June 1 of the start year, and that pumping and rebound occur during average precipitation years. Table 5.2-7 shows rebound times.

7.4.5 Predicted Effects of Extraction Rates on Source Lake Outflow Streams

The effect of pump rates on outlet flows was determined by finding the reduction in predicted 'natural' outlet flow during the October low-flow period. The predicted decrease in flow for Ursula Outlet for a proposed extraction rate of 0.2 m^3/s is 21% (range: 20 to 50%). The predicted decrease for Upper Exeter Outlet for a proposed extraction rate of 0.4 m^3/s was 44% (range: 35 to 60%). Reduction in outlet flow produces reductions in water depth, channel width and wetted perimeter in the downstream watersheds. The magnitude of these reductions in the low-flow period of October was predicted by HEC-RAS modeling to be relatively minor over the range of 0.1 to 0.5 m^3/s. Water depth never fell below 0.1 m, guaranteeing open passage.

7.4.6 Downstream Watershed Effects from Pump Flooding

Watersheds downstream of the source lakes will be affected by water extraction for pit lake flooding. Watershed areas were used to estimate the relative magnitude of the effect. The maximum pump rate proposed for Upper Exeter Lake (0.4 m^3/s) could result in the reduction in October flow from Upper Exeter Outflow of up to 44% during an average precipitation year. This corresponds to a 13% reduction in Lower Exeter Outflow. The pumping rate of 0.2 m^3/s proposed for Ursula Lake would result in a reduction of 13% of Unnamed Outflow and 11% of Duchess Inflow. The pumping rates used as the basis for pump flooding will result in fluctuations in available nearshore fish habitat in Upper Exeter and Ursula lakes, and in their outflow streams and in downstream watersheds, that are within the natural range caused by variability in the local hydrologic cycle.

7.4.7 Fish Habitat in Source Lake Littoral Zones

7.4.7.1 Fish Species of Upper Exeter and Ursula Lakes

Sampling of Upper Exeter Lake (and of Pigeon Stream which flows into Fay Lake above Upper Exeter Lake) from 2001 to 2006 found nine fish species (Table 7.4-3). With the exception of lake whitefish, which is not common in the EKATI claim block, and longnose sucker, which has a limited distribution within the Claim Block, this is the entire list of fish species that have been reported for the EKATI Claim Block. Preliminary sampling of the fish community of Ursula Lake in the summer of 2006 found four species. Based on its relatively large surface area, however, Ursula Lake probably supports most or all of the ten species listed in Table 7.4-3.

Table 7.4-3. Fish Species of the EKATI Claim Block

Common Name	Scientific Name	Upper Exeter Lake	Ursula Lake
Lake trout	*Salvelinus namaycush*	Present	Present
Arctic grayling	*Thymallus arcticus*	Present	Unknown
Round whitefish	*Prosopium cylindraceum*	Present	Present
Slimy sculpin	*Cottus cognatus*	Present	Present
Lake cisco	*Coregonus artedii*	Present	Unknown
Ninespine stickleback	*Pungitius pungitius*	Present	Unknown
Longnose sucker	*Catostomus catatomus*	Present	Unknown
Lake whitefish	*Coregonus clupeaformis*	Not Present	Unknown
Lake chub	*Couesius plumbeus*	Present	Unknown
Burbot	*Lota lota*	Present	Present

7.4.7.2 *Fish Use of Lake and Stream Habitat*

In their reviews of the scientific literature on habitat requirements of Arctic and sub-Arctic fish, Richardson *et al.* (2001) reported that every species in Table 7.4-3 has at least one life stage with high preference for shallow (*i.e.*, <2 m depth) littoral zone habitat. Their habitat ratings showed that, with the exception of bedrock, all substrate types (*e.g.*, boulders, cobble, gravel and sand or silt) are equally valuable as fish habitat.

Stream habitat is equally important for most fish species of the EKATI Claim Block (Scott and Crossman 1973). Arctic grayling are obligate stream spawners. Slimy sculpin and ninespine stickleback spawn in streams, but can also spawn in shallow lake habitat. Burbot and lake chub do not spawn in streams but their juveniles use streams for rearing, as do juvenile slimy sculpin, burbot, lake chub and ninespine stickleback. Juvenile lake trout often make brief excursions into streams in search of food and cover.

Adult lake trout, longnose suckers round whitefish have occasionally been found in streams of the EKATI claim block, indicating that they use streams for migration. Lake cisco are the only species that do not use stream habitat.

7.4.7.3 *Fish Habitat in Source Lakes and Outlet Streams*

Habitat surveys of the upper 1.2 m of the littoral zones of Upper Exeter Lake and Ursula Lake were conducted by Rescan in August 2006 to assess the potential effects of water extraction on littoral habitat (Figures 7.4-2 and 7.4-3). For each lake section, transects perpendicular to the shoreline were established at approximately 50 m-wide intervals. The top of each transect was established at the high water mark, as was determined by examining the rocks and vegetation on the shoreline. Transects were extended out into the lake to a maximum water depth of approximately 1.2 m.

The first measuring points included the high water mark, one or more ground points if the shoreline was sloping and long enough, and the water surface elevation or water level. The survey continued into the lake, with measuring points at every 100 mm increase in water depth. Additional measuring points were used in areas where the substrate was dominated by large boulders.

At each measuring point, the following three variables were recorded using a survey rod with a Trimble RTK Differential Global Positioning System (DGPS) attached to the top of the rod:

- Northing GPS co-ordinate (using the UTM12 NAD83 datum);
- Easting GPS co-ordinate; and
- elevation above mean sea level.

At each measurement point, the rod was held upright and the three coordinates were recorded by the instrument at the push of a button. The system automatically subtracted the length of the rod to give elevation at the base of the rod. The system has a design accuracy of ±20 mm in each of the three dimensions. Error was slightly higher for elevation than for Easting and Northing because the tip of the rod occasionally sank in soft substrate. Distance (m) of each measuring point from the high water mark was calculated from Easting and Northing co-ordinates.

Three control stations were set on high points near the areas of the lakes that were to be surveyed and were tuned to EKATI's GPS radio signal. The base station was set over one of the new control points, and broadcasting commenced on a separate radio signal. The other control points were used to check the base station setup to ensure that the RTK survey data files would be accurate. The surveys were conducted using the separate radio signal being transmitted from the base station.

Location of Bathymetric and Fish Habitat Survey Transects in Upper Exeter Lake (2006)

FIGURE 7.4-2

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Location of Bathymetric and Fish Habitat Survey Transects in Ursula Lake (2006)

FIGURE 7.4-3

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Percent substrate composition (e.g., bedrock, boulder, cobble, gravel and sand) was recorded to the nearest 5% at each measuring point along each transect except for those points on dry land above the water surface that were covered in moss, shrubs or other terrestrial vegetation. For all sites in which substrate composition was recorded, the percentages of bedrock, boulder, cobble, gravel and sand/fines added up to 100%.

Percent vegetation cover for both submergent and emergent vegetation was also recorded at each point, but the two percentages did not have to add up to 100% because the two types of vegetation could overlap each other. Photographs were taken with a digital camera every few transects, or at obvious changes in substrate characteristics, as backup support for substrate characterization. At least two pictures were taken along each transect, one on shore and a second at an approximate depth of 0.4 m.

As an example of results, Figures 7.4-4 shows the elevation-distance profiles along one transect in each of Upper Exeter and Ursula lakes. The average gradient of the littoral zone of Upper Exeter Lake (mean = 8.2%, range = 2.5 to 12.7%) is lower than that of Ursula Lake (mean = 10.7%, range = 5.8 to 17.7%).

Figures 7.4-5 and 7.4-6 show the substrate composition and bathymetry at these two example transects. Overall, littoral zones are dominated by boulders followed by cobble, gravel and sand in roughly equal proportions and there are no consistent trends in substrate type with elevation. Hence, habitat appears homogenous throughout the upper 1.2 m of the littoral zone because there is no statistical change with elevation in the percentages of the five substrate categories: sand, gravel, cobble, boulder and bedrock. Cross-sections of Upper Exeter Outflow and Ursula Outflow were surveyed in August 2006 for use in HEC-RAS hydraulic modeling. Both streams are broad and shallow – typical of streams in the EKATI Claim Block.

7.4.7.4 Minimizing Impacts on Fish Habitat

Mass balance modeling of the two lakes for average hydrological conditions and the 1 in 10 year wet and dry conditions predicted reductions in lake surface elevation as a result of water extraction. For the pumping rates, 0.4 m^3/s for Upper Exeter Lake and 0.2 m^3/s for Ursula Lake, reductions in water surface elevation for the low-flow month of October were predicted to range from 0.05 to 0.08 m in Upper Exeter Lake and 0.04 to 0.08 m in Ursula Lake. These losses are small relative to the 1.2 m-wide range of littoral zone habitat measured in August 2006 and to the natural seasonal ranges for both lakes (35 cm for Upper Exeter Lake and 40 cm for Ursula Lake). Littoral habitat in the source lakes that could be affected by drawdown would be in a zone that is homogenous over this depth range (*i.e.*, there is no structuring by depth).

Mass balance modeling also showed that for the recommended pumping rates decreases in stream flow will range from 35 to 60% for Upper Exeter Outlet and from 20 to 50% for Ursula Outlet. HEC-RAS hydraulic modeling of Upper Exeter Outflow and Ursula Outflow showed that reduction in flow reduces water depth, channel width and wetted perimeter (Figure 7.4-7). The magnitude of these reductions during the low-flow period of October was predicted to be relatively minor over pumping rates of 0.1 to 0.5 m^3/s. Appendices 5.1-4 and 5.1-5 provide further discussion on continued reclamation research and engineering studies on source lake water withdrawal and adjustments to pumping rates during pit filling is provided in.

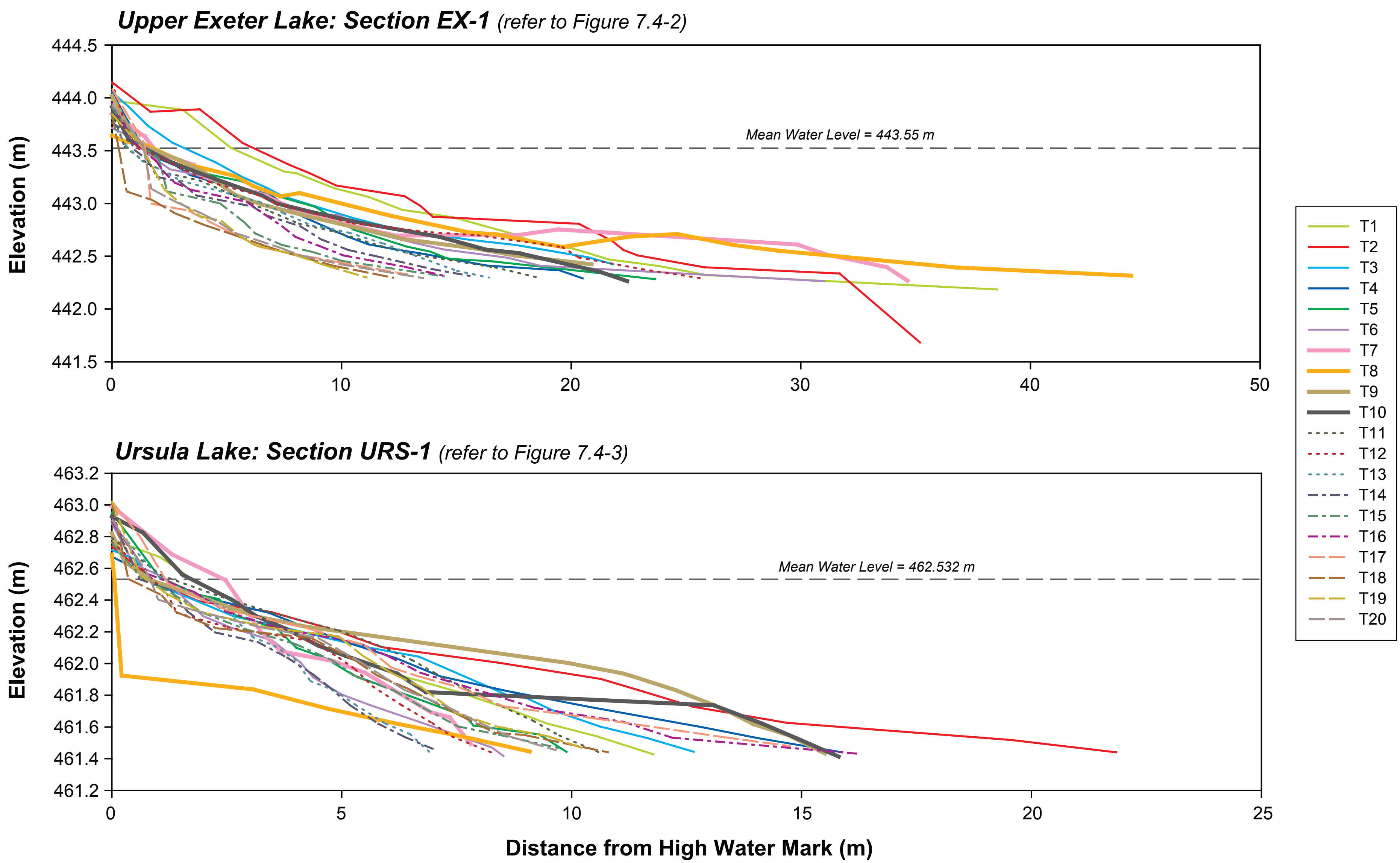

Figure 7.4-4

Elevation-Distance Plots for Sections EX-1 and URS-1

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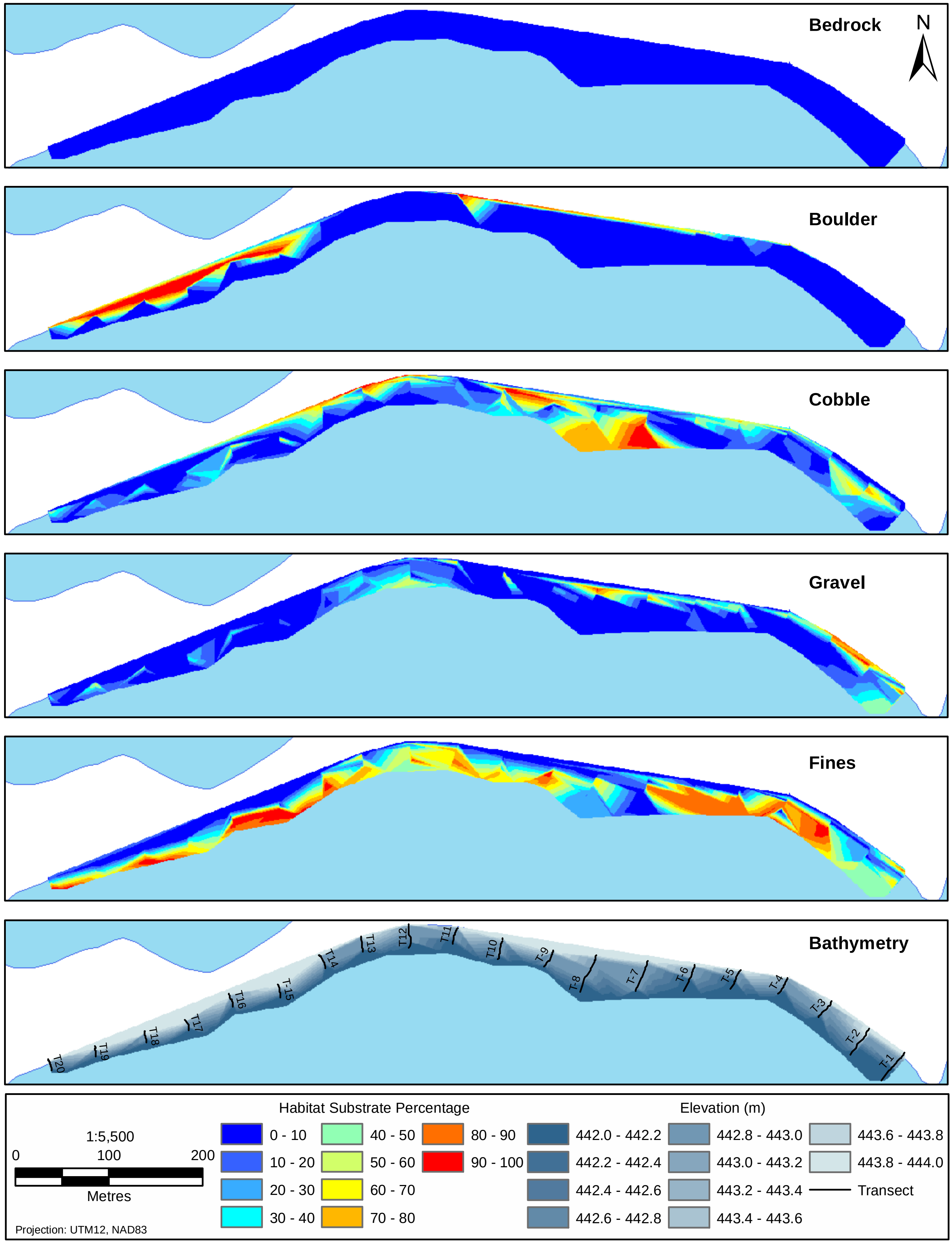
Figure 7.4-4



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Substrate Composition and Bathymetry, Section EX-1, Upper Exeter Lake

FIGURE 7.4-5

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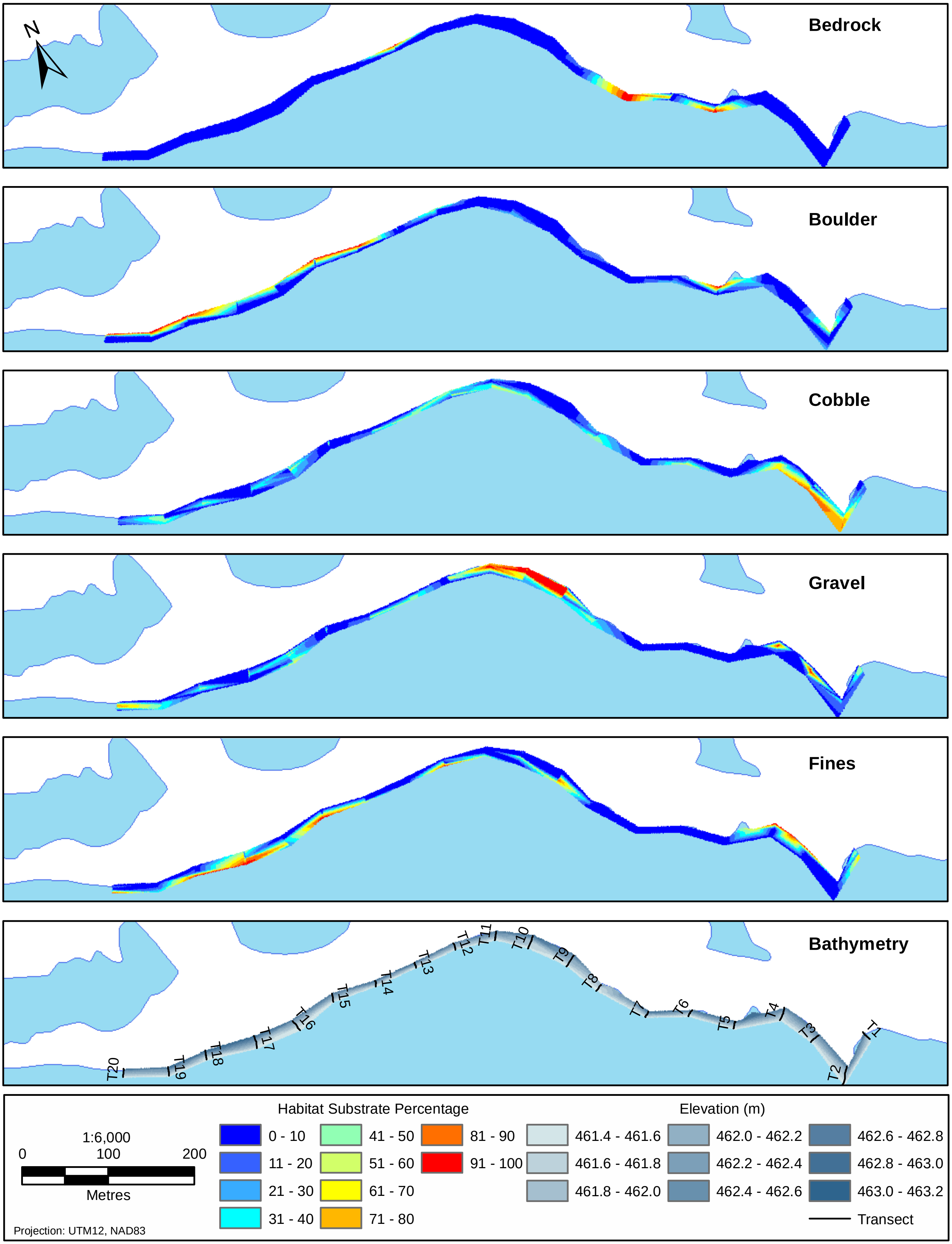


Substrate Composition and Bathymetry, Section URS-1, Ursula Lake

FIGURE 7.4-6

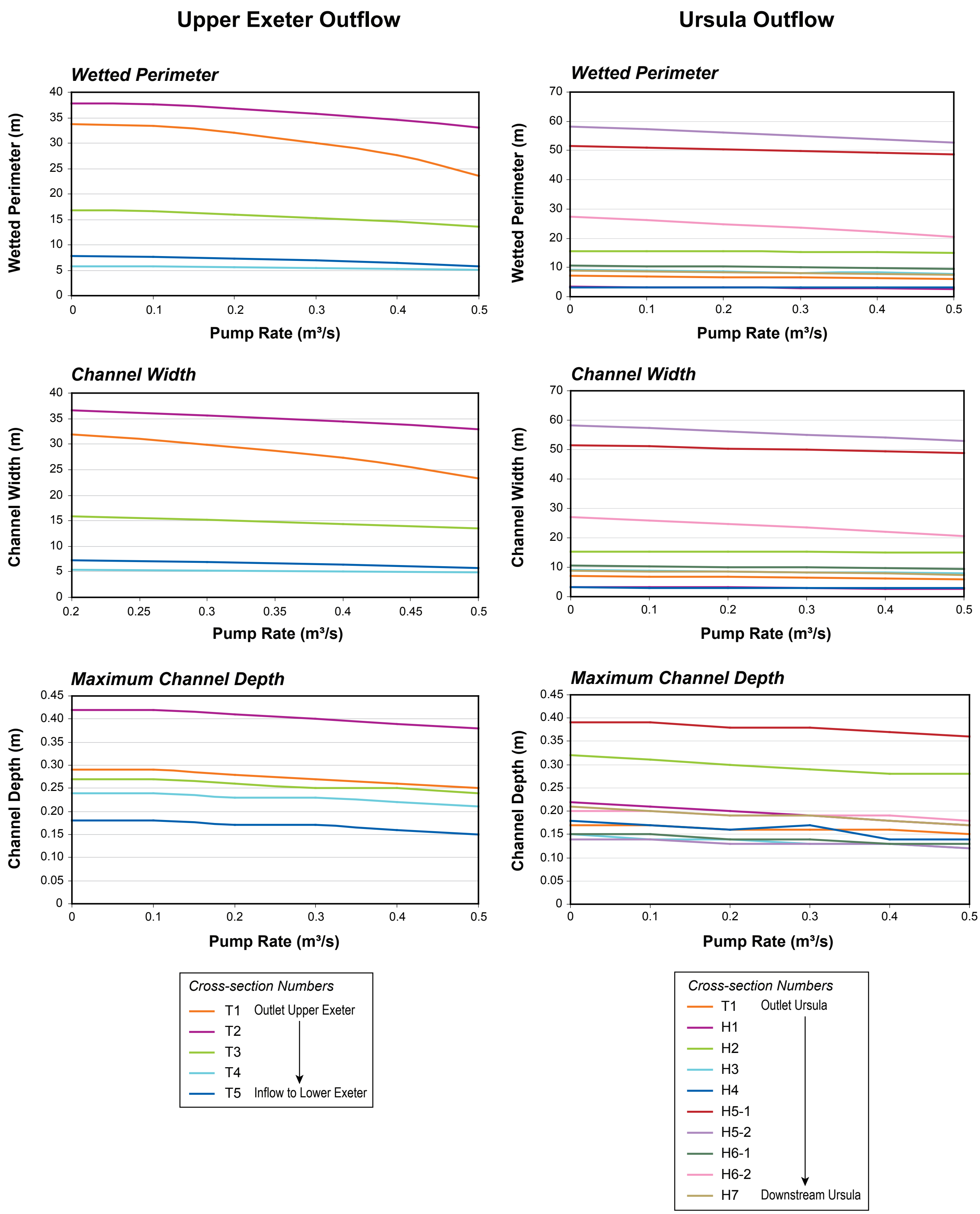


Figure 7.4-7

Stream Characteristics for the Minimum Predicted Outflows

7.5 ESTIMATES OF WRSA SEEPAGE WATER QUALITY AT CLOSURE

Seepage water quality observed over the operational monitoring period constitutes the best available information on which to base estimates of future seepage water quality for neutral and alkaline drainage conditions. As shown in Table 5.4-7, most waste rock at EKATI is not potentially acid-generating and there have been no observed instances of acid water resulting from oxidation of sulphide minerals at the site to date. It is therefore appropriate to use the median and 95th percentile values in Table 5.4-8 as estimates of 'most probable' and 'reasonable worst case' future water quality, respectively. There is less certainty with respect to potentially acid generating rock in the Misery WRSA, although thermal monitoring indicates most of the waste rock is below freezing and therefore not likely to be a source of ARD.

Median and 95th percentile elemental values in Table 5.4-8 represent dissolved concentrations. Operational achievement of total aqueous element concentrations similar to estimated dissolved concentrations will require continued good control of suspended solids following closure.

Concentrations of ammonia are expected to decline with time as leachable sources are depleted. The median and 95th percentile ammonia concentrations in Table 5.4-8 are considered to be relevant at the time of closure. Leachable sources exposed during reclamation by relocation of materials or by surface disturbance are expected to be similar to those sources generated on an ongoing basis during operations.

7.6 LLCF WATER LOAD BALANCE MODEL

7.6.1 Overview

The purpose of the modeling work was to predict water quality in Cell E of the LLCF and Leslie Lake following the end of mining activities. The water quality prediction model of the LLCF is based on a mass balance approach and has been developed using the GoldSim modeling suite. The study used the existing water quality prediction model of the LLCF, updated to consider the post-closure period. The model was set up consistent with Option 3a, which is the preferred option previously identified during a 2004 Multiple Accounts Analysis of LLCF closure options. Details of the model development, set-up, and sensitivity analyses are provided in Rescan (2008a, 2008b).

7.6.2 Model Set-up

All model runs start in 2020, when mine operations are expected to cease, and continue to 2040. The simulations do not consider the evolution of water quality during the lifetime of the mine. To simulate the post-closure situation, the model considers chemical loadings to the LLCF from natural runoff, leaching from the waste rock cap covering exposed tailings beaches and seepage through the tailings beaches. Scenarios also considered seepage through Dike C and additional loadings from submerged tailings seepage.

A sensitivity analysis of the model was undertaken to identify key model parameters. The following were identified:

- climatic conditions;
- flow paths through, and or over Dike C;
- hydraulic conductivity for seepage flow through the processed kimberlite beaches;
- water management of excess water in Cell E; and

- o chemical loadings associated with leaching from waste rock and seepage through the processed kimberlite beaches.

Conservative initial conditions for water quality concentrations within the LLCF were used for those parameters covered by the site Water Licence. Initial water quality in Cell E was set equal to the Water Licence criteria – the highest concentrations that could occur in the LLCF without exceeding permitted Water Licence criteria. For parameters covered by CCME guidelines the initial conditions were set at the CCME guideline level. However, the main focus of the modelling study was on Water Licence parameters.

The model considered the following chemical loadings to the facility during the closure period:

- o ***Natural water***. Runoff is calculated based on return period precipitation estimates. Model concentrations are the average of observed water quality data from the LLCF baseline study.
- o ***Waste rock leaching***. In theory, precipitation percolating through the waste rock caps could leach metals from the waste rock. It must be stressed that the granite used as capping material is not reactive rock. Model concentrations of leach water are based on seepage data from the waste rock dumps at the mine site. These values may be conservative because at closure the waste rock caps will be constructed using old/weathered waste granite that is not very reactive, while the field data are from waste rock dumps containing rock of a range of ages.
- o ***Porewater from processed kimberlite***. Precipitation infiltrating into the beaches will displace pore water in the processed kimberlite and then slowly flow through the beach. This water will eventually discharge into the ponds in the LLCF. Flow rates through the beaches are based on groundwater seepage calculations and water quality from Rollo (2003) who examined process kimberlite seepage water.
- o ***Flow through Dike C***. It is assumed that seepage water through Dike C has the character of processed kimberlite pore water. Historical concentrations measured in Cells D and E indicate that there is negligible leaching from seepage water flowing through Dike D.

7.6.3 Modeling Results

Given the difficulty in estimating concentrations in the facility at closure, the main purpose of the modeling study was to illustrate the rate of dilution expected within the LLCF.

The results of the modeling exercise showed that even for conservative conditions (*i.e.*, assuming parameter concentrations in Cell E are equal to Water Licence levels at closure) all parameters covered by the Water Licence would be below CCME guidelines by 2040 and most by 2035. Dilution of all parameters is predicted to be between two and six times the CCME guidelines 5 years after the end of operations and six to ten times after 10 years.

The model runs are limited by the assumptions made of future loadings entering the facility, and by the uncertainty associated with all the parameters in the model. Sensitivity analyses show that errors associated with input estimates are directly proportional to the modelling results. For example, if the loading of a water quality parameter is over-predicted by 10%, then the maximum predicted concentration of this parameter in Cell E of the LLCF is also over-predicted by approximately 10%. Follow-up information will be required to help constrain these uncertainties, such as improving estimates for leach rates associated with the waste rock cap and seepage loadings from the tailings solids. Additional information required to refine the model includes seepage rates through Dike C to provide a better understanding of flow paths after closure and the associated chemistry associated with water seeping through the dike. The model will be updated as new data become available and following scheduled updates to the closure scenarios. The model is a tool that is used to address specific water quality concerns or proposed water management initiatives. Therefore, the model will not be updated according to a set schedule but will be re-evaluated on an on-going basis, as required.

7.7 TERRESTRIAL RESOURCES AND WILDLIFE

7.7.1 Caribou and their Habitat

Caribou may sometimes be deflected by the Misery Road during the northern migration, but this is mitigated by BHP Billiton's policy of closing roads during major migrations and by ongoing efforts in collaboration with the Inuit Elders Advisory Committee to construct roads that do not act as barriers to caribou (Rescan 2007e). Given that caribou are attracted to roads later in the summer because they provide relief habitat from insects, and that no caribou collisions with vehicles have occurred at EKATI, after mitigation the residual effect of roads on caribou is ranked as negligible (*i.e.*, a specific group of individuals in a localized area are affected during a short period) (BHP Billiton 2006b). The Misery Road will remain in place after closure and is expected to continue to provide relief from insects. At the same time, there will be no heavy equipment traffic on the Misery Road or any roads for that matter and therefore impacts to caribou are predicted to continue to be negligible.

7.7.2 Carnivores and their Habitat

Observations of carnivore habitat use and movement between 2003 and 2005 showed no avoidance effect from mine operations and personnel. On the contrary, there is more evidence of carnivore attraction to EKATI than carnivore avoidance. A wolverine DNA study has been initiated to better assess wolverine activity and distribution relative to the mine (BHP Billiton 2006b). The residual effect of the mine during and after closure on carnivore activity patterns post closure is ranked as minor because closure operations (commencing in 2020) which will include air traffic, mobile equipment movements and landfill activities are not expected to continue over more than one generation.

Vehicle collisions with carnivores will continue to be negligible since the level of vehicle traffic during and after implementation of closure activities will decrease as compared to active mining operations. Over the long-term, there will be no vehicle traffic (other than community access by snowmobiles) in the EKATI site. Given that the current effects on carnivores during active mining operations are negligible, the predicted effects after the closure plan has been implemented will be negligible as well.

7.7.3 Breeding Birds and their Habitat

There is some evidence that increases are occurring in abundance and diversity of upland breeding birds near the mine site. These changes appear to be part of the natural dynamics of bird assemblages. This effect is currently ranked as negligible; future monitoring will determine whether this is the start of a trend.

Falcons continue to nest and produce chicks in the mine area and seem to be attracted to the nesting habitat provided by open pits. Breeding sites have been dominated by peregrine falcons over gyrfalcons in recent years, but it is likely that this reflects natural gyrfalcon cycles rather than a mine-associated effect. The effect of EKATI on falcon breeding is ranked as negligible.

Between 2003 and 2005, some bird deaths resulted from fish traps and vehicle collisions and two incidents occurred when waterfowl became trapped in mine pits. Mitigation measures taken as a result of waterfowl becoming oiled in standing water in the landfarm have been effective in preventing any further incidents since 2002 (BHP Billiton 2006b). Once the landfarm is closed, this type of risk will be eliminated. Similarly, there have been no further incidents of birds becoming trapped in fish nets during fish sampling. Because most of the incidents and mortalities associated with breeding birds have been linked to human activity such as vehicle collisions during active mining operations, the effects on breeding birds after the closure plan has been implemented is predicted to be negligible since these activities will no longer be occurring at the site.

As the open pits are pump flooded over a number of years, the exposed highwall benches that are available for nesting by falcons will diminish and eventually disappear in some pits. Although this may have an effect on habitat during the active flooding period, once the pits are flooded the water levels will remain essentially stable with some water level fluctuations (the amount of seasonal fluctuations will be quantified in the reclamation research plan for pit lakes in Appendix 5.1-4), and any remaining highwalls will be available for nesting habitat and will remain unaffected. The effects on falcon nesting habitat after the closure plan has been implemented is predicted to be negligible.

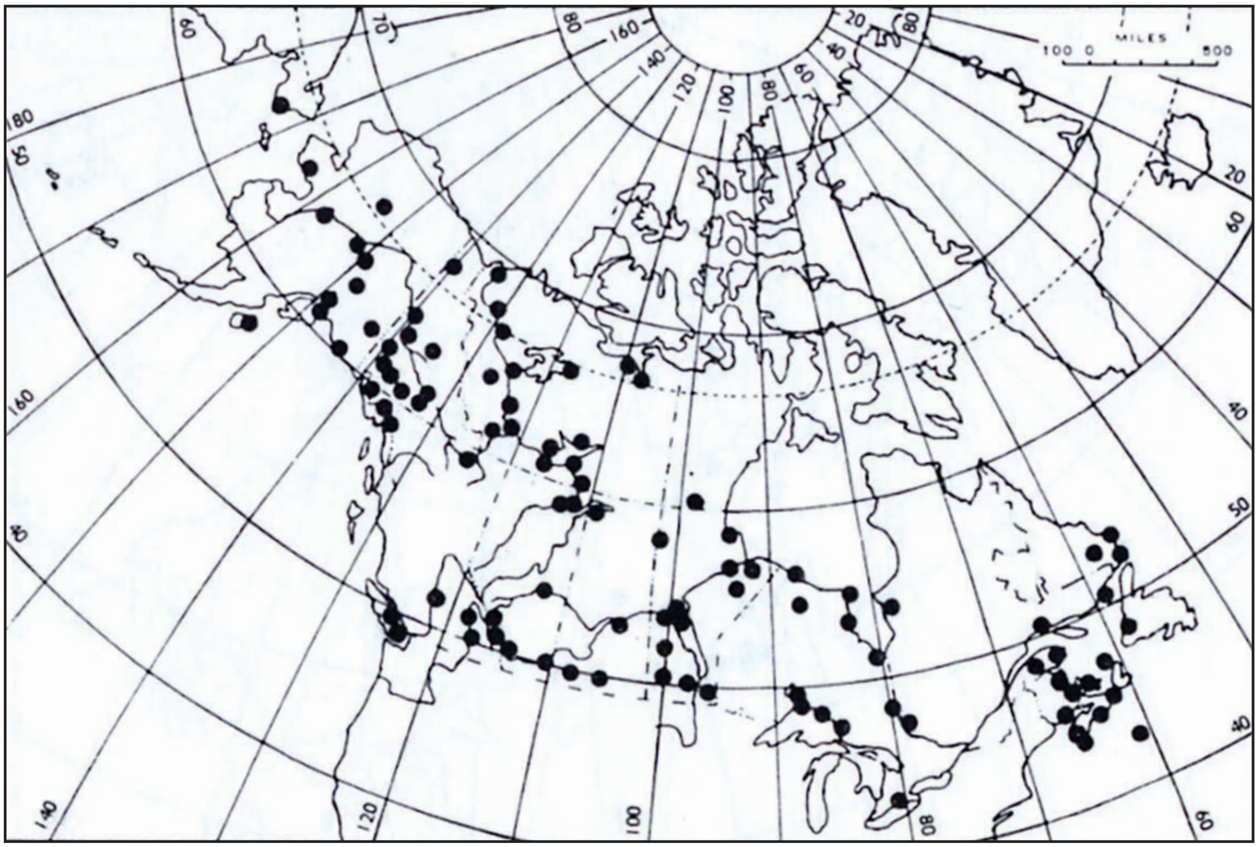
7.7.4 Native Plants and Weeds at EKATI

BHP Billiton has stated the objective of using native plant species for reclamation work at EKATI. Native plants (otherwise referred to as indigenous) are those plants originating in, and produced, growing, native, or living naturally in a particular region or environment. Native grass cultivars, the most commonly used revegetation species for reclamation work at EKATI, although produced in agricultural fields and/or nurseries, have been developed from species that are native to the EKATI Mine site and so qualify as “native”. The practice of reproducing native plants elsewhere is necessitated by the small volumes of plants and seeds available in the EKATI Claim Block. There are very few disturbed sites on the tundra where grasses and other early successional colonizers establish, and the small number plants available must be harvested carefully to ensure they are able to sustain themselves.

Weeds are defined as plants that grow where they are not wanted and that might have detectable negative economic or environmental effects. This definition is founded on ecological principles. By this definition weeds could also be native species. For example, weedy species native to an area are often primary invaders that can in a short time flood a newly disturbed area with a carpet of plant cover. If persistent such a species would be undesirable (not wanted) at the mine site. *Puccinellia borealis* is known as a weedy species (Porsild and Cody 1980), common on rivers and around trading posts and settlements. Fortunately its presence at EKATI is not unwanted, *i.e.,* it is not know to be persistent, and therefore it would not be considered a weed.

Wild barley (*Hordeum jubatum*) is the only weed that has been identified at the EKATI Mine site. Whether or not BHP Billiton was responsible for this plant arriving on site is arguable. According to Porsild and Cody (1980), this “troublesome weed” was in 1980 already found in waste places throughout the western Arctic north to the Mackenzie Delta (Figure 7.7-1). It could well have arrived on site as a reclamation seed contaminant, or it could just as likely have migrated to the site with the aid of natural vectors such as wind or wildlife.

No other weeds have been found in all the monitoring of reclaimed sites carried out since assisted revegetation began on the mine site in 1996 at Fox Portal. This does not mean that weed seeds were not present in the reclamation seed that was applied. Native grass cultivar seed would be the most likely source as this seed is grown in farmers’ fields where weeds of one kind or another might be found. It is impossible to produce seed of grass cultivars without some weed contamination. Weed seeds that are of similar size, or weight to the grass seed are very difficult to remove. The best place to control weeds is in the field, by eradicating the undesirable plants before they set seed, but some plants always seem to go undetected.



Source: Vascular Plants of Continental Northwest Territories, Canada (Porsild and Cody, 1980)

Figure 7.7-1

Geographic Distribution of *Hordeum jubatem*

The climate at EKATI has been instrumental in controlling any weeds that might have inadvertently been applied to reclamation sites as a contaminant of the seed mixture. Weeds growing in agricultural areas are not adapted to the severe climate found at EKATI – with wild barley being a possible exception. While such plants may germinate and establish during the growing season, they are invariably eliminated by the severe winters. Plants might persist for more than one year, if for example they happen to be covered by an extra thick insulating cover of snow, but in the end they have succumbed to the winter's cold.

It is expected that wild barley is the only weed expected to establish at EKATI. If weeds have not managed to gain a foothold on the mine site after 12 years of applying agriculturally grown native grass cultivars, it is highly unlikely that weeds will be successful in the future. If global warming results in significantly warmer winters, then it is possible that this might change. While this might be possible at some point in the future, it is highly unlikely that warming would progress so rapidly that there would be a fundamental change in climate, favouring weed survival, within the life of the EKATI mine.

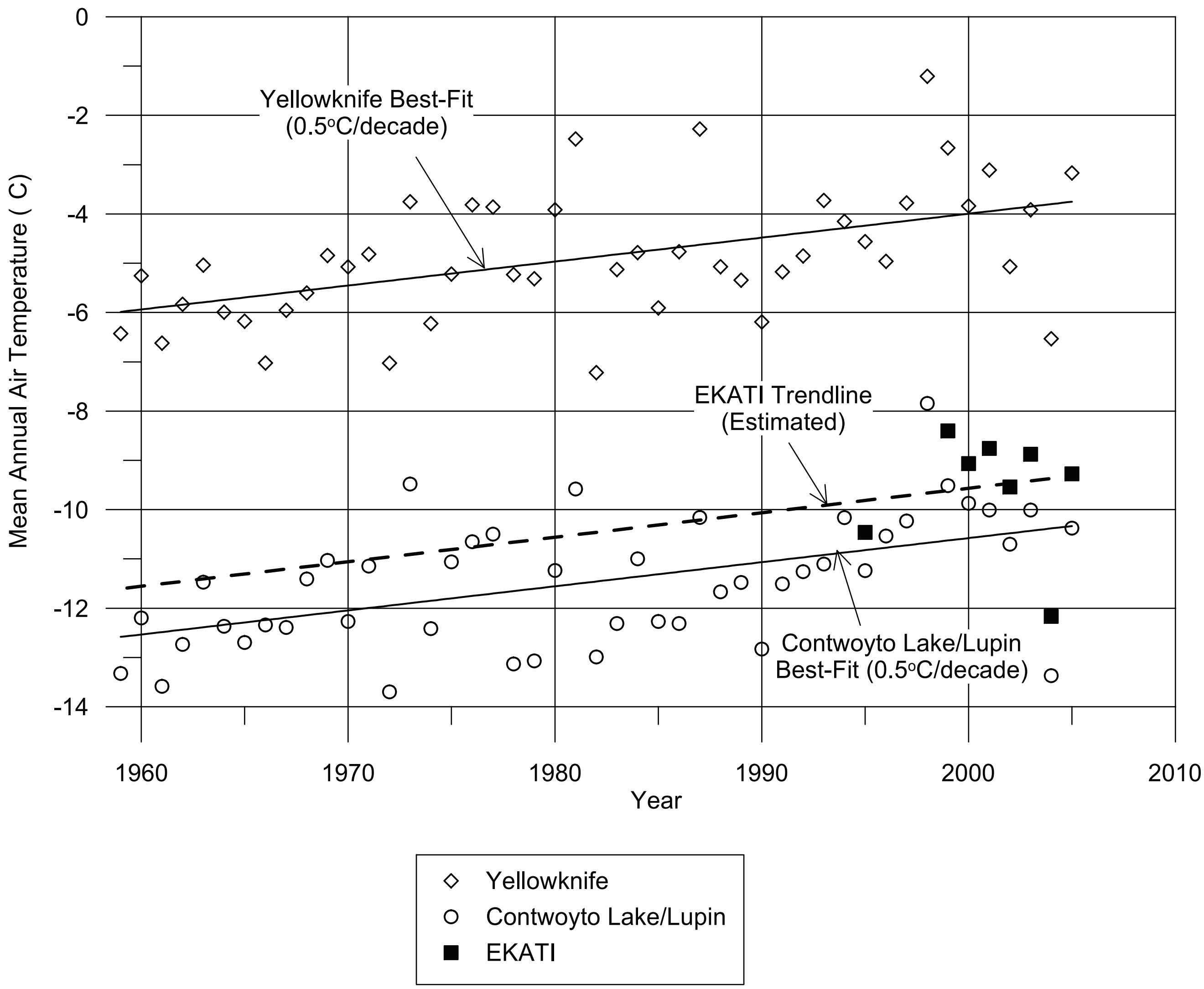
7.8 IMPACT OF LONG TERM CLIMATE PREDICTIONS

7.8.1 Site Climate

Climatic data have been collected at EKATI since 1993. This data set is considered too short to evaluate long-term climatic trends at this site. Engineering structures at EKATI have been designed based on assessments of long-term climatic conditions estimated from nearby meteorological stations with a longer recorded history of climatic data (*e.g.*, EBA 1997, 2000, 2002c). The nearest station with long-term data is Lupin, located approximately 100 km north of EKATI. Other nearby stations with long-term data are Yellowknife, located approximately 300 km southwest of EKATI, and Fort Reliance, located approximately 220 km south of EKATI. Figure 7.8-1 presents the historical annual air temperature histories from Yellowknife, Contwoyto Lake/Lupin, and EKATI since 1959. Data from EKATI are only plotted for those years with complete data sets; there are many gaps in the EKATI data set due to malfunctioning or damaged data loggers.

Figure 7.8-1 shows that the historical warming trend in annual air temperatures from Yellowknife and Contwoyto Lake/Lupin are practically identical and average approximately 0.5ºC per decade since 1959. Figure 7.8-1 also shows that EKATI is warmer than Contwoyto Lake/Lupin, but colder than Yellowknife. The monthly air temperature record from Lupin was compared with the corresponding monthly record from EKATI for the period of 1993 to 2005. The results show that monthly air temperatures are typically warmer at EKATI by between 0.3ºC and 1.5ºC. On average, annual air temperatures at EKATI have been 1.0ºC warmer than at Lupin. Long-term temperatures at EKATI were estimated by adding the mean monthly difference in air temperatures between EKATI and Lupin to the mean monthly air temperatures at Lupin for the period of 1971 to 2005. The mean annual air temperature at EKATI is estimated to be -10.2ºC.

Long-term monthly wind speeds at EKATI have been estimated by interpolating the monthly data, proportional with latitude, from Contwoyto Lake/Lupin and Fort Reliance for the climate normal period of 1961 to 1990 (EBA 1995). Monthly snow depths at EKATI have also been estimated using the same method, but were multiplied by a fixed factor based on calibration of the geothermal model against measured ground temperature data and on anecdotal observations of snow cover on top of the waste rock pile surface as reported by EBA (2006d). Daily solar radiation is available for only a limited number of sites in the arctic. Based on their similar latitudes, the mean daily solar radiation from Baker Lake, located approximately 700 km east of EKATI, for the climate normal period of 1951 to 1980 (Environment Canada 1982) was used for EKATI.



Notes:
1. Yellowknife and Contwoyto Lake/Lupin data from Environment Canada's website.
2. EKATI data from site meteorological station.
3. EKATI historical trendline estimated to be follow the same slope as Contwoyto Lake/Lupin and adjusted by the average temperature difference between EKATI and Lupin from 1993 to 2005.

Source: EBA Engineering Consultants Ltd.

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Mean Annual Air Temperature History at EKATI, Yellowknife and Contwoyto Lake /Lupin (1959-2005)

Figure 7.8-1

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Table 7.8-1 shows the estimated long-term monthly climatic conditions at EKATI.

Table 7.8-1. Estimated Long-Term Climatic Conditions at EKATI

Month	Monthly Air Temperature (°C)	Monthly Wind Speed (km/h)	Monthly Snow Cover (cm)	Daily Solar Radiation (W/m2)
January	-29.9	18	39	9.1
February	-28.1	12	47	38.7
March	-24.6	13	54	119.5
April	-14.8	14	56	206.4
May	-3.8	15	38	259.7
June	7.2	14	0	252.0
July	12.2	15	0	226.4
August	9.9	17	0	160.8
September	2.7	21	0	124.9
October	-7.3	19	7	41.3
November	-19.8	16	19	14.4
December	-26.1	15	31	3.7

7.8.2 Projected Climate Change at EKATI

According to Environment Canada's *Annual 2005 Climate Trends and Variations Bulletin* (http://www.mscsmc.ec.gc.ca/ccrm/bulletin/annual05/national_e.cfm), the Canadian national average annual air temperature has increased by 0.2ºC per decade from 1951 to 1980, and several of the warmest years on record have occurred in the past decade. As Figure 7.8-1 suggests, air temperatures in the area around EKATI may have warmed at an even faster rate (0.5ºC per decade).

The Intergovernmental Panel on Climate Change (IPCC) was jointly established by the World Meteorological Organization (WMO) and the United Nationals Environment Program (UNEP) to assess scientific information on climate change. The IPCC's work has provided the scientific background and justification for the Kyoto Protocol on limiting greenhouse gas emissions. The IPCC has issued three reports at five-year intervals, the most recent in 2001 (IPCC 2001). These reports establish a clear case for the observed recent global climate warming to be caused by increasing concentration of greenhouse gases.

General Circulation Models (GCMs) are mathematical representations of the global climate system that are used to explore the effects on climate of changes in the composition of the atmosphere, and, specifically, human-induced changes. GCMs are highly complex and include global representations of the atmosphere, oceans and land surface. The IPCC's working groups use several GCMs, but there are five models that are highly regarded and well-reported:

- CGCM2 (Canadian Centre for Climate Modelling and Analysis, Canada);
- CSM_1.4 (National Center for Atmospheric Meteorology, United States);
- ECHAM (Max-Planck Institute of Meteorology, Germany);
- GFDL-R30 (Geophysical Fluid Dynamics Laboratory, United States); and
- HadCM3 (Hadley Centre for Climate Prediction and Research, United Kingdom).

The magnitude of climate change projected by GCMs depends on the amount of change in concentration of atmospheric gases, which depends, in turn, on the emissions of active gases into the atmosphere which radiate heat from both natural and anthropogenic sources. The IPCC has developed emission scenarios based on assumptions of "storylines" of the global socioeconomic conditions. These are known as the SRES emissions scenarios after the IPCC's Special Report on Emissions Scenarios (IPCC 2000). The SRES scenarios are divided into four main "families": A1, A2, B1 and B2. The A1 and A2 families have a more economic focus than the B1 and B2 families, which are more environmentally based. The A1 and B1 families are based on storylines that assume a high degree of global coordination and uniformity, whereas A2 and B2 maintain considerable regional diversity.

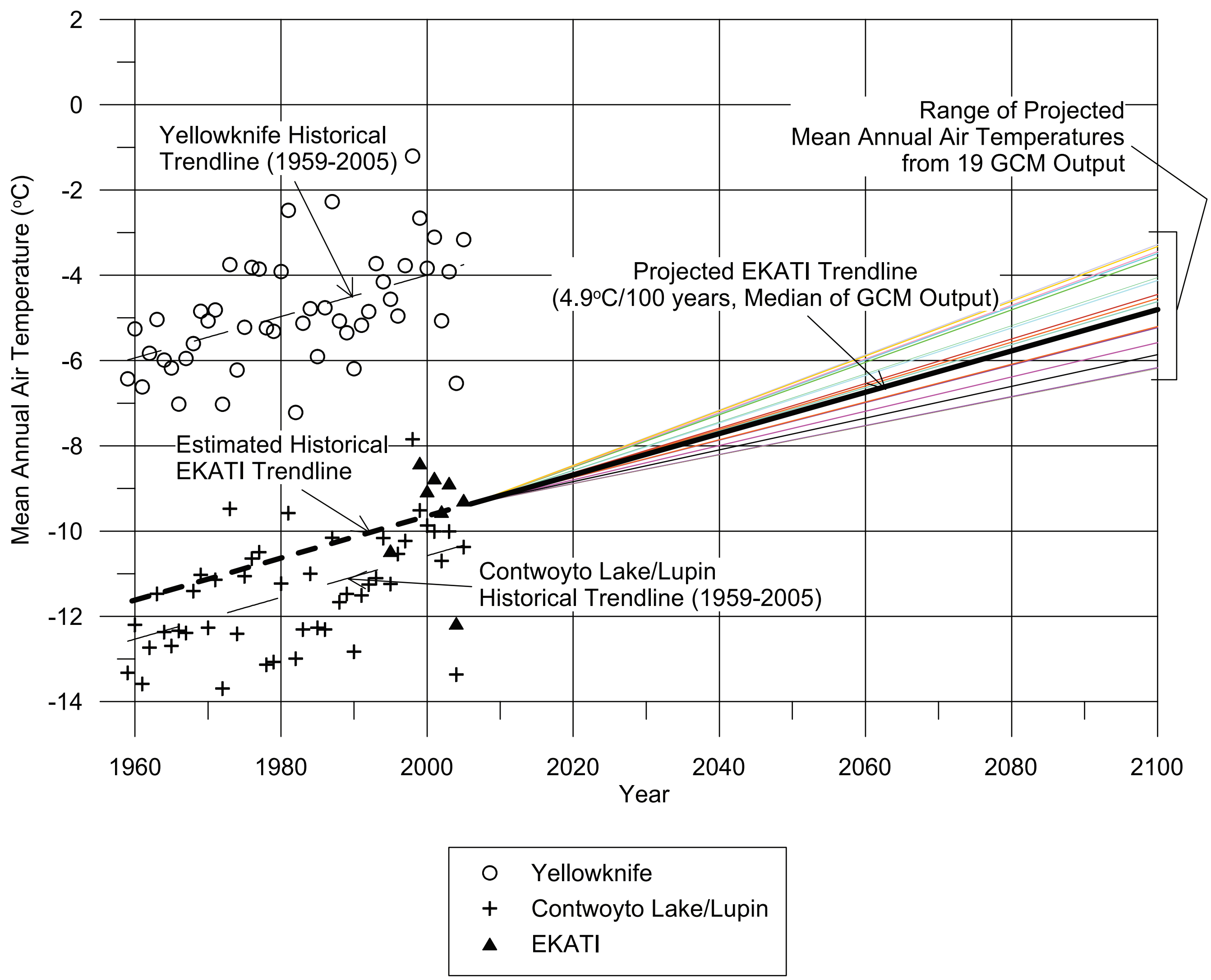
The Arctic Climate Impact Assessment (ACIA) was an international project of the Arctic Council and the International Arctic Science Committee (IASC) to evaluate and synthesize knowledge on climate variability, climate change and increased ultraviolet radiation and their consequences in the Arctic (ACIA 2005). The ACIA reports that the average temperature rise throughout the Arctic (defined as north of 60° latitude) is predicted to be 5°C and 7°C by 2100 for the B2 and A2 families, respectively (ACIA 2005). The predicted rise in temperature is generally less with the B1 and B2 families than with the A1 and A2 families. The ACIA considered the B2 family for most cases.

Data for GCMs for Canada are available from the website of the Canadian Institute for Climate Studies' Canadian Climate Impacts Scenarios (CCIS) Project (http://www.cics.uvic.ca/ scenarios). The CCIS web site provides GCM output for a baseline period (1961-1990) and three future intervals (2019-2039; 2040-2069; and 2070-2099). Climate change estimates are rarely given for years beyond 2100, given the uncertainties in projecting greenhouse gas emissions, especially over a long time interval. It is noted that different GCMs and SRES scenarios result in various temperature projections, with some GCM output predicting greater temperature changes during certain seasons (*e.g.*, during the winter).

For the grid cell encompassing the EKATI mine site, seasonal air temperature changes from a total of 19 GCM output, derived mainly from the A2 and B2 families, were obtained for the future interval of 2070 to 2099. For this evaluation, these values are considered equivalent to the change in temperature over a 100 year period. According to these models, annual air temperatures at EKATI are predicted to rise by between 3.4°C and 6.5°C over a 100-year period.

Future air temperatures at EKATI were estimated by linearly projecting these changes in temperature from the estimated temperature at EKATI for 2006. Figure 7.8-2 shows the projected air temperatures at EKATI from the various GCM outputs. It also shows the median annual projection for EKATI is 4.85°C over 100 years, calculated by averaging the median seasonal projections from the 19 GCM output. Seasonal changes in temperature corresponding to the median GCM output are estimated to be 6.0°C (December to February), 4.4°C (March to May), 4.6°C (June to August), and 4.4°C (September to November). The median annual projection corresponds well with the observed historical trends (5.0°C per century) in the area, as described in Section 7.8.1.

Climate change predictions generally look up to 100 years into the future and assume continued accumulation of greenhouse gases will sustain a warming trend for that period. There is little or no scientific basis for extrapolation of these predicted trends beyond the 100 year time frame. In order to adopt a worst case scenario for EKATI, an un-abating warming trend of +9.7°C/200 years has been assumed for the next 200 years. The projected annual air temperatures at EKATI in the years 2006, 2100 and 2200 are predicted to be -9.4°C, –4.8°C, and 0.0°C, respectively. Under this scenario, the climatic conditions at EKATI in 2200 would be similar to present-day Hay River.



Notes:
1. EKATI air temperature data from site metorological station (BHP Billiton & from Environment Canada).
2. Air Temperature Data for Yellowknife and Contwoyto Lake/Lupin from Environment Canada's website.
3. Projected global warming trends obtained from Canadian Climatic Impacts Scenarios project for EKATI region.
4. General Circulation Models (GCMs) used: CGCM2, ECHAM4, GFDLR30, and HadCM3.
5. Emissions Scenarios used: A2 and B2.

Source: EBA Engineering Consultants Ltd.

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Figure 7.8-2

Historical and Projected Annual Air Temperatures in the EKATI Region

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7.8.3 Impact on Open Pits after Closure

As noted previously, the permafrost in the wall rock of the flooded pits is likely to retreat as the water creates a talik zone. Changes in the ground temperatures close to 0ºC will result in the talik zones steadily increasing as the natural permafrost degrades. The pit lakes are contained in bedrock and degradation of the permafrost is not expected to have a significant impact on the lakes or their water quality. Research on the uncertainty of stability in pit walls, the processes that will effect stability and how instabilities might be mitigated to ensure safe use of the pit lake by people and wildlife is found in Appendix 5.1-5, Engineering Study # 1.

7.8.4 Impact on WRSA after Closure

As discussed previously, measurements of the internal temperature of the WRSA indicate that they are currently colder than the natural permafrost. The results of modeling based on the worst case of an un-abating warming trend of +9.7ºC/200 years, indicate the WRSA will remain frozen over this period. By contrast, the regional permafrost is expected to degrade over this same period, with a deepened active layer and ground temperatures close to 0ºC. In fact, the waste rock piles at EKATI, especially those which currently exhibit convective cooling, will likely retain the last remnants of permafrost in the EKATI area under long-term climatic predictions.

7.8.5 Impact on LLCF after Closure

Permafrost has been observed moving into the fine processed kimberlite in the LLCF. This process is expected to continue during and after closure. Long-term climate modeling based on the worst case of an un-abating warming trend of +9.7ºC/200 years indicates that the ground temperatures will rise close to 0ºC over this timeframe. The permafrost in the LLCF will degrade at a similar rate to that of the surrounding area. Further modeling is underway in this area and is expected to be presented in future ICRPs.

7.8.6 Impact on Dams, Dikes and Channels after Closure

Evaluation of the impact of long-term climate predictions on the PDC and the Panda Diversion Dam has not yet been carried out. All current dams at EKATI (with the exception of East and West Coffer Dams) are constructed on permafrost foundations that would be unstable and/or permeable if they were allowed to thaw. Therefore, all dams have been designed to maintain the permafrost foundation at a defined maximum temperature to effectively act as an impermeable barrier to seepage.

In a worst-case scenario, complete loss of permafrost from the embankment and foundation could result in uncontrolled seepage losses developing over a long time period. It is expected that there is negligible risk of an overall dam failure or sudden release of water. Thermosyphons have been used extensively as part of dam design to ensure that the dam and foundation are sufficiently cold through construction and the operating life of the dam (*e.g.*, see Panda Diversion Dam ground temperature history in Figures 5.1-2f(a) and 5.1-2f(b) in Appendix 5.1-2). Thermosyphons have a practical life span of 20 years. As this is new technology, this assumption is not based on specific observations, but rather on a broader generalization that these devices have limited long-term performance history in civil engineering practice beyond 20 years.

7.9 IMPACTS TO OTHER RESOURCE USERS

Impacts to other resource users within the localized area of the mine site were assessed as part of the EKATI Environmental Impact Statement (BHP and Dia Met 1995). At the time of the assessment predicted impacts from mine operations were the disruption of activities to other land users in the vicinity of the mine. The assessment also stated that given the potential influences from other diamond mines elsewhere in the region the impacts related specifically to EKATI would be difficult to isolate. The possible areas of impact from the project were:

- Barrenground Caribou Sports Hunting Outfitters
- Coppermine River Tours
- Trappers
- Aboriginal Hunters

Impacts to other resource users that may have occurred during mine operations would be progressively reduced while the reclamation work is being undertaken. For example, once demolition work was completed there would be a significant reduction in air traffic and winter road use. Revegetation and capping work would eliminate surface erosion and power generation would be minimized to support the much smaller needs for ongoing post closure monitoring. No significant residual impacts to other resource users would be anticipated once final reclamation and monitoring is complete.

7.10 ENVIRONMENTAL IMPACTS

Monitoring and reporting on the results of stabilizing and mitigating potential impacts to wildlife, terrestrial and aquatic environments will continue during and after the reclamation period. The Environmental Agreement will remain in place through the reclamation period, as will other permitting and licence requirements (the Water Licence will be updated through the reclamation period). These permits and licences require procedures in place for managing erosion, remediation of contaminated sites, groundwater contamination, impacts to aquatic environments, and wildlife safety. BHP Billiton will also continue reporting every 3 years on environmental impacts through the Environmental Impact Report (EIR); a requirement in the Environmental Agreement and discussed in Section 8.3. Table 7.3-1 outlines the potential effects to VECs during reclamation, contingencies to mitigate effects and predicted residual effects post-reclamation. These are further discussed in Section 7.3. The assessment results showed there were no minor, moderate or major residual effects after reclamation. Reclamation work that would take place to reduce environmental effects would include capping/armouring of areas with potential erosion, removal/remediation of contaminated materials, monitoring through the AEMP, WEMP and AQMP programs.

8. Progressive Reclamation

8. Progressive Reclamation

8.1 RECLAMATION OVERVIEW

The EKATI ICRP is updated every 3 years as required by the BHP Billiton Closure Standard (BHP Billiton 2004b), or when there is a significant change to the mine plan. A Final Closure and Reclamation Plan will be prepared and submitted at least 2 years before final closure of the mine.

The general purpose of the EKATI ICRP is to update preceding plans according to the current mine operating plan, or advances in mine reclamation technology. The document provides conceptual detail on the reclamation of mine components at EKATI which will not be closed until near the end of the mining operations, and operational detail for components which are to be progressively reclaimed earlier in the mine life.

Reclamation of disturbed land is the principal means by which mine effects will be mitigated at EKATI. Plans have been developed to return the site to a condition that will be compatible with the original uses of the area. BHP Billiton has adopted a progressive reclamation policy, which means that reclamation will begin as early as possible, starting with areas no longer needed for mine operations. Reclamation will continue throughout the life of the mine. For those sites that are no longer required for operations and that will be progressively reclaimed, prior to the submission of the Final Closure Plan, a detailed closure plan for these mine components will be submitted to the WLWB for review and approval.

8.2 RECLAMATION COMPLETION REPORT

Every 5 years, commencing in 2015, BHP Billiton will submit a Reclamation Completion Report that will provide details of the progressive reclamation work completed during the mine operating life, and actual reclamation work completed after mine operations cease in 2020. The Reclamation Completion Report will include the following as outlined in the Northwest Territories Mine Reclamation Guidelines:

- engineered “as-built” reports;
- comparison of actual work conducted versus planned work for each reclamation component;
- updated photographs depicting what the site looks like after reclamation;
- environmental monitoring and mitigation plans and schedules; and
- updated detailed reclamation cost liability and updated financial security estimates which are based on release certification and securities reduction agreements.

8.3 ENVIRONMENTAL IMPACT REPORT

Every 3 years during the reclamation period, BHP Billiton will submit an Environmental Impact Report, until full and final reclamation of the Project site has been completed in accordance with the requirements of all regulatory instruments and the terms of the Environmental Agreement. The Environmental Impact Report will include:

- a summary of operational (reclamation) activities during the reporting period;
- actions taken or planned to address impacts or compliance programs which are set out in the Environmental Impact Report;
- a summary of operational (reclamation) activities for the next reporting period; and

- a list and abstracts of all Environmental Plans and Programs.

8.4 PERFORMANCE ASSESSMENT REPORT

A Performance Assessment Report will be completed at the end of the initial monitoring period when the primary reclamation work has been completed and when environmental conditions are projected to demonstrate that closure objectives have been achieved. At that time, the closure criteria, and monitoring plan (if required) will be updated. BHP Billiton's closure monitoring plan will take effect after reclamation activities have been completed for each mine component, and will continue for at least 10 years to establish if closure objectives have been met. The proposed date for the completion of the Performance Assessment Report will be 2030. However, this delivery date will be reviewed as part of the Final Closure Plan submission 2 years prior to completion of mining operations.

8.5 PROGRESSIVE RECLAMATION PLANNED

8.5.1 Progressive Reclamation Stages

8.5.1.1 Schedule of Design

Progressive reclamation at BHP Billiton mines and assets is conducted under the company's Project Management Framework which ensures project management processes and practices are consistent with "best practice" within the company. BHP Billiton has established a set of underlying fundamentals for the development and completion of projects; the fundamentals of which are based on key lessons from BHP Billiton's long history of projects. These fundamentals apply to all types of projects, from developing a facility, reclaiming a facility, and to implementing new systems or business changes. When mine components at EKATI such as open pits, or the LLCF are reclaimed, the reclamation activities of research, planning and design and execution are separated into five distinct project phases. Figure 8.5-1 shows the schedule of design (conceptual, pre-feasibility and feasibility), execution and monitoring for reclamation, based on the 2005 LOM plan. These phases and an explanation for each are listed below.

8.5.1.2 Conceptual

Conceptual planning is the first level or undertaking of closure planning. It is at a level of detail relevant to the information available at the time, and is synonymous with preliminary interim reclamation planning in the early stages of the mine operation because of the extended time period in the future when reclamation will take place, and the potential for future changes in the active mining operation and LOM Plan. At the conceptual level there are a number of unanswered questions (or uncertainties) on how mine components will be reclaimed, in which case research and engineering studies are identified and initiated to address these uncertainties. Conceptual level planning commenced in 1997 for those pipes in the MV2003L2-0013 Water Licence, and in 2002 for those pipes in the MV2001L2-0008 Water Licence.

8.5.1.3 Pre-feasibility

The pre-feasibility level of closure planning is designed to provide enough detail and support to determine whether the proposed reclamation activities will be successful and what will be the technical challenges. Research and engineering studies are refined, and there should be enough detail for decision makers to move forward with the closure option as the preferred option for reclaiming mine components.

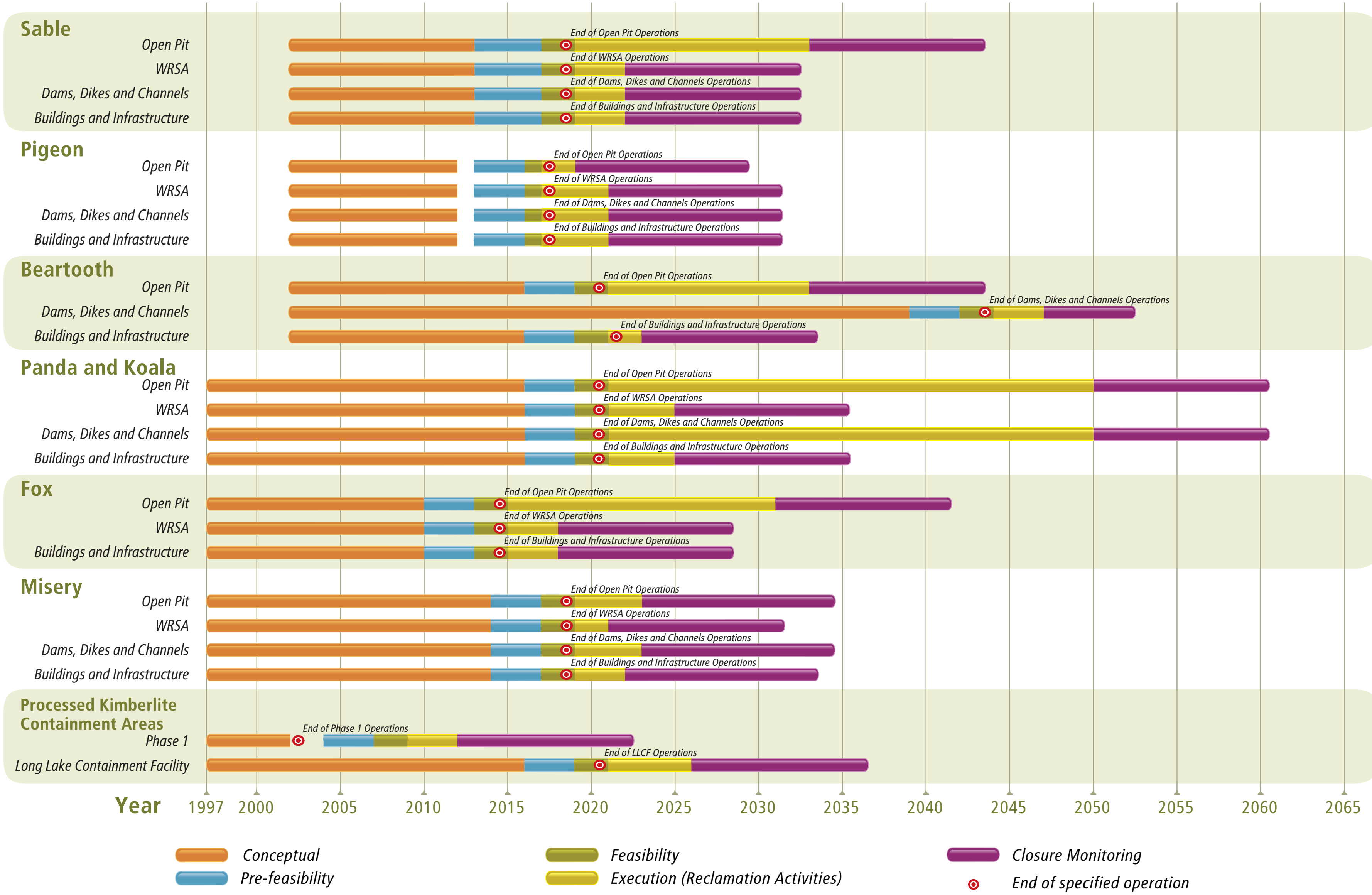

Figure 8.5-1

EKATI Reclamation Schedule

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Pre-feasibility planning usually occurs well into the mining operations phase and is indicative of a refined ICRP that has identified the go-forward closure option for each major mine component (*e.g.*,. flooding of open pits), a fully developed Reclamation Research Plan, and a set of preliminary closure objectives and criteria. Approximately 3 years have been provided for pre-feasibilities studies for the reclamation of EKATI mine components in Figure 8.5-1.

8.5.1.4 Feasibility

The feasibility level of closure planning is based on the completion of extensive reclamation research and engineering studies that have addressed uncertainties in how mine components would be effectively reclaimed. Closure objectives and criteria have been refined and established, usually from lessons from progressive reclamation activities, and the final closure option and activity for mine area components is selected. The feasibility level of planning will contain drawings and designs that are essentially at a level that can be implemented and constructed in the field. This level of planning is synonymous with the Final Closure Plan. Upon approval from the appropriate regulatory agencies responsible for the various reclamation obligations, closure activities are initiated. Approximately 2 years has been provided for feasibility studies for the reclamation of EKATI mine components in Figure 8.5-1.

8.5.1.5 Execution

At the execution level, the Final Closure Plan has been approved, the mine component is no longer required for mining operations, demobilization has commenced and reclamation activities are underway.

8.5.1.6 Monitoring

The monitoring period follows after reclamation activities are completed, and is used to observe and track the performance of closure criteria in meeting closure objectives. Monitoring periods are selected based on reasonable and currently used time periods that are sufficient in duration to detect any trends or changes in monitoring indicators. The duration of monitoring period is designed to ensure that mine site components, where practicable, are confirmed to be returning to self-sustaining ecosystems that are compatible with a healthy environment, human activities, and the surrounding environment.

8.5.2 Progressive Reclamation Schedule

The LOM Plan is the basis for reclamation scheduling. It outlines the commencement of infrastructure development (*i.e.*, roads, dams, camp pads), mine development (removal of overburden (*i.e.*, lake sediments and waste rock), the start of mine production *(i.e.*, or hauling and processing), and the end of mining operations. LOM Plans change for the following reasons:

- the value of the resource found;
- cost efficiencies in infrastructure development, mining and reclamation operations; and
- the level of regulatory obligations required when mining the resource.

Reclamation options (*e.g.,* the options to backfill open pits with waste rock or processed kimberlite), designing for closure (*e.g.,* the salvage of topsoil from open pit stripping, and placement of potential reactive materials within permafrost zones of the WRSA), and progressive reclamation work are all influenced by when mine components begin and end their operations. As the LOM Plan changes BHP Billiton reassesses the above opportunities, and updates the Interim Closure Plan accordingly. The current LOM Plan, which includes reclamation and monitoring for closure at EKATI, is provided in Figure 1.1-1.

Figure 8.5-1 shows the schedule for reclamation activities is based on the above LOM Plan. The Conceptual, Pre-feasibility, Feasibility, Execution and Monitoring phases have all been presented, along with the year that the particular mine component is no longer required for the mining operation. Based on a BHP Billiton requirement for a Closure Plan update of every 3 years, the following mine components will be within the feasibility planning stage, and requiring Final Closure Plans prior to the next ICRP update in 2012:

- Old Camp Final Reclamation Plan (including the Old Camp pad and Phase 1 Pond); and
- Airport Esker Final Reclamation Plan.

8.5.3 Reclamation Activities Completed

There are currently no reclaimed areas at EKATI. The mine is still in the early stages of operations, and as yet no release agreements are in place with INAC to outline when reclamation is complete, and the company is released from liabilities. A number of progressive reclamation projects are underway and have served to provide important experience that is valuable for planning reclamation and closure of the major mine area components. Examples of past and current progressive reclamation activities are grouped into the six major mine components and are highlighted below.

8.5.3.1 Open Pits

All open pits are either scheduled for future operations or are currently in operation.

8.5.3.2 Underground Mines

All underground mines are currently in operation.

8.5.3.3 Waste Rock Storage Areas

All WRSA are either scheduled for future operations or are currently in operation. Lake sediment/glacial till storage sites and topsoil sites are currently being remediated to ensure sites are stabilized. These materials have been stockpiled for future reclamation work.

<u>2001-2002</u>

- Fertilizing and seeding with native-grass cultivars was completed in the Panda/Koala North Lake Sediment/Glacial stockpiles to provide a stabilizing cover against erosion.
- Fertilizing and seeding with native-grass cultivars was completed on the Beartooth, Koala, Fox and Misery Topsoil Storage Areas to provide a stabilizing cover against erosion.

<u>2005-2006</u>

- In July 2005 Misery site went into a temporary suspension of operations. A 5 m-deep granite cap was placed over the Misery WRSA in June of 2005 to ensure the encapsulation of all potentially acid generating rock (PAG), and facilitate permafrost gradation through all metasedimentary rock. The first phase of the Misery WRSA is now considered closed. Waste rock from future mining at Misery will be placed adjacent to and adjoining the current WRSA but the present structure will not be re-opened. Some additional re-contouring and adjustment of ramps on the existing pile may occur.

8.5.3.4 Processed Kimberlite Containment Areas

The Phase 1 Pond at the Old Camp is currently ready for reclamation, but at this time no reclamation work has been completed. The LLCF is currently part of active mining operations.

8.5.3.5 Dams, Dikes and Channels

<u>1999-2000</u>

- Fish habitat structures (e.g., rock weirs, boulder clusters, and point bar vens) were placed in the PDC. Seeding with native forts and native-grass cultivars was completed. Native wetland grasses and shrubs were transplanted from tundra site into select areas of the channel.

8.5.3.6 Buildings and Infrastructure

<u>1996-2000</u>

- The perimeter of the airstrip was contoured, fertilized and seeded with native-grass cultivars and native forbs.
- The Culvert Camp area adjacent to Fred's Channel was landscaped, seeded and fertilized.
- The Southern End of the Airport Esker was landscape, aerial seeded and fertilizer. Arctic pendant grass was planted around pond areas and tundra plugs were placed in shallow depressions.
- The Old Camp infrastructure including sea-cans, trailers, fuel tanks, Pilot Process Plant and pipelines were decommissioned and removed.

<u>2001-2002</u>

- Contouring and placement of structures and rock armour to prevent hydraulic and thermal erosion was completed in Fred's Channel on the Airport Esker.
- Native wetland grasses and shrubs were transplanted into Fred's Channel.
- The road to Fox Portal was closed and is being allowed to naturally re-vegetate.
- Contouring and landscaping to create surface topographic diversity was completed in the Tercon Laydown Area. Fertilizing and seeding with native-grass cultivars was also completed.
- The Paul Lake Laydown Pad was removed. Fertilizing and seeding with native-grass cultivars was completed.

<u>2003-2004</u>

- In 2004, Phase I, II and III Environmental Site Assessments were conducted on the Old Camp pad. The assessments included a site inspection, an historical review of site activities, and sampling of soil from test pits and water from wells. The assessment identified two small areas of surface soil that were affected by mine activities. Future work may involve excavating the soils, placing them in a soil containment cell located next to the Old Camp pad, and scarifying and fertilizing the site to promote oxygenation of soils, to enhance microbial growth and to accelerate bioremediation of soils.
- Several reclamation projects were initiated at Airport Esker. The first was the planting of dwarf birch and blueberry seedlings at the South Airport Esker.
- In September 2004, fertilizer was applied to an area near Culvert Camp. In August 2005, the effects of that fertilizer application were evident in increased vegetation cover.
- In September 2004, a revegetation trial was established along the north shoreline of the Airstrip Lake basin. In 2004, fertilizer was applied over the area north of Fred's Channel east and west of the Airport Esker road.

2005-2006

- Boxcar Camp, an exploration camp southeast of the Main Camp, was decommissioned. The infrastructure was removed and sold to a local contractor for transportation off-site. It included accommodation trailers, a fuel tank, an incinerator and a sealift can. In July 2005, all remaining fuel drums and scrap metal were removed. An inspector from INAC visited the site in late summer 2005 to verify the site had been reclaimed.

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Appendix 1.1-1

Acronyms and Abbreviations

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Appendix 1.1-1. Acronyms and Abbreviations

ABA	Acid Base Accounting
ACIA	Arctic Climate Impact Assessment
AEMP	Aquatic Effects Monitoring Program
AN	Ammonium Nitrate
ANFO	Ammonium nitrate fuel oil
AP	Acid-generating Potential
AQMP	Air Quality Monitoring Program
ARD	Acid Rock Drainage
A & R Plan	Abandonment and Reclamation Plan
BHP Billiton	BHP Billiton Canada Inc.
CBC	Community Beneficiary Committee
CCIS	Canadian Climate Impact Scenarios
CCME	Canadian Council of Ministers of the Environment
CDA	Canadian Dam Association
CMP	Carbon Mineralization Potential
CRSA	Coarse Rejects Storage Area
CSCF	Contaminated Snow Containment Facility
DDMI	Diavik Diamond Mines Inc.
DFO	Fisheries and Oceans Canada
EARP	Environmental Assessment Review Panel
EC	Environment Canada
ECCP	Environment, Community Communication and Planning Department
EFPK	Extra Fine Processed Kimberlite
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EKATI	EKATI Diamond Mine
EWRM	Enterprise Wide Risk Management
FPK	Fine Processed Kimberlite
Ga	Billions of years
GCM	General Circulation Model
GED	General Equivalency Diploma
GTC	Ground Temperature Cable
HFO	Hydrous Ferric Oxide
HSEC	Health, Safety, Environment and Community
HSI	Habitat Suitability Index
IASC	International Arctic Science Committee
IBA	Impact and Benefit Agreement
IACT	Inter Agency Coordinating Team
ICRP	Interim Closure and Reclamation Plan

IEMA	Independent Environmental Monitoring Agency
INAC	Indian and Northern Affairs Canada
IPCC	Intergovernmental Panel on Climate Change
JHA	Job Hazard Analysis
JSO	Job Safety Objectives
KIA	Kitikmeot Inuit Association
KPSF	King Pond Settling Facility
LLCF	Long Lake Containment Facility
LOM	Life of Mine
Ma	Millions of years
MASL	Meters Above Sea Level
MAA	Multiple Accounts Analysis
ML	Metal leaching
MMER	Metal Mining Effluent Regulations
Mt	Million tonnes
MVLWB	Mackenzie Valley Land and Water Board
MW	Mega Watt
NAAQO	National Ambient Air Quality Objectives
NP	Neutralizing Potential
NPR	Neutralization Potential Ratio
NRCan	Natural Resources Canada
NSMA	North Slave Métis Association
NTKP	Naonaiyaotil Traditional Knowledge Project
OEMP	Operational Environmental Management Plan
PAG	Potentially Acid Generating
PASS	Positive Attitude Safety System
PDC	Panda Diversion Channel
PSD	Pigeon Stream Diversion
PK	Processed Kimberlite
PKCA	Processed Kimberlite Containment Are
QA/QC	Quality Assurance/Quality Control
QMS	Quality Management System
RMP	Revegetation Monitoring Program
RMR	Rock Mass Rating
SAR	Sodium Absorption Ratio
SNP	Surveillance Network Program
SOP	Standard Operating procedure
TAC	Technical Advisory Committee
TK	Traditional Knowledge
TDS	Total Dissolved Solids
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
TOR	Terms of Reference

UNEP	United Nations Environment Program
VEC	Valued Ecosystem Component
VMP	Vegetation Monitoring Program
WCB	Workers Compensation Board
WEMP	Wildlife Effects Monitoring Program
WHC	Water-Holding Capacity
WLP	Workplace Learning Program
WLWB	Wek'èezhìi Land and Water Board
WMO	World Meteorological Organization
WRSA	Waste Rock Storage Area
WROSMP	Waste Rock and Ore Storage Management Plan
WWPKMP	Waste Water and Processed Kimberlite Management Plan

Appendix 1.1-2

Definitions of Reclamation and Closure Terms

Engineers and Scientists

Appendix 1.1-2. Definitions of Reclamation and Closure Terms

Colour Legend

Language	Colour
English	Black
Inuinnaqtun	Blue
Inuktitut	Purple
Tlicho	Red
Chipewyan	Green

Term	Description
Acid/Alkaline rock drainage (ARD)	*The production of acidic or alkaline leachate, seepage or drainage from underground workings, ore piles, waste rock, processed kimberlite, and overburden that can lead to the release of metals to ground water and surface water during the life of the mine and after mine closure. Uutingnaktuk kiniktaliklooneen oyagak imagagvia: Nunap eloanit havagvingmit maghaktok kiniktamiklooneen uutingnaktomiklooneen oyakani. Emaalo nunap kaanganon emakmongaobloni. Havivalongniklooneen uyagagahiovikmi emaalooneen havagvioyongnaigaloaghoni kakoongogyoagaagaat. ᐆᑕᕐᓇᖅᑐᓖᑦ/ᓱᕈᖅᓯᒪᔪᕐᑲᖅᑐᑦ ᐅᔭᕋᙳᓐᖓᖅᑐᓂᒃ ᒥᕐᑭᓂᒃ ᑯᕕᕕᒃ: ᓴᕿᐸᒃᑐᑦ ᐆᑕᕐᓇᖅᑐᑦ ᐅᕙᓘᓐᓃᑦ ᐅᔭᕋᐃᑦ ᒪᕿᖕᒐ ᓄᐃᕙᒃᑐᖅ ᓄᓇᐅᑉ ᐃᓗᐊᓂᒃ ᐱᓕᕆᐊᖑᓯᒪᔪᓂᒃ, ᐅᔭᕋᐃᑦ ᐲᔭᖅᑕᐅᓂᖏᓐᓂ, ᐅᔭᕋᐃᑦ ᐊᒃᑕᑯᓐᖑᕐᓂᖏᓐᓂ, ᓯᑎᔪᓂᒃ ᓴᓇᔭᐅᓯᒪᔪᓂᒃ, ᐊᒻᒪᓗ ᐊᒥᐊᒃᑯᕕᓂᕐᓂᒃ ᓴᕕᕋᔭᙳᖅᐸᓪᓚᐊᔪᓐᓇᖅᑐᓂᒃ ᓴᕿᐸᓪᓚᐊᓂᖏᓐᓄᑦ ᐃᒪᕐᓄᑦ ᐃᖏᕐᕋᓂᖏᓐᓂ ᐅᔭᕋᓐᓂᐊᕐᕖᑦ ᐊᒻᒪᓗ ᐅᔭᕋᓐᓂᐊᕐᕖᑦ ᒪᑐᔭᐅᓚᐅᖅᑎᓪᓗᒋᑦ. Satsö Wenàèdi Edanàhtso: Ndè gotå'a ts'ô satsökwè, diamond kwè eyits'ô kwèwàch'ì ndè kah eåaetå'ô siì wenàèdi ndè goka ti k'ètå'ò tah ade ha wehoidi. Æasí ch'ÿlé naíye tu yétå'ír: Tsamba k'é æeghálada ts'î tthe-u, kimberlite-u ghááhdâ ts'î t'a beæaãze sí nok'e tu dághe to tu to yetå'ìr
Active layer	The top layer of the ground, above the permafrost table, that thaws each summer and refreezes each fall. Nunap kaanga Nunap kaanoanga kikomaniop mahaktighoni aoyami kikitighonilo ukiaghaligaangat. ᓄᓇᐃᑦ ᖄᖏᑦ ᕐᑯᓕᓇᓕᖅᓯᒪᓂᖏᑦ ᐊᐅᒍᓇᖅᑐᑦ ᕐᑯᐊᖑᓂᖏᑦ: ᓄᓇᐅᑉ ᖄᖓ ᐳᖅᑐᓂᖅᐹᖅ, ᕐᑯᓚᓃᑦᑐᖅ ᕐᑯᐊᖑᓂᖓᑕ, ᐊᐅᒃᐸᒃᑐᖅ ᐊᐅᔭᑖᖅ ᐊᒻᒪᓗ ᕐᑯᐊᒃᑲᓐᓂᖅᐸᒃᑐᖅ ᐅᑭᐅᒃᓴᑖᑦ Ndè Godì: Ndè goka edàk'ô eyits'ô hat'ô tat'è ehtå'è nayî eyits'ô natî siì ndè godì gihdi hôt'e. Ní dághe nálghi-u, tth'i naáltÿn: Ní dághe hetÿn (permafrost) húlye, síne nálghî-u, xáy t'aãze naáltÿn.
Adaptive management	A formal process of formulating and continually improving resource management policies and practices by learning from the outcomes of operational programs. ᐋᕿᒋᐊᖅᑕᐅᖏᓐᓇᕐᓂᒃᑯᑦ ᐊᐅᓚᑦᑎᓂᖅᐃᓕᑕᕆᔭᐅᓯᒪᔪᑦ ᐱᖅᑯᓯᕆᔭᐅᓕᖅᑐᑦ ᐋᕿᖁᓂᕐᒥᒃ ᑲᔪᓰᓐᓇᖅᑐᒥᓗ ᐱᐅᓯᒋᐊᖅᑎᑦᑏᓐᓇᕐᓂᖅ ᓄᓇᒥᐅᑕᓂᒃ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐊᑐᐊᒐᕐᓂᒃ ᐊᒻᒪᓗ ᐱᖅᑯᓯᕆᔭᐅᓂᐊᖅᑐᓂᒃ ᐃᓕᑦᑎᕙᓪᓕᐊᓂᒃᑯᑦ ᖃᓄᐃᓕᐅᖃᑦᑕᕐᒪᖔᑕ ᐊᐅᓚᑕᐅᔪᓂᒃ ᐊᑐᖅᑕᐅᕙᓪᓕᐊᔪᑦ

Term	Description
	Naàwo gèèhdza hagèèta K’etå’as ts’‡n æasíe k’oneta æedû nalye dé xa.
Amendment	An addition of materials to existing substrate that modifies texture and nutrient potential, with the intent of encouraging plant growth through improvement of soil condition. Examples of amendments are: compost, sand, peat moss, fertilizer. Ehoaghaot nunamut: Eelaongnik nunap naotianginut ehoaghaghogo kanoginega naonigalo ema angigliyangini naotiat eehoaghaghimaaghugo nuna. Hapkoat eelaongneet atolikpaktot heogaklo nunamiklo angiglilegonmik. ᐋᕿᒋᐊᕈᑏᑦ: ᐱᖁᑎᒃᑲᓅᑦ ᐃᓚᔭᐅᓯᒪᔪᑦ ᒫᓇᐅᔪᖅ ᐱᕈᖅᕕᐅᓯᒪᔪᓇᖅᑐᑦ ᓄᓇᐃᑦ ᐊᓱᔾᔨᖅᐸᓪᓚᐊᔪᓇᖅᑐᑦ ᐊᒻᒪᓗ ᐱᕈᕝᕕᐅᔪᓇᖅᑐᑦ, ᐱᕈᖅᕕᐅᕚᓪᓚᕐᑯᓪᓗᒋᑦ ᐱᐅᓯᒋᐊᖅᑕᐅᓯᒪᓂᖕᒑᑦ ᓯᐅᕋᐃᑦ, ᒪᕋᐃᓪᓗ. ᓲᕐᓗ ᐋᕿᒋᐊᕈᑎᑦ ᒪᑯᓂᖓ ᐃᓚᖃᕈᓇᖅᑐᑦ: ᐊᑐᖅᑕᐅᓯᒪᔪᕕᓃᑦ ᐱᕈᖅᓯᒫᓂᒃᑐᑦ ᐊᒥᐊᒃᑯᐃᑦ, ᓯᐅᕋᐃᑦ, ᒪᓴᐃᑦ ᒪᕋᐃᑦ, ᐱᕈᖅᓇᐊᒃᑲᓂᕈᑏᓪᓗ Ndè åadî kàæa: Ehtå’è, ewà, kw’ah eyits’ô nàèdi hazô kàæa t’à ît’ô ts’ehshe. Bet’á æasí hozû neshe xa ní yéæálæñ : Æasí thay yé æàlæî bet’á æasí hozû neshe xa. Diri sí, compost húlye-u, fertilizer-u peatmoss-u, húlye ní yé æálæî.
Analytical detection limits	The smallest amount of a substance that can be detected. ᖃᐅᔨᓴᖅᑕᐅᓂᒃᑯᑦ ᖃᐅᔨᔭᐅᖄᕋᔭᖅᑐᑦ: ᓱᓇᑐᐃᓇᐃᑦ ᒥᑭᓪᓕᑎᖅᑕᐅᓯᒪᔪᑦ ᒥᑭᓐᓂᖅᐹᖑᔪᓇᖅᑐᒥᒃ ᖃᐅᔨᔭᐅᔪᓇᖅᑐᑦ ᖃᐅᔨᓴᕈᑎᑎᒍᑦ Asìi necha-lèa hò wegogihæà Æasíe nejaíle húlí bek’oneta dé húlæáy æat’e
Analysis	The process of breaking information down into smaller parts to study and understand it. ᖃᐅᔨᓴᐃᕙᓪᓕᐊᓂᖅ: ᐱᖅᑯᓯᕆᔭᐅᕙᒃᑐᑦ ᑐᑭᓯᓂᐊᖅᑕᐅᓂᐊᖅᑐᓂᒃ ᒥᑭᓐᓂᖅᓴᐅᓕᕐᓗᑎᒃ ᑐᑭᓯᔭᐅᔪᓇᕐᓂᐊᕐᒪᑕ ᐊᒻᒪᓗ ᖃᐅᔨᓴᖅᑕᐅᓗᑎᒃ. Deæö asìi wedanàts'èta Æasíe beneredí xa bek’oneta
Angle of repose	The maximum slope at which a heap of any loose or fragmented solid material will stand without sliding or come to rest when poured or dumped in a pile or on a slope. ᓯᑯᕕᐅᔪᓃᕐᕕᖓ ᐅᔭᕋᖕᓄᑦ ᓯᐅᕋᕐᓄᓪᓗᓐᓃᑦ ᐳᖅᑐᓂᕐᒥ: ᐳᖅᑐᓂᖓ ᓯᑯᕕᐅᔪᓇᖅᑐᒥ ᐅᔭᕋᐃᑦ ᐅᕙᓘᓐᓃᑦ ᓯᐅᕋᐃᑦ, ᓄᕐᑲᕐᕕᑎᓯᒪᓂᐊᖅᑕᖓᑦ ᓯᑐᔪᓃᕐᓗᓂ, ᑲᑕᒑᕈᓃᕐᓗᑎᒃ ᑖᕙᓂ ᒪᓂᕋᐅᖏᓐᓂᕐᒥ ᐳᖅᑐᓂᕐᒥ. Edàanì naìtå'ì T’at’u nñtå’ir
Anoxic	Without oxygen. Term commonly used to refer to water with extremely low dissolved oxygen concentrations, and sediment with no oxygen present. ᐊᓂᖅᖄᖅᑑᑎᖅᑲᖏᓐᓂᖅ: ᐊᓂᕐᓂᖅᕐᕕᐅᔪᓇᖏᑦᑐᖅ. ᐅᖃᐅᓯᖅᑕᖅ ᐊᑐᖅᑕᐅᒐᔪᒃᑐᖅ ᐅᖃᐅᓯᐅᓂᖏᓐᓂ ᐃᒪᐃᑦ ᐊᓂᖅᖄᖅᑐᒐᓴᒥᒃ ᐱᑕᖃᖏᑲᓴᒃᑐᖅ, ᐊᒻᒪᓗ ᓯᐅᕋᖅᖅᑐᑦ ᐊᓂᕐᓂᖅᖏᑦᑎᐊᖅᑐᒥᒃ. Wet'à ts'eèjì whìle Æasíe beyé yayí hûlñle sí
Anthropogenic	Coming from or caused by man. ᐃᓄᐃᑦ ᐱᓕᕆᕕᒋᓯᒪᔭᖏᑦ: ᐃᓄᐃᑦ ᐱᑎᓯᒪᔭᖏᑦ ᐅᕙᓘᓐᓃᑦ ᑕᐃᒪᐃᓕᓕᖅᑎᓯᒪᔭᖏᑦ Dône wets'ïæö ajà Dÿne ts’î æ‡né náádhÿr
Aquatic	Growing, living or frequenting water; occurring or situated in, or on water. ᐃᒪᕐᒥᐅᑕᐃᑦ: ᑭᓯᓕᒫᑦ/ᓱᓇᑐᐃᓐᓇᐃᑦ ᐱᕈᖅᑐᑦ, ᐆᒪᔪᑦ, ᐃᒪᕐᒥᑦᑐᓪᓗᓐᓃᑦ; ᐃᒪᐃᓪᓃᓂᑦ ᖃᖓᓃᑦᑐᑦ

Term	Description
	Teè naàdè Teyághe æasíe dána-u/dáníye
Aquatic Effects Monitoring Program (AEMP)	*A monitoring program designed to determine the short- and long-term effects in the water environment resulting from the Project (EKATI Diamond Mine), to evaluate the accuracy of impact predictions, to assess the effectiveness of planned impact mitigation measures, and to identify additional impact mitigation measures to reduce or eliminate environmental effects. ᐃᒪᕐᒥᐅᑕᓂᒃ ᖃᐅᔨᓴᕐᑎᑦ: ᖃᐅᔨᓴᕐᑎᑦ ᐋᕿᐅᒪᔭᐅᔪᑦ ᕿᓚᒻᒥᐅᔪᓘᑦ ᐊᑯᓂᐅᔪᓘᓪᓗ ᖃᓄᐃᓕᕆᓪᓕᐊᓂᖏᓂᒃ ᐃᒪᐃᑦ, ᐱᔾᔪᑕᐅᓂᖏᓐᓄᑦ ᐅᔭᕋᖕᓂᐊᕐᕕᑦ ᐊᐅᓚᑕᐅᓂᖏᓐᓄᑦ, ᖃᐅᔨᓴᖅᑕᐅᕙᓪᓗᒋᑦ ᖃᓄᖅ ᓱᓕᑎᒋᖕᒪᖔᑕ ᓇᓚᐅᑦᑖᖅᑕᐅᓯᒪᔪᑦ, ᖃᐅᔨᓴᖅᑕᐅᕙᓪᓗᒋᑦ ᐋᑐᑎᖃᑎᐊᕐᓂᒪᖔᑕ ᐸᕐᓇᒃᑕᐅᓯᒪᔪᑦ ᓱᕈᓗᐊᖅᑕᐃᓕᒪᔾᔪᑎᒃᓴᐃᑦ ᐊᑐᕈᒫᕐᓂᐊᖅᑐᑦᖅ ᐊᒻᒪᓗ ᓇᓗᓇᐃᖅᑕᐅᕙᓪᓗᒋᑦ ᐊᓯᖏᑦ ᒥᑭᓪᓕᒋᐊᕈᑕᐅᔪᓐᓇᖅᑐᑦ ᐊᕙᑎᒧᑦ ᓱᕈᕈᑕᐅᕙᓪᓕᒪᔾᔪᑎᒃᓴᐃᑦ ᐊᑐᕈᒫᕐᓂᐊᖅᑐᑦ ᐊᒻᒪᓗ ᓇᓗᓇᐃᖅᑕᐅᕙᓪᓗᒋᑦ ᐊᓯᖏᑦ ᒥᑭᓪᓕᒋᐊᕈᑕᐅᔪᓐᓇᖅᑐᑦ ᐊᕙᑎᒧᑦ ᓱᕈᕈᑕᐅᕙᒃᑐᓄᑦ Teè asìi naàdè åadî wek'ahòta Teyághe æasíe náde k'oneta
Aquatic receiving environment	Down-stream water bodies from the mine site facilities including, but not limited to, sedimentation ponds and waste rock piles. ᐃᒪᖃᖓᑦ ᓯᓚᑖᓂ ᓴᓇᕕᐅᔪᑦ: ᐃᒪᖃᖓᑦ ᑕᓯᓪᓗᓐᓃᑦ ᐅᔭᕋᖕᓂᐊᕐᕖᑦ ᖃᓂᒋᔭᕐᕆᓐᓂᒃ ᐃᒪᖃᖓᑦ, ᓲᕐᓗ ᑕᓯᑦ ᑕᓯᕋᐃᓪᓗ ᐊᒻᒪᓗ ᐅᔭᕋᕕᓂᖃᖓᑦ Sômbak'è gots'ô haîlî Tsamba k'e ts'î tu haíli
Archaeological site	A location exhibiting physical signs of past human use, typically greater than 50 years in age. ᐱᖁᑎᕕᓃᖃᖓᑦ/ᐃᑦᑕᕐᓂᑕᖃᖓᑦ: ᓄᓇᐃᑦ ᐊᑐᖅᑕᐅᕙᒃᑐᕕᓃᑦ ᐃᓄᖕᓄᑦ ᑕᐃᔅᓯᒪᓂ, 50 ᐊᕐᕌᒍᐃᑦ ᐅᖓᑖᓂ ᐅᑭᐊᖃᕋᔭᒃᑐᑦ Whàedô kök'è Tthay dÿne behøhk'e
Arctic	A geographic region in the northern hemisphere that is circumpolar in extent and generally characterized as being north of the treeline, in an area of continuous permafrost. ᐅᑭᐅᖅᑕᖅᑐᖅ: ᓄᓇᐃᑦ ᐅᑭᐅᖅᑕᖅᑐᒥ ᓇᐹᖅᑐᖃᕐᕕᑦᑐᑦ, ᓄᓇᐃᑦ ᐃᓗᐊ ᖁᐊᕐᔪᐃᓐᓇᖅᑐᖅ Edza nèk'e Æadza nǂné
Armouring	Placement of material on/in a channel or pond to protect against erosion. ᓭᐳᑎ: ᐃᓚᐅᖃᐃᓂᖅ ᓭᐳᑎᓂᒃ ᐃᒪᕐᒥ ᐃᒪᐃᓪᓗᓐᓂᑦ ᐊᕙᑎᐊᓂ ᓱᕈᖅᑕᐅᓂᐊᕐᒪᑦ Ndè tsiìwhi ch'aà asìi wek'e whehchì Ni ts'çdhir ch'a æasíe bek'e nílchuth
As-built (drawings)	Engineering drawings portraying a site as constructed/reclaimed, including all changes from the original design that were implemented during construction and/or reclamation. ᓴᓇᔭᐅᓯᒪᓂᓪᓚᓇᐊᓂᒃ ᑎᑎᕋᐅᔭᐃᑦ: ᑎᑎᕋᐅᔭᖅᑕᐅᓯᒪᔪᑦ ᓄᓇᒥ ᓴᓇᔭᐅᓯᒪᓂᒃᑐᓂ/ᓴᓗᒻᒪᖅᓴᖅᑕᐅᕋᓂᒃᑐᓂᓗᓐᓃᑦ, ᓲᕐᓗ ᐃᓚᖃᖅᑐᑦ ᑕᒪᐃᓐᓂᒃ ᐊᓯᔾᔨᖅᑕᐅᓯᒪᓂᖕᖏᓐᓂᒃ ᓯᕗᓪᓕᖅᐸᒥᒃ ᑎᑎᕋᐅᔭᖅᑕᐅᓚᐅᖅᑐᑦ ᐊᑐᓕᖅᑎᑕᐅᓯᒪᔪᓂ ᓴᓇᔭᐅᕙᓪᓕᐊᔪᓂ ᐊᒻᒪᓗ/ᐅᕙᓘᓐᕕᓃᑦ ᓴᓗᒻᒪᖅᓴᖅᑕᐅᔪᓂ Hoòlî tå'ahô wenîhtå'èchì Xáli tå'ãghe t'abúrelæî

Term	Description
Assessment	An evaluation made based on observations and data. ᖃᐅᔨᓴᖅᑕᐅᓯᒪᔪᑦ: ᖃᐅᔨᓴᖅᑕᐅᓯᒪᔪᑦ ᒪᓕᒃᑕᐅᓪᓗᑎᒃ ᑕᑯᔭᐅᓂᑯᑦ ᐊᒻᒪᓗ ᑲᑎᖅᓱᖅᑕᐅᓯᒪᔪᑦ ᖃᐅᔨᒪᔾᔪᑏᑦ Wek'aàta Bek'oneta
Available nutrients	That portion of any element or compound in the soil that can readily be absorbed and assimilated by growing plants. Nunap nekaotait : Nunap nekaotait angilglilegotit naotianik naoyilegaangat ᐱᑕᖃᖅᑐᑦ ᐱᕈᕈᑕᐅᔪᓇᖅᑐᑦ: ᖃᓄᐃᑐᑐᐃᓇᐃᑦ ᐱᕈᖅᐸᐅᔪᓐᓇᖅᑐᑦ ᓄᓇᐃᑦ ᒪᕐᕋᐃᑦ ᐊᑐᕈᓐᓇᖅᑐᑦ ᐊᒻᒪᓗ ᐊᑐᖅᑕᐅᓇᔭᖅᑐᑦ ᐱᕈᖅᑐᓄᑦ ᐱᕈᕈᑎᒃᓴᓄᑦ Ndè Wenàèdi: Ehtå'è tah nàèdi gòåî t'à ît'ô dehshe ha dì-le.
Backfill	Mine waste or rock used to fill the void created by mining on ore body. ᓯᐅᕋᐃᑦ/ᐅᔭᕋᐃᑦ ᑕᑕᑎᕈᑏᑦ ᐊᖏᔪᓕᐊᓂᒃ: ᐊᒃᑕᑯᐃᑦ ᐅᔭᕋᐅᓃᑦ ᓯᐅᕋᐃᓪᓗᓃᑦ ᑕᑕᑎᕈᑏᑦ ᐃᑎᓂᕐᒥᒃ ᓄᓇᒥᒃ ᐅᔭᕋᖕᓂᐊᖅᑕᐅᓯᒪᓂᐅᓂᖏᓐᓄᑦ Kwew t'à ndè yìì nàgehtå'ì Bet'a æasí ní ts'î hozû neshe: T'a ní yé, thay-u ts'î t'ãchay-u, k'aí-u, bet'á hazû neshe.
Barrenlands	The area of the Northwest Territories east of the Mackenzie River valley and north and east of the tree line characterized by a low rolling tundra landscape, continuous permafrost and low densities of human settlement. ᓇᐹᖅᑐᖃᖏᓐᓃᑦ ᓄᓇᐃᑦ: ᓄᓇᕐᓯᐊᕐᒥ ᓄᓇᐃᑦ ᐅᐊᖕᓇᖕᒐᓃᑦᑐᑦ ᒪᑭᓐᓯᐸ ᓄᓇᖏᓐᓂ ᐅᑭᐅᖅᑕᖅᑐᒥ, ᓇᐹᖅᑐᖃᖏᓐᓂᐅᔪᑦ ᓄᓇᑐᐃᓇᐃᑦ, ᐃᓗᐊᓂ ᖁᐊᖑᐃᓐᓇᖅᑐᑦ ᐊᒻᒪᓗ ᐃᓄᖃᓗᐊᖏᑦᑐᑦ. Hòezik'e Hazú N‡né
Baseline studies	Initial scientific investigations that determine the present ecological state of an area and establish a basic reference necessary for further mandatory studies once development begins. ᓄᓇᐃᑦ ᑕᐃᒪᐃᓐᓇᐃᑐᑐᖃᐃᑦ: ᓯᕗᓪᓕᕐᒥ ᖃᐅᔨᓴᖅᑕᐅᒋᐊᖅᑐᑦ ᑐᑭᑖᕈᑏᑦ ᒫᓇᐅᔪᒥ ᖃᓄᐃᓕᐅᖅᑕᐅᓯᒪᖏᑎᓪᓗᒋᑦ ᓱᓕ ᓄᓇᐃᑦ ᐊᒻᒪᓗ ᖃᐅᔨᒪᔾᔪᑏᑦ ᖃᓄᐃᓐᓂᖏᓐᓂᒃ, ᖃᐅᔨᓴᖅᑕᐅᒃᑲᓐᓂᕈᒫᖅᑐᓂᒃ ᖃᐅᔨᒪᔾᔪᑏᑦ ᓴᓇᕙᐅᓯᒪᓕᖅᑎᓪᓗᒋᑦ Weghaà wek'ahoòtah T'at'u høæâ ghåre bek'oneta
Bedrock	The solid rock under soil, gravel, sand or loose boulders. ᐅᔭᕋᐃᑦ ᓄᓇᒦᑦᑐᑦ ᓄᐃᑕᔪᓐᓇᕐᒥᔪᑦ: ᐅᔭᕋᐃᑦ ᓯᖃᓯᒪᖏᑦᑐᑦ ᐊᑖᓃᑦᑐᑦ ᓄᓇᐃᑦ, ᓯᐅᕋᐃᑦ, ᐅᔭᕋᓪᓛᑦ, ᐅᔭᕋᐃᓗᓐᓃᑦ ᓯᖃᑎᖅᓯᒪᔪᑦ Ndè gotå'a kwe The n‡né
Behavioural response	The way an animal behaves normally. ᐆᒪᔪᐃᑦ ᖃᓄᐃᑉᐸᖕᓂᖏᑦ: ᐆᒪᔪᐃᑦ ᐱᖅᑯᓯᑐᖃᖏᑦ Edàanì tich'adi k'ehòæa Dech'adíe benádhÿré
Bench (open pit)	A ledge, which in open-pit mines forms a single level of operation above which mineral or waste materials are excavated from a continuous bank or bench face. The material or waste is removed in successive layers, each of which is a bench, several of which may be in operation simultaneously in different parts of, and at different elevations in an open pit mine.

Term	Description
	ᒪᕙᕋᐅᑏᑦ ᓄᓇᒥ (ᒪᑐᐃᖓᕙᒥ ᐅᔭᕋᖕᓂᐊᕐᕕᖕᒥ): ᒪᕙᕋᕐᕖᑦ ᓄᓇᒥ ᒪᑐᐃᖓᕙᓂᒃ ᐅᔭᕋᖕᓂᐊᕐᕕᐅᕙᓂ ᐊᓯᑲᖅᑕᕐᕖᑦ ᐅᔭᕋᖕᓂᒃ ᐊᒃᑕᑯᓂᒡᒍᓐᓂᑦ ᐲᔭᖅᑕᐅᓯᒪᕙᓂ ᐋᑖᓄᐊᖅᐸᓪᓕᐊᕙᑦ ᒪᕙᕐᕕᓖᑦ. ᐅᔭᕋᐃᑦ ᓴᕕᕋᔭᒃᓴᐃᓗᓐᓂᑦ ᐲᔭᖅᑕᐅᓯᒪᕙᑦ ᐳᖅᑐᓕᕇᒃᑎᑕᐅᓯᒪᓪᓗᑎᒃ, ᐊᑐᓂ ᒪᕙᕐᕕᕐᑲᕐᒪᑕ, ᐊᒥᓱᑦ ᐊᑕᐅᑎᒃᑯᑦ ᐊᑐᕈᓐᓇᖅᑐᑦ ᐊᔾᔨᖕᒋᑦᑑᑎᓂ ᐳᖅᑐᓂᓕᖕᓂ, ᐊᒻᒪᓗ ᐋᔾᔨᖕᒋᑦᑑᑎᓂᒃ ᐳᖅᑐᓂᖃᖅᑐᑦ ᒪᑐᐃᖓᕙᒥ ᐅᔭᕋᖕᓂᐊᕐᕕᖕᒥ. Weyìigôöæà dagoæô Ni yuyaghe dãøæa
Benthic	Pertaining to the bottom region of a water body, such as a lake. ᑕᓰᑦ ᓇᑎᖕᒋᑦ ᓇᑦᑎᕐᒥᐅᑕᐃᑦᑐ: ᐱᔮᑎᖅᑲᖅᑐᑦ ᐊᑖᓂ ᐃᒪᐃᑦ ᓇᑎᐊᓂ, ᓲᕐᓗ ᑕᓯᕐᒥ. Teè gotå'a Tetå'aghe
Benthic invertebrates	Little animals without bones (like bugs) that live on the bottom of a lake, creek, or the ocean. ᑕᓯᕐᒥ ᓇᑦᑎᕐᒥᐅᑕᐃᑦ: ᐆᒪᔪᕋᑏᑦ ᓴᐅᓂᖅᑲᖕᒋᑦᑐᑦ (ᓲᕐᓗ ᖁᐱᕐᕈᐃᑦ) ᐆᒪᔪᑦ ᓇᑎᐊᓂ ᐃᒪᐃᑦ, ᑕᓯᑦ, ᑕᓯᕋᐃᑦ ᐅᕝᕙᓘᓐᓃᑦ ᑕᕆᐅᕐᒥ. Tehtsà kaæa Teyághe ts'î gu
Benthos	Assemblage of organisms living in or on the bottom sediments of a water body and dependent upon the decomposition cycle for most, if not all, of its basic food supply. ᐊᔾᔩᖕᒋᑦᑐᑦ ᓇᑎᕐᒥᐅᑕᐃᑦ ᐃᒪᕐᒥ: ᓱᓇᑐᐃᓐᓇᐃᑦ ᐆᒪᔪᑦ ᓇᑎᕐᒥᐅᑕᐃᑦ ᐃᒪᕐᓂ, ᑐᕐᖁᖓᔪᕕᓂᖅᑐᓰᑦ ᓂᕿᒃᓴᕆᓪᓗᒋᑦ. Tehtsà kaæa lää naàde Te tå'aghe ts'î guæaze dána
Berm	A linear shaped rock barrier created to impede access by vehicles people or wildlife. ᐊᖅᑯᑎᒥ ᐃᑳᕇᒃᑯᑏᑦ: ᐊᖅᑯᑎᐅᐸ ᓇᓛᓂᑦᑐᖅ ᐃᑳᕇᒃᑯᑎ, ᐃᑳᖅᕕᐅᑦᑕᐃᓕᒫᔭᑎ ᓄᓇᒃᑰᕈᑎᓄᑦ, ᐃᓄᖕᓄᑦ, ᐆᒪᔪᓄᓪᓗ. Dakaa hohåè Ttth t'a bãåch'a xaåe
Best management practice	Operating practice that enhances the sustainability of the resource to which the practise relates. Must be practical and economically achievable. ᐃᐅᓂᖅᐹᒥᒃ ᐊᐅᓪᓚᑦᑎᔮᑏᑦ ᐱᖅᑯᓯᕆᔭᐅᔭᑦ: ᐊᐅᓚᑦᑎᓂᕐᒥᒃ ᐱᖅᑯᓯᕆᔭᐅᔭᑦ ᐱᐅᓯᕚᓪᓕᕈᑕᐅᓂᐊᖅᑐᑦ ᐆᒪᔭᖅᑲᖅᑎᑦᑏᓐᓇᕐᓂᕐᔫᑦ/ᐱᕈᖅᕕᐅᖕᒋᓐᓇᕐᓂᐊᕐᒪᑦ. ᑐᑭᖃᑦᑎᐊᕆᐊᖃᖅᑐᖅ ᐊᑐᕈᓐᓇᑦᑎᐊᕐᓗᓂ ᐊᒻᒪᓗ ᐱᓐᖑᖅᑎᑕᐅᔪᓐᓇᖅᓗᓂ. Asìi denahk'e k'è seèæî Æate hûzø æasíe xadi
Bioaccumulation	*The process by which chemicals build up in organisms from sources in food and water. ᓱᕈᕐᓇᖅᑐᖅᑖᖅᐸᓪᓕᐊᑐᐃᓐᓇᕐᓂᖅ ᑕᐃᒃᑯᓂᖓᑦᓴᐃᓐᓇᖅ: ᓱᕈᕐᓇᖅᑐᖅᑖᖅᐸᓪᓕᐊᑐᐃᓐᓇᕐᓂᖅ ᓂᕆᓐᓇᕐᑲᑦᑕᕐᓂᕐᒥᒃ ᑕᐃᒃᑯᓂᖓᑦᓴᐃᓐᓇᖅ ᓱᕈᖅᓇᖅᑐᕐᑲᖅᑐᓂᒃ ᓂᕿᓂᒃ. Tich'adi eåedè t'à nàediåî nàtso at'î Æasíe æeåeldél t'á naídí såine bet'î æat'ñ

Term	Description
Bioassay	The use of an organism or part of an organism as a method for measuring or assessing the presence of biological effects of one or more substances under defined conditions. A bioassay test is used to measure a degree of response (e.g., growth or death) produced by exposure to physical, chemical or biological variable. ᐆᒃᑐᖅᑕᐅᔪᒃᓴᖅ ᖃᐅᔨᓴᖅᑕᐅᓂᐊᕐᒪᑦ: ᐋᖅᑕᐅᓯᒪᔪᖅ ᑎᒥᒥᒃ/ᐱᕈᖅᑐᒥᒃ ᐆᒃᑐᕋᖅᑕᐅᓂᐊᕐᒪᑦ ᖃᐅᔨᓴᖅᑕᐅᓂᐊᕐᓗᑎᒃ ᐊᓯᔾᔨᖅᓯᒪᖕᒪᖕᒫᑕ ᓱᓇᑐᐃᓐᓇᕐᓂᒃ (ᓲᕐᓗ ᐃᖃᓘᑉ ᓂᕿᖕᒐᓂᒃ ᐋᖅᓯᕙᐅᓯᒪᔪᖅ ᖃᐅᔨᓴᖅᑕᐅᓂᐊᕐᒪᑦ). Asìi wekwö wek'ahòeta Æasíe tth‡n gháre bek’oneta
Biodiversity	*The variety of organisms found within a specific geographic region. ᐊᔾᔩᖕᖏᑦᑑᑏᑦ ᐅᒪᔪᐃᑦ/ᐱᕈᖅᑐᓪᓗ: ᖃᓄᐃᑦᑑᓂᖕᖏᑦ ᐊᔾᔩᖕᖏᑦᑑᑏᑦ ᐱᕈᖅᑐᑦ ᐆᒪᔪᐃᓪᓗᓐᓃᑦ ᐱᑕᖃᖅᑐᑦ ᓄᓇᒥ, ᐃᒪᕐᒥ, ᓄᓇᓚᖕᓂ, ᐊᕕᒃᑐᖅᓯᒪᓂᐅᔪᓂ ᐅᕙᓘᓐᓃᑦ ᓄᓇᖅᔪᐊᕐᒥ. Ndè k'e asìi kaæa eda Háyoriæâ k’éyaghe æasíe dána hûli
Biological stability	Applies to vegetation, aquatic habitats and wildlife habitats, and is reached when these habitats are stable, self-sustaining, and productive. ᐆᒪᔪᐃᑦ ᐱᑕᖃᐃᓐᓇᕈᓐᓇᕐᓂᖕᖏᑦ: ᐅᖃᐅᓯᖃᖅᑐᑦ ᐱᕈᖅᑐᓂᒃ, ᐃᒪᕐᒥᐅᑕᓂᒃ, ᐆᒪᔪᖃᕐᕕᐅᔪᓂᓪᓗ, ᐊᒻᒪᓗ ᑕᐃᒪᐃᑉᐸᖕᓂᖕᖏᓐᓂᒃ ᑕᒪᒃᑯᐊ ᖃᓄᐃᖕᖏᑦᑎᐊᖅᑎᓪᓗᒋᑦ, ᐱᑕᖃᓚᖅᐸᓪᓚᐊᖕᖏᓐᓇᕈᓐᓇᖅᑎᓪᓗᒋᑦ, ᐊᒻᒪᓗ ᕿᑐᖕᖏᐅᖅᐸᓪᓚᐊᖕᖏᓐᓇᕈᓐᓇᖅᑎᓪᓗᒋᑦ. Tich'adi whacho edeèda Tech’adíe dáåelna
Biomagnification	*The increasing concentration of a substance, such as a toxic chemical, in the tissues of organisms, at successively higher levels in a food chain. ᓱᕈᕐᓇᖅᑐᖅᑖᖅᐸᓪᓚᐊᓂᖅ: ᐱᕚᓪᓚᐊᓂᖕᖏᑦ ᓱᕈᕐᓇᖅᑐᕐᑲᕐᓂᖕᖏᑦ ᑎᒥᒥ ᓱᓇᑐᐃᑦ ᓂᕆᔭᐅᓯᒪᔪᕕᓂᕐᓂᒃ, ᓲᕐᓗ ᐃᒪᕐᒥᒃ ᓱᕈᖅᑕᐅᓯᒪᓂᖕᖏᓐᓂᒃ ᐅᕙᓘᓐᓃᑦ ᓂᕆᔭᐅᕚᓪᓚᓂᖕᖏᓐᓂ ᓂᖀᑦ ᓱᕈᕐᓇᖅᑐᕐᑲᖅᑐᑦ Tich'adi eåedè nindè nàediåî nàtso at'î Æak’ék’ÿr æaåa æasíe ts’eldél ts’îæ‡né naídi såine æeåeth’ír
Biomass	The total mass of living organisms, usually expressed as a weight per unit area or volume (e.g., grams per m^3). ᐆᒪᔪᐃᑦ ᐆᒃᑐᕋᖅᑕᐅᓯᒪᕐᑲᑦᑕᕐᓂᖕᖏᑦ: ᑲᑎᓪᓗᒋᑦ ᐅᒪᔪᐃᑦ ᐱᑕᖃᕐᓂᖕᖏᑦ, ᐊᖏᓂᖕᖏᓐᓂᒃ ᐆᑦᑐᕋᕈᑕᐅᕙᒃᑐᑦ (ᓲᕐᓗ ᖁᒪᐃᓐᓂᖕᖏᑦ ᐊᖏᓂᖕᖏᓐᓂ) Edàanì asìi eda wexègìhdzà/the way living things are measured T’at’u æasíe dána húldzáy
Broadcast seeding	Scattering seed on the surface of the soil. Contrasted with drill seeding, which places seed in rows in soil. Naoyoghat nunami koyaginak: Heamitogit naotiaghat nunap kaangani. Ahiatigotaok eehoaghatoaghogit nalgoyomik naoyoghanik ᐃᖃᑦᑕᐃᓂᒃᑯᑦ ᐱᕈᖅᓯᐊᖅᓯᓂᖅ: ᐱᕈᖅᑐᒃᓴᓂᒃ ᐃᖃᑦᑕᐃᓗᑎᒃ ᐱᕈᕈᒫᖅᑐᓂ ᓄᓇᒥ. ᓴᓂᐊᓂ ᐳᑐᓚᐅᖅᓗᑎᒃ ᐱᕈᖅᑐᒃᓴᓚᐅᖅᓂᖅ, ᐃᓚᐅᖃᖅᑕᐅᓯᒪᓪᓗᑎᒃ ᐱᕈᖅᑐᒃᓴᑦ ᓴᓂᓚᓇᖅᑐᒥᒃ. T’asi dehsee wedzìi ndè ka ats’ehæî: Ndè k’è t’ala ît’ô wedzìi dehshe ats’ehæî. Æasí hozû neshe xa ní k’e dzérredhi: Ní ke æasí dzéreddhi bet’á hozû æasí neshe xa. Æasí neshe xa nìlye dé æeåtth’i húæa-u alæî, dírí xát’ele.

Term	Description
Canadian Ambient Air Quality Objectives (CAAQO)	*The objectives and standards for permissible air pollutant concentrations. ᑲᓇᑕᒥ ᐊᓂᕐᓂᕐᒥᒃ ᐆᒃᑐᕋᐃᓂᖅ: ᐊᓂᕐᓂᒥᒃ ᓱᕈᕐᓇᖅᑐᕐᑲᕐᒪᖔᑦ ᖃᐅᔨᓴᕈᑎᑦ, ᒥᑭᑦᑐᒻᒪᕆᐅᓇᖅᑕᐅᓯᒪᔪᓂᒃ (ᐱᓕᔾᔪᓐᖏᓐᓃᑦᑐᓂᒃ). Edàanì nîhts'i wexiìdzà T’at’u yayñ húldzáy
Carnivore	A flesh-eating animal considered a VEC. In the context of this report, grizzly bears, wolverines and wolves. ᐆᒪᔪᖅᑐᓲᑦ ᐆᒪᔪᐃᑦ: ᐆᒪᔪᖅᑐᓲᑦ ᓂᕿᑐᓲᑦ ᐆᒪᔪᐃᑦ. ᓱᕐᓗ ᐊᒃᖤᐃᑦ, ᑭᖕᒐᐃᑦ, ᐊᒻᒪᓗ ᐊᒪᕈᐃᑦ. Tich'adi eåegedè/animals eating each other Ch’adíe b‡r heldél/æeåeådél
Cave Cone	Is a zone of instability or subsidence related to underground extraction of the kimberlite pipes. The size of the cave cone is modeled based on the diameter of the extraction, rock mass conditions and depth of mining. ᓄᓇᐅᑉ ᐳᐊᕐᓇᔾᖅᑕᐅᓯᒪᓂᖓᓂ ᐃᓗᑐᓂᐅᑉ ᑲᑕᒐᓕᕈᓐᓇᕐᓂᖓᑕ ᓴᓂᕋᖓᒍᑦ: ᓄᓇᐅᓂᖓ ᑲᑕᒍᑐᐃᓐᓇᓇᐊᓕᒃ ᒪᑭᑕᔪᓃᑐᐃᓇᓇᐊᓕᒃ ᐅᔾᔨᖅᑐᖅᑕᐅᑦᑎᐊᓇᐊᓕᒃ ᓄᓇᐅᑦ ᐃᓗᐊᓃᑦᑐᖅ ᐊᓕᑑᔾᖃᖅᓂᐅᑉ ᐃᓗᐊᓂ, ᓱᓪᓗᓕᐅᔾᖅᓯᓂ. ᐊᖏᓂᖓ ᓱᕋᑐᐃᓐᓇᓇᐊᓕᒃ ᓄᓇ, ᐊᕿᐅᒪᓲᖅ ᐊᕙᓗᖓᓂᒃ ᐊᖓᔫᑉ, ᐅᔭᕋᐅᑉ ᖃᓄᐃᓂᖏᓐᓂᒃ ᐊᒻᒪᓗ ᐃᓗᑐᓂᖓᓂᒃ ᐅᔭᕋᖕᓂᐊᕐᕕᐅᔫᑉ. Ndè weyìigôöæa wemôö wexòedi/cautious around the hole their working on Ni yéoniæa náre horeåi
Chemical stability	Occurs when surface waters and groundwater are protected against significant adverse environmental effects resulting from discharges. Discharges do not endanger public and wildlife health and safety, nor result in unacceptable deterioration of environmental resources. ᓱᕈᕐᓇᖅᑐᑦ ᖃᓄᐃᓐᓇᖏᑦᑐᑦ: ᓴᖅᑭᓲᑦ ᐃᒪᐃᑦ ᖄᖓᓂ ᐊᑖᓂᓗ ᓴᐳᔾᔭᐅᓯᒪᕙᒃᑐᑦ ᐱᐅᖏᑦᑐᓂᒃ ᓱᕈᕐᓇᖅᑐᓂᒃ ᓄᐃᔭᐅᕙᓪᓕᐊᔪᓂᒃ. ᓄᐃᑕᐅᓯᒪᔪᑦ ᐅᓗᕆᐊᓇᖏᑦᑐᑦ ᐃᓄᖕᓄᑦ ᐆᒪᔪᓄᓪᓗ, ᐊᒻᒪᓗ ᓱᕈᕐᓇᖏᑦᓯᑎᒃ ᐊᕙᑎᒥᐅᑕᕐᓄᑦ. Nàediåî sìì nàtso-le Tu delk’ál/tu ts’îdhÿríle
Clay	(1) A soil separate consisting of particles 0.002 mm in equivalent diameter; (2) a soil textural class containing > 40% clay, < 45% sand, and < 40% silt. Magluk: Magluk 0/002 milameetamik kaimalogiktomik elalik 2. Magluk hapkoning elalik 40% magluk, mikitkiamut 45% heogaklo mikitkiamiklo 40%mik tagiok. ᒪᕋᐃᑦ: ᒪᕋᐃᑦ ᓯᐅᕋᕐᓂᖔᖅᓯᒪᔪᑦ ᐃᓚᖅᑲᖅᑐᑦ 0.0002-ᒥᓕᒦᑕᒥᒃ ᐊᖏᓂᖅᑲᖅᑐᒥᒃ. ᒪᕋᐃᑦ ᖃᑯᖅᑐᑦ ᐃᓗᓕᖅᑲᖅᑐᑦ 40%-ᒥᒃ ᒪᕋᕐᒥᒃ, 45%-ᒥᒃ ᓯᐅᕋᕐᒥᒃ ᐊᒻᒪᓗ 40%-ᒥ ᓱᕈᓕᖕᓂ. Ehtå’èk’ò: 40% ehtå’èk’ò, 45% ewà eyits’ô 40% ehtå’ètì eåetah t’à ehtå’èk’ò elî hôt’e. Háhtå’ÿs gáí (1) Thay ts’î naíye, 0.002 mm. Æarelyâ debãdh. (2) Thay t’at’e sí 40% hahtå’ÿs gaí-u 45% thay-u, 40% thaydhíaze-u harelyø æeåta.
Closure	When a mine ceases commercial production (in whole, or in part through progressive closure of mine components) without the intent to resume mining activities in the future. ᒪᑐᔾᔨᓂᖅ: ᐅᔭᕋᖕᓂᐊᕐᕕᒃ ᓴᓇᔪᓐᓃᖅᑎᓪᓗᒍ ᓂᐅᕐᕈᑎᒃᓴᓕᐊᖑᓂᐊᖅᑐᓂᒃ (ᑕᒪᐃᓐᓂᒃ ᐃᓚᐃᓇᖕᒐᒍᓗᓐᓃᑦ ᒪᑐᔾᔨᕙᓪᓕᐊᔪᓐᓇᕐᒥᔪᖅ) ᒪᑐᐃᖅᑕᐅᒃᑲᓐᓂᕈᒫᕈᓐᓃᕐᓗᓂ ᓯᕗᓂᒃᓴᒥ. Sômbak'è wedaìtï Tsamba k’é bedãretâ

Term	Description
Closure criteria	Criteria which define specific performance requirements for progressive reclamation and closure of mine components. They are also used to determine successful reclamation and the completion of monitoring programs (e.g., water license discharge criteria). <u>ᒪᑐᔾᐅᓂᖓᓄᑦ ᒪᓕᒐᐃᑦ:</u> ᒪᓕᒐᐃᑦ ᑐᑭᓕᐅᕈᑏᑦ ᖃᓄᐃᓕᐅᕐᓚᓇᒋᐊᖃᕐᓂᐊᕐᒪᖔᑕ ᒪᑐᔾᐅᕙᕐᓕᐊᓂᐊᕐᓂᖕᖏᓐᓄᑦ ᐅᔭᕋᖕᓂᐊᕐᕖᑦ ᐊᑐᖅᑕᐅᖃᑦᑕᕐᒥᔪᑦ ᑐᑭᑖᕈᑕᐅᓂᖕᖏᓐᓄᑦ ᑲᔪᓯᑎᐊᕐᓂᐊᖅᑐᓂᒃ ᓴᓗᒪᖅᓴᖅᑕᐅᑦᑎᐊᕆᐊᖃᕐᓂᐊᕐᓂᖕᖏᓐᓂᒃ ᐊᒻᒪᓗ ᐱᔭᕇᖅᑕᐅᓂᖕᖏᓐᓂ ᖃᐅᔨᓴᕈᑏᑦ (ᓲᕐᓗ ᐃᒪᕐᓂᒃ ᐊᑐᐊᓂᒃᐸᑕ ᓴᓗᒪᖅᓴᐃᓂᕐᒧᑦ ᒪᓕᒐᐃᑦ). Sômbak'è wedaìtî gha naàwo/following rules to close mine Tsamba k'é dárçtâ t'at'u beghálahdâ
Coagulants	Highly-charged cationic chemicals added to wastewater to break emulsions and cause coagulation of particles. Used across Canada in water treatment plants. <u>ᓱᑭᔪᖕᓄᑦ ᐅᕐᑯᒪᐃᒪᓗᑕᐃᑦ ᐃᒪᕐᓂ:</u> ᓴᖏᔫᒪᓃᑦ ᐃᓚᒃᓴᔾᐃᑦ ᐃᓚᔾᐅᕙᒃᑐᑦ ᓱᑭᕐᓄᑦ ᐊᑦᑕᑦᑕᕐᓂᐊᕐᒪᑕ ᑭᕕᔾᔪᑕᐅᓗᑎᒃ ᒪᕐᖁᕐᓄᑦ. ᐊᑐᖅᑕᐅᕙᒃᑐᑦ ᑲᓇᑕᓕᒫᒥ ᐃᒪᕐᒥᒃ ᓴᓗᒪᖅᓴᐅᑕᐅᑦᑐᑎᒃ. Asìi wet'à teè tå'a ts'ö neyeèhtå'ì/something that makes it sink to the bottom Æasíe bet'á tetå'aghe nítå'ir
Coarse-textured soil	*Soil composed mostly of gravel, sand and sandy loam. From the GNWT Site Remediation Guideline (2003) soil with a median grain size of < 75 µm as defined by the American Society for Testing and Materials. <u>Nuna kigyaktok</u>: Nuna kikyaomagami oyagaliakaghoni, heogakaghonilo maglulilktuttut itomik heogakmiklo. <u>ᑐᐊᐸᓛᑦ ᓛᑦ ᐅᔭᕋᕋᓛᓛᑦ ᓄᓇᔭᐃᑦ ᐃᑉᔪᖅ:</u> ᓄᓇᔭᐃᑦ ᐃᑉᔪᐃᑦ ᑐᐊᐸᐃᑦ ᐅᔭᕋᐃᑦ ᐱᓗᐊᖅᑐᒥᒃ ᐅᔭᕋᕋᓛᖅᑲᐅᖅᑐᑦ, ᓯᐅᕋᖅᑲᖅᑐᑦ. <u>Kwèwà Ehtå'è:</u> Ehtå'è tah kwèwà, ewà eyits'ô kw'ah. <u>Harelyû æeåta æasí thay yé:</u> Thay beta tthedhiaze-u, hahtå'ÿs-u harelyû æeåta.
Community (plants and animals)	Populations of plants or animals living and interacting with one another in a given area. <u>ᐅᒪᔪᐃᑦ ᐱᕈᖅᑐᓪᓗ ᑲᑎᙵᔪᑦ:</u> ᐆᒪᔪᐃᑦ ᐱᕈᖅᑐᓪᓗ ᓄᓇᒥ ᑕᑯᓐᓇᖅᑕᐅᔪᑦ Tå'oh dehsheè eyits'ô tich'adi naàde k'è Æasíe neshe/dána æeånis náde
Concentration	A measure of the amount of a substance present per unit volume or per unit weight of material. <u>ᐱᑕᖃᖅᑎᒋᓂᖅ:</u> ᐆᒃᑐᕋᐅᑏᑦ ᖃᓄᑎᒋ ᐱᑕᖃᕐᒪᖔᑕ ᐱᑕᖃᕐᒥᒻᒪᖔᑕᓘᓐᓃᑦ ᐱᑕᖃᕐᕕᐅᖃᑦᑕᖅᓯᒪᔪᓂ. Edàtåô nee wexiìæiìdzà/measuring how many there is Æasíe t'aníåt'e hûli xa húldzáy
Conceptual	A preliminary idea, plan, and/or strategy with generalized statements. In mining this is the phase which involves defining the project opportunity, looking at alternative, business benefits and risks, research studies to answer questions, and ensuring the opportunity aligns with strategic objectives and securing appropriate support. In reclamation this parallels the initial closure planning prior to construction of a project, and/or if the project is many years away from completion of mining operations and hence availability for decommissioning and reclamation.

Term	Description
	ᐃᓱᒪᒋᔭᐅᓂᖓ: ᓯᕗᓪᓕᖅᐸᖅᒥ ᐃᓱᒪᒋᔭᐅᕙᓪᓕᐊᓪᓛᖅᓂᖓ, ᐸᖅᓇᐅᑎᖓ ᐊᒻᒪᓗ/ᐅᕙᓘᓐᓂᑦ ᑕᒪᐃᓐᓂᒃ ᐅᖃᐅᓯᐅᖃᓪᓛᖅᓂᖓ. ᐅᔭᕋᖕᓂᐊᖅᕕᖕᓂ ᑕᒪᓐᓇ ᑐᑭᖃᖅᑐᖅ ᑐᑭᓕᐅᖅᓂᖅᒥᒃ ᓴᓇᔭᐅᓕᕈᓐᓇᖅᑐᓂᒃ, ᐊᓯᖕᓘᖕᒋᓂᒃ ᐱᓕᕆᐊᒃᓴᓂᒃ ᑕᑯᓇᕐᓗᑎᓪᓗ ᐃᑲᔫᑕᐅᔪᓐᓇᖅᑐᓂᒃ ᐊᒻᒪᓗ ᐅᓗᕆᐊᓇᖅᓂᖏᓐᓂᒃ, ᖃᐅᔨᓴᖅᑕᐅᓂᖏᓐᓂᒃ ᑭᐅᔾᔪᑎᒃᓴᖅᓯᐅᕐᓗᑎᒃ ᐊᐱᖁᑎᓄᑦ, ᐊᒻᒪᓗ ᐱᓕᕆᐊᕐᔪᓕᖅᓂᐊᖅᑐᑦ ᓈᒻᒪᖅᑎᐊᕆᐊᖅᑲᖅᓂᐊᖅᓂᖏᓐᓂᒃ ᖃᓄᐃᓕᐅᖅᑕᐅᔪᒪᔪᓂᒃ ᒪᓕᒃᓗᑎᒃ, ᐃᑲᔪᖅᓯᖅᑕᐅᓗᑎᓪᓗ. ᓴᓗᒻᒪᖅᓴᐃᔪᖅᑲᖅᑎᓪᓗᒍ, ᑕᒪᒃᑯᐊ ᐅᖃᐅᓯᖅᑲᖃᔭᖅᑐᖅ ᓯᕗᓪᓕᖅᒥ ᒪᑐᔭᐅᓂᐊᖅᑐᓂᒃ ᓯᕗᓂᐊᒍᑦ ᓴᓇᔭᐅᒋᐊᓚᐅᖏᓐᓂᖏᓐᓂ ᓴᓇᔭᐅᓂᐊᖅᑐᑦ, ᐊᒻᒪᓗ/ᐅᕙᓘᓐᓃᑦ ᓴᓇᔭᐅᓂᐊᖅᑐᑦ ᐊᒥᓱᓄᑦ ᐊᕐᖁᓄᑦ ᓴᓇᔭᐅᔾᔫᖏᑉᐸᑕ ᓯᓚ ᐱᔭᕇᖅᑕᐅᕕᒃᓴᖏᑦ ᐅᔭᕋᖕᓂᐊᕐᕖᑦ ᐃᖏᕋᓂᐊᕐᓂᖏᓐᓂᒃ, ᐊᒻᒪᓗ ᑖᕙᓐᖓᓪᓗ ᐊᑐᕈᓐᓂᖅᑎᑕᐅᓂᖏᓐᓄᑦ ᐊᒻᒪᓗ ᓴᓗᒻᒪᖅᓴᖅᑕᐅᓕᒫᕐᓂᖏᓐᓄᑦ. Hats'îwô/thinking about it Háúnidhÿn
Connate water	*(also known as fossil water) Water that is trapped in the pores of a rock during the rock's formation. The chemistry of the water can change throughout the history of the rock. Connate water at EKATI is found below the permafrost. ᐃᒪᐃᑦ ᐅᔭᕋᖕᓄᑦ: ᐃᒪᐃᒪᑦ ᓄᓇᒦᑦᑐᑦ ᐳᑐᖕᓂ ᐅᔭᕋᖕᓂ ᖃᖅᓯᕐᓂᑯᓂ, ᐅᔭᕋᕈᖅᐸᓪᓕᐊᓂᖏᓐᓂ. ᐅᔭᕋᐃᑦ ᐃᒪᕐᓂ ᐊᓯᖑᖅᐸᓪᓕᐊᔪᓐᓇᖅᑐᑦ ᓴᓇᓯᒪᓂᖏᑦ. ᐃᒪᐃᑦ ᓯᑎᔩᔪᓐᓇᖅᑐᑦ ᐱᐊᒃᑑᓗᑎᒃ, ᓴᓂᐊᓂ ᑕᕆᐅᕐᒥᒃ ᐃᒪᐃᑦ. ᐃᒪᐃᑦ ᓄᓇᒦᑦᑐᑦ, ᐱᑕᖃᖅᑲᖅᑐᑦ ᐊᖕᒪᔪᖅᑲᖅᓂᖏᓐᓂ ᐅᔭᕋᐃᑦ, ᐊᒻᒪᓗ ᐃᓪᒥᓵᖅᑐᕕᓂᐅᔪᓇᖅᑐᑦ ᐅᔭᕋᐃᑦ ᐱᑕᖃᖅᑐᖅᑲᐅᓚᖅᑎᓪᓗᓂᑦ ᑭᓯᐊᓂ. ᐃᒪᑐᖃᐃᑦ ᐅᔭᕋᖕᓂᖔᖅᑐᑦ. Kwetah ti whekô/water amongs the rock Tthe ta hús yé tu dáthekâ
Consolidation	The gradual reduction in volume of a mass of material resulting from an increase in compression stress. The adjustment of a saturated soil in response to an increasing load involves the squeezing of water from pores and a decrease in the void ratio. ᓯᑎᓪᓕᕚᓪᓕᐊᓯᒪᓂᖓ ᐅᔭᕋᖑᖅᐸᓪᓕᐊᔪᖅ: ᐅᔭᕋᐃᑦ ᐅᔭᕋᖑᖅᐸᓪᓕᐊᑐᐃᓐᓇᖅᑐᑦ ᐅᖁᒪᐃᓐᓂᖅᑲᖅᓂᖏᓐᓄᑦ ᖁᓖᓂᒃ ᓯᓚᑖᓂᓗ, ᒥᑭᓪᓕᑎᖅᓯᒪᒻᒪᕆᓪᓕᖅᓗᑎᒃ ᓯᑎᓪᓕᕚᓪᓕᐊᓗᐊᒍᑦ. ᓄᓇᕕᓂᑐᐃᓐᓇᐃᑦ ᓯᑎᓪᓕᕚᓪᓕᐊᖅᑲᑦᑎᖅᓂᖏᑦ ᐅᖁᒪᐃᓪᓕᕚᓪᓕᐊᓯᒪᓂᖏᓐᓄᑦ ᖁᓖᓃᑦᑐᑦ ᐃᒪᖅᑲᕈᓐᓂᖅᐸᓪᓕᐊᓪᓗᑎᒃ ᐊᖕᒪᔪᖏᑦ. Edàanì kwe ehåè/how a rock forms Tthe t'at'u tthe neåe
Contaminant	A general term referring to any chemical compound added to a receiving environment in excess of natural conditions. The term includes chemicals or effects not generally regarded as 'toxic', such as nutrients, salts and colour. ᓱᐳᖅᓇᖅᑐᑦ: ᑕᒪᐃᓐᓂᒃ ᐅᖃᐅᓰᑦ ᐱᔾᔪᑎᖃᖅᑐᑦ ᓱᓇᑐᐃᓇᖅᓂᒃ ᓱᐳᖅᓇᖅᑐᖅᑖᖅᐸᓪᓕᐊᓗᐊᖅᓂᖏᑦ ᐊᕙᑎᒥ, ᐅᖓᑖᓂ ᑕᐃᒪᐃᖅᑕᖏᑲᓗᐊᖅᑎᓪᓗᒋᑦ ᐱᖁᓯᑐᖅᑲᖅᒥᓂ. ᓲᖅᓗ ᐃᓚᒃᓴᓂᒃ ᑕᖁᓇᖅᑑᖏᑦᑐᓂᑕᒪᐃᓐᓂᒃ ᐅᖃᐅᓰᑦ ᐱᔾᔪᑎᖃᖅᑐᑦ ᓱᓇᑐᐃᓇᖅᓂᒃ ᓱᐳᖅᓇᖅᑐᖅᑖᖅᐸᓪᓕᐊᓗᐊᖅᓂᖏᑦ ᐊᕙᑎᒥ, ᐅᖓᑖᓂ ᑕᐃᒪᐃᓪᓕᖕᒪᓕᐅᖏᑎᓪᓗᒋᑦ. ᓲᖅᓗ ᐃᓚᒃᓴᓂᒃ ᑐᖁᓇᖅᑑᖏᑦᑐᓂᒃ, ᓲᖅᓗ ᐱᕈᖅᓇᖅᑐᓂᒃ, ᑕᕆᐅᖅ ᑲᓚᒥᓗ. ᐊᓯᔾᔨᕈᑕᐅᕙᖅᑐᑦ. Asìi wet'à ts'ìiwi/something that damages things Æasíe ts'îæÿn æasíe dzçde
Contaminated Snow Containment Facility	*A lined area set aside within the Waste Rock Storage Facilities for the containment of snow and ice that is contaminated by hydrocarbons and other products, as approved in the Hydrocarbon Contaminated Materials Management Plan. ᓱᐳᖅᓇᖅᑐᓕᖕᓂ ᐊᐳᑕᐃᔭᐃᕕᒃ: ᐃᓂᒋᔭᐅᔪᑦ ᐃᑳᑎᒥ ᐊᐳᒥᒃ ᓴᓂᒃᕚᐃᕕᒃ ᐲᔭᐃᕕᒃᑯ ᓱᐳᖅᓯᒪᔪᓂᒃ ᐊᐳᒥᒃ, ᐊᐳᑕᐃᔭᐃᕕᒃ Zhah tsîîwo åaiåt'ì k'è/dumping contaminated snow in an area

Term	Description
	Yath ts'îdhÿr sí k'áni k'é nñtthir
Contingency	An action or plan put in place in preparation to remediate or remove a risk, that may but is not certain to occur. ᑐᐊᕕᕐᓇᖅᑐᓕᕆᔾᔪᑎ: ᖃᓄᐃᓕᐅᕈᑎ ᐸᕐᓇᒃᓯᒪᓗᓂ, ᐅᓗᕆᐊᓇᖅᑐᖅᓯᐅᑎᑦᓗᓐᓃᑦ, ᓴᕿᑳᓪᓚᑐᐃᓐᓇᕆᐊᖃᖅᑐᒥᒃ Edàanì asìi senaàæï/how to plan if something goes wrong Natthe ts'etáy sets'út'e
Core	A sample taken from a rock formation for geological analysis. ᐃᓗᓕᖕᒐᓂᖕᖔᖅᑐᖅ ᓄᓇᒥᒃ ᐊᒧᔭᐅᓯᒪᔪᖅ ᐅᔭᖅ: ᐲᖅᓯᕕᐅᓯᒪᔪᖅ ᓱᓪᓗᓕᒃ, ᐅᔭᕋᖕᒥᒃ ᐃᓗᓕᖓ ᖃᐅᔨᓴᖅᑕᐅᓂᐊᕐᒪᑦ ᐃᑰᑕᖅᑕᐅᓯᒪᔪᒥᖕᖔᖅᑐᖅ. Kwe nîïæa/rock tube Ni yághe heldeth t'á tthe hílchu
Crusher	A machine used to reduce materials such as kimberlite ore to particle sizes where diamonds can be found. ᓰᖃᓕᑎᕈᑏᑦ: ᓴᓇᕐᕈᑎ ᐊᑐᖅᑕᐅᕙᒃᑐᖅ ᒥᑭᓪᓕᑎᓇᓂᕐᒧᑦ ᓯᑎᓂᖅᐹᒥᒃ ᐅᔭᕋᖕᒥᒃ ᐲᖅᑕᐅᓯᒪᔪᒥᒃ, ᒥᑭᓪᓕᑎᑕᐅᓗᓂ ᓰᖃᓕᑎᖅᑕᐅᓗᓂ ᓇᓂᔭᐅᓂᐊᕐᒪᑕ ᒥᑭᓐᓂᖅᓴᐃᑦ ᐊᓕᒎᔭᐃᑦ ᓴᓇᕐᕈᑎᒃᓴᓄᑦ ᐱᐅᓂᖅᓴᐅᓂᐊᕐᒪᑕ. Sats'ö wet'à kwe naède Satsán tt'á the náltå'ÿs
Cubic meter (m^3)	*A unit of volume measurement which is equivalent to volume occupied by 1 tonne of water. Waste rock, processed kimberlite and kimberlite ore are usually measured in cubic meters. (In mining, dry bulk density is applied to the various rock types to determine the rock mass in tonnes) ᑭᑉᐸᓇᒃᑐᑦ ᒦᑕᐃᑦ (m^3) ᐆᒃᑐᕋᐅᑦ: ᐆᒃᑐᕋᐅᑦ, ᐆᒃᑐᕈᑎ ᐊᖏᓂᖏᓐᓂᒃ ᐅᔭᕋᐃᑦ Edàanì asìi xìihdzà T'at'u æasíe húldzáy
Cultivars	Plant material that has been commercially propagated and/or formed. Naotiak angiglipkaghimayok eloani: Naotiak angiliglipkaghimayok eloani elayoomighimayok naoliktoklooneen. ᐱᕈᖅᑎᑕᐅᓯᒪᔪᑦ: ᐱᕈᖅᓯᐊᑦ ᓂᐅᕐᕈᑎᒃᓴᓕᐊᖑᓗᑎᒃ ᐱᕈᖅᑎᑕᐅᓯᒪᔪᑦ Ît'ö ts'ehshe: Ît'ö ts'ehshe/plants we grow Bet'á t'ãchay-u huneshe: T'ã chay-u, k'ái-u, thÿn neshe xaæaíle t'á æasí t'á æalæî.
Cumulative effect	The combined environmental impacts that accumulate over time and space as a result of a series of similar or related actions or activities. ᐊᑕᐅᓯᐅᖏᑦᑐᒧᑦ ᐊᒃᑐᖅᑕᐅᓯᒪᓕᖅᑐᑦ: ᐊᒥᓱᓄᑦ ᐊᕙᑎ ᐊᓯᔾᔨᖅᑕᐅᓯᒪᔪᖅ ᐊᒃᑐᖅᑕᐅᓯᒪᓂᖓᓄᑦ ᐊᑯᓂᐅᓕᖅᑐᖅ ᐃᓂᖏᓐᓂ, ᐊᔾᔨᒌᒃᑐᓂᒃ ᐱᓕᕆᐊᖃᕐᓂᖓᓄᑦ. Asìi ndè xèidi ha wedanagetah Æasíe bet'á dzêde
Cuttings	Sections of shrub stem capable of rooting and sprouting into independent plants when placed in appropriate media. Kivyangneet naotiat: Naotiak kivyaghimayot naotiktoghat emangmi emaalo nunamut eleeogagangata naotiangoghotik ᓇᑲᑎᖅᑕᐅᓯᒪᔪᑦ ᐊᓯᐊᓂᒃ ᐱᕈᕐᓂᐊᕐᒪᑕ: ᓇᑲᑕᐅᓯᒪᔪᑦ ᐲᔭᖅᑕᐅᓪᓗᑎᒃ ᐱᕈᖅᑐᒥᒃ ᐊᒻᒪᓗ ᐱᕈᖅᓯᐊᖑᓕᖅᓯᑎᒃ ᓈᒻᒪᒃᑐᒥ ᐃᓂᒃᓴᒥ.

Term	Description
	K'òò xo chî K'ò ts'ô xo chî dehshe Bet'á k'aí-u, æasí k'ek'ÿre æaneshe: T'a hunélyâ nílye dé k'aí-u, así huneshe sí nanelye æat'e.
Decommissioning	The process of permanently closing a site and removing equipment, buildings and structures. ᐊᑐᕈᓃᖅᑎᑕᐅᓂᖓᑦ: ᐊᑐᖅᑕᐅᔪᓃᕐᓂᖓᑦ ᖃᖓᓕᒫᖅ ᐃᓂᕖᓂᑦ ᐊᒻᒪᓗ ᓃᑕᐅᓂᖓᑦ ᐲᔾᖅᑕᐅᓗᑎᒃ ᐱᕐᑯᑏᑦ, ᐃᒡᓗᕐᔪᐊᑦ ᐊᒻᒪᓗ ᐱᕐᑯᑎᕐᔪᐊᑦ ᓴᓇᕖᑦ. Sômbak'è wedaìtî/closing down the mine Tsamba k'é dârêtñ
Diabase	A common basic igneous rock usually occurring in dikes or sills. Oyagak naohimayok oonaktomin: Oyagak naohimayok oonaktomin eeloghangni. ᐅᔭᕋᒃ ᐊᐅᒃᓯᒪᔪᕖᓂᖅ: ᐅᔭᕋᒃ ᐊᐅᒪᓚᐅᖅᓯᒪᔪᖅ ᓄᓇᐅᑉ ᐃᓗᐊᓃᒐᔪᒃᑐᖅ. Kwèzhô nedè nîæa: Kwè nedè xè neghoa nîæa siì kwèzhô tah nîæa. T'ók'e naíye tthe húlæá: Tthe æéåk'éch'a æél-u, xát'l æasí yé hul æa.
Diamond	An extremely hard crystalline form of carbon, often used as a gem stone, and for cutting. ᐅᔭᕋᒃ ᓯᑎᓂᖅᐹᖅ ᐊᓕᒂᔭᖅ (ᑕᐃᓐ) Æeja kwe, kwe sade, lamôö kwe/glass rock, shining rock, ring rock
Dike	An engineered berm or horizontal barrier made of rock and small granular materials, which selectively impounds waste materials. Filter dikes at the EKATI LLCF allow water to pass through, but not large materials. ᓴᐳᑎ: 1. ᓴᓇᔭᐅᓯᒪᔪᖅ ᓴᐳᑎ ᐅᕙᓘᓐᓃᑦ ᓯᒥᒃ ᓴᓇᓯᒪᔪᖅ ᐅᔭᕋᖕᓂᒃ ᐅᕙᓘᓐᓃᑦ ᒥᕐᓇᓂᖅᓴᓂᒃ ᑐᐊᐸᓂᒃ, ᓄᕐᖃᖅᑎᑦᑎᓲᖅ ᐃᑳᕋᔭᖅᑐᓂᒃ ᐊᒃᑕᑯᓂᒃ. ᓱᓗᓪᓕᖓᓂ ᓴᐳᑏᑦ ᐃᑳᑎᒃᑯᓐᓂ ᐃᒪᕐᒥᒃ ᑲᔪᓯᑎᑦᑎᕗᐅᕙᒃᑐᑦ ᓱᕈᔪᐃᑦ ᐱᑕᖃᓗᐊᓗᑎᒃ. 2. ᓄᓇᒥ ᐋᕿᐅᒪᔪᑦ ᐅᔭᕋᖃᕐᓂᖏᓐᓄ ᐃᒪᐃᑦ ᐊᖅᑯᑎᖏᓐᓂ. Wedàezhe Æedãrelye/æél dãrélye
Discharge	A volume of water flowing through a stream at a given place and a given time. ᐃᒪᐃᕐᕖᑦ: ᐃᒪᐃᑦ ᑯᕖᓂᖏᑦ/ᐃᖏᕐᕋᓂᖏᑦ ᑰᓂᒃᑯᑦ ᖃᖓᑐᐃᓐᓇᖅ ᓇᓂᑐᐃᓐᓇᖅ. Ti xàetåʼì wexèæiidzà/water volume is measured Tu t'aníåt'e xáíli
Drainage patterns	The pattern that surface water flows and drains in a watershed. ᑯᕖᕙᓪᓚᐊᓂᖏᑦ: ᐃᒪᐃᑦ ᑯᕖᕙᓪᓚᐊᓂᖏᑦ ᐊᒻᒪᓗ ᐃᖏᕐᕋᕖᓪᓚᐊᓂᖏᑦ ᐊᒻᒪᓗ ᐊᕖᒃᑐᒥᒃ ᐃᒪᐃᑦ ᑯᕖᕙᓪᓚᐊᓂᖏᑦ Edàanì ti nîìlî/how water flows Tu æeåk'íl
Drawdown	The partial removal of water from any natural waterbody by pumping or draining. ᐃᒪᐃᔭᐃᓂᖅ ᑕᓯᕐᒥᒃ: ᐃᒪᐃᔭᐃᓂᖅ ᑕᓯᕐᒥᒃ ᐃᒥᖅᑕᖅᑕᐅᓂ ᐅᕙᓘᓐᓃᑦ ᑯᕖᐅᖅᑲᖅᑕᐅᕙᓪᓚᐊᓗᓂ ᐳᖅᑐᓂᖓ ᐃᑎᓂᖓ ᒥᕿᓪᓕᓂᐊᕐᒪᑦ Ti æiìchi Tu xádil

Term	Description
Drilling	To create holes in the ground for exploration or for loading explosives. ᐃᑰᑕᕐᓂᖅ: ᓄᓇᒥ ᐃᑰᑕᕐᓂᖅ ᕿᓂᕐᕕᐅᓂᖕᒋᓂ ᐅᕙᓘᓃᑦ ᖃᖅᑎᑎᖅᑕᐅᓂᐊᖅᑐᓂ. Ndè yìì gihdè Tthe heldÿth
Dust suppressants	Products and techniques used to minimize dust emissions from unpaved roads. ᓴᓂᕐᒥᒃ ᖁᒻᒧᐊᓰᒃᑯᑎ: ᖃᓄᖅᑑᕈᑏᑦ ᓴᓂᕐᒥᒃ ᖁᒻᒧᐊᒍᑕᐅᑦᑕᐃᓕᒪᔪᑦ, ᕿᑯᓕᖅᑎᖅᑕᐅᓯᒪᖕᒋᑦᑐᓂ ᐊᖅᑯᑎᓂ Wet'à ehtå'è daèdi-le/to prevent dust from flowing around Tthay dzérétth'ay ch'á
Ecology	The study of the interactions between organisms and their environment. ᐆᒪᔪᐃ/ᐱᕈᖅᑐᓪᓗ ᖃᓄᐃᓐᓂᖕᒋᑦ: ᖃᐅᔨᓴᖅᑕᐅᓯᒪᓂᖕᒋᑦ ᖃᓄᖅ ᐊᑕᖕᒪᖕᒫᑕ ᐱᕈᖅᑐᑦ ᐊᕙᑎᖕᒋᓪᓗ Ndè k'e asìi eda wedanàgetah/reseaching living things on land Harelyû æasíe dána bek'oneta
Ecosystem	A community of interacting organisms considered together with the chemical and physical factors that make up their environment. ᑕᒪᕐᒥᒃ ᐆᒪᔪᐃᑦ ᐱᕈᖅᑐᓪᓗ ᓇᓅᓐᓂᖕᒋᑦ: ᑕᒪᕐᒥᒃ ᐱᕈᖅᑐᑦ ᐆᒪᔪᐃᓪᓗ ᐊᑕᐅᓯᕐᒦᑦᑐᑦ ᐊᕙᑎᒥ. Ndè k'e asìi hazhô eåexè eda/all living things living togehter on land Æeånis harelyû æasíe dána
Effect	A change to a Valued Ecosystem Component (VEC) due to human activities. An effect is not necessarily a negative impact; an effect may be neutral or even positive. For example, a change in caribou migration routes may not adversely affect the caribou. Replacing one fisheries habitat with another may enhance the fishery. ᐊᒃᑐᖅᑕᐅᓯᒪᓂᖅ: ᐊᓯᔾᔨᖅᓯᒪᓂᖅ ᓱᓇᑐᐃᓐᓇᖅ ᐃᓄᒃ ᐱᓕᕆᓂᖕᒐᓄᑦ. ᐊᒃᑐᖅᑕᐅᓯᒪᓂᖅ ᐱᐅᖕᒋᑦᑐᖕᒋᑦᑐᓐᓇᖅᑐᖅ; ᐊᒃᑐᖅᑕᐅᓯᒪᔭᕆᐊᓐᓇᖅᑐᖅ ᖃᓄᐃᓐᓇᖕᒋᑦᑐᒥᒃ ᐅᕙᓗᓐᓃᑦ ᐱᐅᔪᒥᒃ, ᓲᕐᓗ ᐆᒃᑑᑎᒋᓗᒍ ᐊᓯᔾᔨᖅᓂᖕᒋᑦ ᑐᒃᑐᐃᑦ ᐊᖅᑯᑎᒋᕙᒃᑕᖕᒋᑦ ᓱᕈᕈᑕᐅᖕᒋᑦᑐᐃᓐᓇᓇᐊᖅᑲᖅᑐᑦ ᑐᒃᑐᓄᑦ. ᐊᓯᖕᒋᓐᓂ ᐃᖃᓗᖃᕐᓂᖅ ᐱᐅᓯᑎᐊᕈᑕᐅᔭᕐᓇᕐᒥᔪᑦ ᐃᖃᓗᖃᕐᓂᕐᒧᑦ. Asìi ts'îæö hagot'î/because of something it happens Bets'î æ‡né náádhÿr
Effluent	Treated or untreated waste water that is discharged into the environment. ᐊᒃᑕᑯᐃᑦ ᐃᒪᐃᑦ: ᓴᓗᒻᒪᖅᓴᐅᑎᓕᖅᓯᒪᔪᖅ ᐃᓚᔭᐅᓯᒪᔪᒥᒃ ᐅᕙᓘᓐᓃᑦ ᓴᓗᒻᒪᖅᓴᐅᑎᖃᖕᒋᑦᑐᖅ ᐊᒃᑕᑯ ᐃᒪᖅ ᐊᕙᑎᒧᑦ ᑯᕕᔭᐅᓯᒪᔪᖅ Tich'ii åaàtå'o Tu æãdil
EFPK	Extra Fine Processed Kimberlite.
Electrical conductivity	A physical quantity that measures the readiness with which a medium transmits electricity. Commonly used for expressing the salinity of soil extracts or irrigation waters because it can be directly related to salt concentrations. It is expressed as mmhos per centimeter. Koaghalaangootit uuktuutaa: Kanogitilaanga naonaiyaotaa koaghalaangnaktumik piyok. Atoktaovaktok naonaigiangani tagiokagiagha nuna emaiyangneetlo tagiokagahogilogo. Naonaitok mmbosmik santameetakot.

Term	Description
	ᐅᒻᒪᖁᑎᓄᑦ ᐊᖅᑯᑎᒋᔭᐅᔪᓐᓇᖅᑐᑦ: ᐆᒃᑐᕋᕈᑏᑦ ᐅᒻᒪᖁᑎᓄᑦ ᐊᖅᑯᑎᒋᔭᐅᔪᓐᓇᕐᓂᖏᓐᓂᒃ ᐃᒪᕐᓂ ᑕᕆᐅᖅᑲᕐᓂᖏᑦ, ᒪᓕᒃᖃᑦᑕᕐᓂᖓᓂᒃ ᑕᕆᐅᖅᑲᖅᑎᒋᓂᖏᓐᓂᒃ ᐃᒪᐃᑦ. ᐆᒃᑎᖅᑕᐅᖃᑦᑕᖅᑐᑦ ᒪᓕᒃᑕᐅᓪᓗᑎᒃ ᐅᑯᐊ ᐆᒃᑐᕋᐅᑏᑦ mmhos per centimeter. Edikö edànahtso wexiìdza Æedíkún húldzá: Tthay yé t'anéåt'e dedhay æats'êlî bulæá-u, tth'i t'á ts'‡n tu nñlî æedíkún t'á húldzay dedhay tthii dedhay bets'çli t'a at'e hunidhÿn t'á.
Emissions	Pollutants going into the atmosphere (such as car exhaust, chemicals) ᓱᕈᕐᓇᖅᑐᑦ ᐳᐊᐃᑦ: ᓱᕈᕐᓇᖅᑐᑦ ᐳᐊᐃᑦ ᓯᓚᒧᐊᖅᐸᓪᓕᐊᔪᑦ (ᓲᕐᓗ ᓄᓇᒃᑰᕈᑎᓂᒃ ᐳᐊᐃᑦ, ᓱᕈᕐᓇᖅᑐᓖᓪᓗ ᐳᐊᐃᑦ) Åotsï/åozha daèdi/exhaust in the air Æasíe lÿre ts'îæ‡né dzçæødhir
Encapsulate	To bury and/or cover over a material so that it is not exposed to the outside environment. For example, metasediments (biotite schist) are encapsulated in the Misery Waste Rock Storage Area within 5 m of granite to ensure that permafrost aggrades into this material, and reduces the potential for acid rock drainage. ᐅᓕᒃᓯᓯᒪᓂᖅ: ᓴᐅᔭᐅᓗᓂ ᐅᕙᓘᓐᓃᑦ ᐅᓕᒃᑕᐅᓯᒪᓗᓂ ᓱᓇᐅᐃᓐᓇᖅ ᓴᕿᔮᕐᓂᐊᖏᒻᒪᑦ ᐊᕙᑎᒧᑦ. ᓲᕐᓗ ᐆᒃᑑᑎᒋᓗᒍ, ᐅᔭᕋᐃᑦ ᓯᐅᕋᐃᓗᓐᓃᑦ ᐅᓕᒃᑕᐅᓯᒪᕐᑲᑦᑕᖅᑐᑦ ᐊᒃᑕᑰᕐᓴᓂ ᐅᔭᕋᕐᑲᕝᕕᖕᓂ ᑐᕐᑯᖅᑎᓇᕝᕕᖕᒥ, ᐃᓗᐊᓂ 5 ᒦᑕᐃᑦ ᐅᔭᕋᐃᑦ ᑕᐃᓖᒃ ᓄᓇᐃᑦ ᖁᐊᖑᓂᖏᑦ ᓯᐊᒻᒪᒃᐸᓪᓕᐊᕐᑲᑦᑕᖅᒪᑕ ᑕᒪᑯᓐᓄᖓ ᖁᐊᖅᑲᑕᐅᕙᓪᓕᐊᓪᓗᑎᒃ ᐊᒻᒪᓗ ᓱᕈᕐᖏᓐᓂᖅᓴᐅᓗᑕᐅᓪᓗᑎᒃ ᐆᑕᕐᓇᖅᑐᖅᑲᖅᑐᓂᒃ ᑯᕕᕙᒃᑐᓂᒃ ᓯᐊᒻᒪᒃᑎᖅᑕᐅᓯᒪᔪᓂᒃ. Wedaèdzè/you seal it up Bedãrçdze
Environment	The components of the Earth including land, water, and air, and all layers of the atmosphere. Also all organic and inorganic matter and living organisms and the interacting natural systems of such, including the cultural, social and spiritual components. ᐊᕙᑎ: ᐃᓚᓕᒡᒑᖏᑦ ᓄᓇᐅᑉ, ᓲᕐᓗ ᓄᓇ, ᐃᒪᖅ, ᓯᓚ, ᐊᒻᒪᓗ ᑕᒪᕐᒥᒃ ᓯᓚᐃᑦ, ᐊᔾᔨᒋᖏᑦᑑᑏᑦ ᐳᖅᑐᓂᓪᓕᑦ. ᐊᒻᒪᓗ ᑕᒪᕐᒥᒃ ᐱᕈᖅᑐᑦ ᐱᕈᓐᖏᑦᑐᓪᓗ, ᐊᒻᒪᓗ ᐅᒪᔪᑦ ᐊᒻᒪᓗ ᐃᓚᒌᖕᓂᖏᑦ ᐊᕙᑎᒥᑦᑐᑦ, ᓲᕐᓗ ᐃᓕᖅᑯᓯᒃᑯᑦ, ᐆᒪᓂᖏᓐᓂ, ᐊᒻᒪᓗ ᐊᓂᕐᓂᕐᑲᕐᑲᑕᐅᓂᖏᓐᓂ. Ndè k'e edàanì hoòæô Ni k'e t'at'u háæâ
Environmental Agreement (EA)	An agreement between the governments of Canada and the Northwest Territories and BHP Billiton CanadaInc. It sets forth guidelines and management strategies to protect the environment. The aim of the Environmental Agreement is to respect and protect land, water and wildlife, and the land-based economy, essential to the way of life and well being of the aboriginal peoples; to facilitate the use of holistic and ecosystem-based approaches for the monitoring of the Project; to provide advice to BHP Billiton to assist in managing the Project consistent with these purposes; to maximize the effectiveness and co-ordination of environmental monitoring and regulation of the Project; and to facilitate effective participation of the aboriginal peoples and the general public in the achievement of the above purposes. Angigotaa Nunamutlo Hilamutlo: Angigotlo monaginikotlo nunamutlo hilamutlo. Angigat taamna havaghimayok monagiyaangani nunakputlo emautikputlo hogayatlo kanogitilaangalo inuit/itkileetlo nunamik atoktot, nunaplo pikohia atoktaoyaangani monagitiangnialo BHPkot havaohiatigot, tonihimayaangani BHPBkot nagoyomik aitoghimayaangani okaotmik ikayoglogitlo, angigliyoomigiangani ehoangnia nunaplo emaklo hogayatlo naonaiyangneet maligatlo havaohiatigot emaalo ehoaktomik pikataoyaangani Inuungnun/Itkileenotlo enegotighait hapkoat

Term	Description
	ᐊᕙᑎᓕᕆᓂᕐᒧᑦ ᐊᖏᕈᑖᑦ: ᐊᖏᕈᑖᑦ ᑲᓇᑕᐅᑉ ᒐᕙᒪᒃ ᑯᖓᓂ, ᓄᓇᑦ ᓱᐊᕐᒥ ᐊᒻᒪ BHP Billiton Canada Inc-ᑯᑦ ᐅᔾᕋᖕᓂᐊᕐᑎᒃ ᑯᓐᓂᒃ. ᒪᓕᒐᖅᑐᑦ ᐊᒻᒪ ᐊᐅᓚᑦ ᑎᓂᕐᒧᑦ ᖃᓄᐃᓕᐅᕈᑎᒃ ᓴᖅᑐᑦ ᓴᐳᓐᓂᐊᖅᑕᐅᓂᖖᓄᑦ ᐊᕙᑎᖏᑦ. ᑐᕌᒐᖅᐳᑦ ᐊᕙᑎᒥᒃ ᐊᖏᕈᑖᑦ ᐃᒃ ᐱᒍᓯᑦ ᑎᐊᕆᐊᖅᑲᓂᖖᓂ ᓴᐳᓐᓂᐊᖅᑕᐅᔾᔭᕆᐊᖅᑲᓂᖖᓂᒧ ᓄᓇᐃᑦ, ᐃᒪᐃᑦ, ᐆᒪᔪᐃᑦ ᐊᒻᒪ ᓄᓇᒥ ᐅᑕᐅᓂᖅᒥᒃ ᐃᓅᓯᓕᐅᕈᑖᑦ, ᐃᓅᓯ ᖃᕈᑎᑦ ᓚᕆᐅᓂᖖᓂ ᐊᒻᒪ ᖃᓄᐃᓕᑕᐃᓕᒪᔾᔭᕆᐊᖅᑲᓂᖖᓂ ᓄᓇᖅᑲᖅᑲᖅᓯᒪᔪᓂᒃ ᐃᓄᒃᓂᒃ; ᑕᒪᐃᓐᓂᒃ ᐃᒃ ᐱᒍᓯᓗᑎᒃ ᐊᒻᒪ ᐋᖅᑭᒪᐃᓐ ᓇᖁᑦ ᓗᕆᑦ ᓄᓇᐃᑦ ᐊᕙᑏᒧᑦᓗ ᖃᐅᔨᓴᖅᑕᐅᖃᑦᑕᖅᓗᑎᒃ ᓴᓇᔪᐅᕙᑦ ᓕᐊᔪᑦ; ᐅᖃᐅᔾᔨᕆᐊᖅᑕᐅᖃᑦᑕᖅᓗᑎᒃ BHP Billiton-ᑯᑦ ᐃᑲᔪᖅᑕᐅᓗᑎᒃ ᐊᐅᓚᑦ ᑎᓂᕐᒧᑦ ᐱᓕᕆᐊᓴᒃᓂ ᒪᓕᑦ ᑎᐊᕆᐊᖅᑐᓂᒃ ᑕᒪᒃ ᑯᓂᖓ ᐱᖁᔭᐅᔪᓂᒃ; ᐋᕿᐅᒪᑦ ᑎᐊᖁᑦ ᓗᕆᑦ ᐊᕙᑎᒥᒃ ᖃᐅᔨᓴᐃᖃᑦᑕᕐᓂᖏᑦ ᒪᓕᒐᖅᓗᑎᒃ ᓴᓇᔪᐅᕙᑦ; ᐊᒻᒪ ᐃᓚᐅᑎᑕᐅᖃᑦᑕᕐᓗᑎᒃ ᓄᓇᖅᑲᖅᑲᖅᓯᒪᕙᑦ ᐃᓄᑐᐃᓐᓇᐃᑦᓗ ᑎᑭᐅᒪᔪᓐᓇᕐᓂᖏᑦ ᓂᖅᑲᖅᓯᒪᕙᑦ ᐃᓄᑐᐃᓐᓇᐃᑦᓗ ᑎᑭᐅᒪᔪᓐᓇᕐᓂᖏᑦᓂᒃ ᖁᓚᓂ ᐱᓇᓯᐊᖅᑕᐅᔾᔭᕆᐊᖅᑐᓂᒃ. Ndè Hoidi Gha Naàwo Atå’è (EA): Naàwo hohåe weghàà eghàlageda t’à ndè hoidi ha hôt’e. Ndè Hoidi Gha Naàwo Atå’è t’à ndè, ti eyits’ô tich’adi hoidi ha eyits’ô dône sôåî ndè k’è edets’eda naàwo wet’àæa t’à wehoidi ha hôt’e. Ndè naàwo t’à ndè hoidi ha eyits’ô wegha naàwo hohåe ha. BHPB xè di haàni t’asi k’è eghàlats’eda ha; hoti nezî ndè naàwo t’à ndè hoidi ha eyits’ô wegha naàwo hohåe k’è eåexè eghàlats’eda ha. Dône Sôåî eyits’ô köta gots’ô dône xè eghàlageda ha gîîwô hôt’e. Nuwe náre xa æeåk’úret’â: Begháre nuwe náre t’ohøt’e xaádi-u, bek’aáni. Nuwe náre xa æeåk’úret’â sí t’á, tu-ú, ní-u, techádiye-u, besets’údi-u, ní ts’î æasí xáádi-u, t’at’u, nuwets’î dÿne sí denexél ní t’áhet’î yexáåni xa. BHPB xél æasí hôzû æat’e xa dÿne séyahereåtí-u, t’at’u súghá sí nuwets’ñ dÿne chu æeåa yek’e æeghálahena xa.
Environmental Impact Statement (EIS)	*The document prepared by BHP Minerals Inc. and dated July 24, 1995, including the Additional Information Request of December 19, 1995, the Environmental Impact Statement updates of December 15, 1995, and the Environmental Baseline Study - all of which were submitted by BHP Minerals Inc. to the Federal Environmental Assessment Review Panel. Nunap kanoginiagotta Titektaohimayok: Titigaktauhimayok naonaigiangani ilihimalogolo okaotigilogolo nagooneet emaalo nagooneghaa nuna inuit atokpangmatko. ᐊᕙᑎᒥᒃ ᐊᒃᑐᖅᓯᓯᒪᓂᕐᒧᑦ ᓇᓄᓇᐃᒃᑯᑖᑦ: ᖃᐅᔨᓴᕈᑖᑦ ᑎᑎᖅᑲᐃᑦ ᓴᓇᔪᐅᓯᒪᕙᑦ ᓇᓄᓇᐃᔭᐃᓂᕐᒧᑦ, ᓇᓚᐅᑦᑖᕐᓂᕐᒧᑦ, ᑐᑭᓕᐅᕐᓂᕐᒧᑦ ᐊᒻᒪ ᑐᓴᐅᒪᔭᐅᑎᑦᑎᓂᕐᒧᑦ ᐊᒃᑐᖅᑕᐅᓯᒪᕙᓐᓇᕐᓂᖏᓐᓂ ᐱᓕᕆᐊᖑᕙᓂᒃ ᐃᓄᐃᑦ, ᖃᓄᐃᓐᓂᖏᑦ, ᐊᒻᒪ ᐃᓯᒪᒋᔭᐅᓗᑎᒃ ᖃᓄᐃᖏᓐᓂᖏᓐᓂ ᐊᕙᑎᖏᑦ ᐆᒪᔪᖃᕈᑖᓗ ᐆᒪᔪᐃᑦᓗ ᐃᓅᓯᕙᑕᐅᕙᒃᑐᑦ. Edaàni Ndè Xèidi ha Wegodi: Ndè k’è eghàlageda ha nidè edaàni dône eyits’ô ndè k’è tich’adi t’à edegeda siì wexèidi ha nîhtå’è hohåe. Æeríhtå’ís xálî hñle, begháre yunedhé t’at’u bet’á dÿne æedû nádé-u, harelyû t’ohøt’e sí ghâ hubexél xaáldí-u, nuwe náre t’aát’î sí hubenatâ xáile.
Environmental Site Assessment	A process by which a property is assessed (usually after the removal of infrastructure and buildings) to identify areas, type and volume of contamination. This is completed through Phase 1 - historical review and site inspection; Phase 2 - intrusive investigation to determine potential areas of environmental concern, and Phase 3 - delineation of the spatial extent and volume of contamination. ᐊᕙᑎᒥᒃ ᐃᓂᑭᔭᐅᔪᑦ ᖃᐅᔨᓴᖅᑕᐅᓂᖏᑦ: ᐱᖅᑯᓯᕆᔭᐅᕙᒃᑐᑦ ᐱᕐᑯᑖᑦ ᖃᐅᔨᓴᖅᑕᐅᓂᖏᓐᓄᑦ (ᐲᔭᖅᑕᐅᓚᐅᖅᑎᓪᓗᒋᑦ ᐱᕐᑯᑎᕐᔪᐊᑦ ᐊᒻᒪ ᐃᒡᓗᕐᔪᐊᕐ) ᓇᓄᓇᐃᖅᑕᐅᓂᐊᕐᒪᑕ ᖃᓄᐃᑦᑐᓂᒃ, ᓇᐅᒃᑯᓪᓗ, ᖃᓄᑎᒋᓗ ᓱᕈᖅᑕᐅᓯᒪᔪᕐᑲᕐᒪᖔᑕ. ᑕᒪᓇ ᐲᔭᕆᐊᖅᑕᐅᕙᒃᑐᖅ ᓯᕗᓪᓕᕐᒥ: ᖃᓄᐃᓚᐅᖅᓯᒪᓂᖏᑦ ᕿᒥᕐᕈᐊᖅᑕᐅᓪᓗᑎᒃ ᐊᒻᒪ ᐃᓂᑭᔭᐅᕙᓃᑦ ᖃᐅᔨᓴᖅᑕᐅᓪᓗᑎᒃ; ᑐᒡᓕᕐᒥ: ᖃᐅᔨᓴᖅᑕᐅᒃᑲᓂᕐᑲᑦᑕᖅᑐᑦ ᐊᕙᑎᒥ ᐃᓯᒪᔫᑕᐅᔪᑦ, ᐊᒻᒪ ᐱᖓᔪᐊᓂ; ᖃᓄᖅ ᐊᖏᑎᒋᒪᖔᑕ ᓱᕈᖅᓯᒪᕕᐅᔪᑦ, ᖃᓄᕐᓗ ᓱᕈᖅᑕᐅᓯᒪᑎᒋᒪᖔᑕ ᓱᕈᕐᓇᖅᑐᕐᑲᕐᓂᖏᓐᓂ. Ndè wek'e eghàlada k'è Ni k’e náádhÿr tå’ághe bek’oneta

Term	Description
Ephemeral stream	Streams where surface water flow is not always measurable. These streams could become dry seasonally (e.g., every summer), or only occasionally (once every 10 years). ᐃᓛᓃᓇᒃᑯᑦ ᐃᒪᖅᑲᖅᕖᑦ ᑯᖕᖑᑦ: ᑰᖅᑲᖅᓂᖕᒋᑦ ᑰᒡᕕᐅᖕᒋᓐᓇᖅᑲᑦᑕᖕᒋᓐᓂᖕᒋᓐᖑᑦ ᐆᒃᑐᖃᖅᑕᐅᖕᒋᓐᓇᕈᓐᓇᖅᑲᑦᑕᖕᒋᑦᑐᖅ. ᑕᒪᒃᑯᐊ ᑰᖃᓛᖅ ᐸᓂᕈᓐᓇᖅᒪᑕ ᐃᓛᓂᒃᑯᑦ (ᓲᖅᑐ ᐊᐅᔭᒃᑯᖅ) ᐅᑭᐆᓐᓃᑦ ᐃᓚᓂᒃᑯᑦ (ᓲᖅᑐ ᖁᓖᑦ ᐊᖅᖀᒍᐃᑦ ᓈᔭᖅᖄᖕᒪᑕ). Ôhk'èa ti k'eètå'o/water flows sometimes Æaåk'é tu tsÿleæaze nîåi
Erosion	The wearing away of rock, soil, or other surfaces of the land by water, ice or wind. ᓄᖕᒍᑉᐸᑦᑕᐊᓂᖕᒐ: ᐅᔭᖃᒃ ᓄᖕᒍᑉᐸᑦᑕᐊᓂᖕᒐ, ᓯᐅᖃᐃᑦᑐ, ᐊᓯᖕᒋᑦᑐ ᓄᓇᐅᑉ ᖃᖕᒪᓂᑦᑐᖅ, ᓄᖕᒍᑉᐸᑦᑕᐊᕙᑦ ᐃᒪᖅᒥᒃ, ᓯᑯᒥᒃ, ᐊᓄᓇᒥᒡᓗᓐᓃᑦ. Ndè naàza/land getting worn down Tu chu niåts'î chu t'á tth'e názas
Esker	*A winding ridge of weakly stratified gravel and sand deposited by a stream flowing in (or beneath) the ice of a retreating glacier, and left behind when the ice melted. Kingaotak: Kingaotat naohimayok oyagaliamik heogakmitlo koogak engilgagaangat kikomaneop kaanoangani nunap eloani ᖃᖅᑲᔮᖅ/ᐊᑭᕕᖕᒐ: ᓯᐅᖃᐃᓐᓇᑲᓴᐃᑦ ᖃᖅᑲᔮᑦ ᑐᐊᐸᐃᑦᑐ ᓯᐅᖃᐃᔭᖅᕕᐅᓯᒪᕙᑦ ᐃᒪᖅᒥᒃ ᐊᖅᑯᑎᕕᓂᖅᓂᒃ (ᐅᑭᐆᓐᓃᑦ ᐃᒪᖅᑲᖅᑐᑦ ᐊᑖᓂ) ᓯᖅᒥᖕᒍᑦ ᐱᖅᑲᑐᔭᓄᑦᑐᓐᓃᑦ ᐃᓂᕆᔭᐅᕙᕕᓂᖅ ᐊᒻᒪᓗ ᑕᐃᒪᐃᓕᖕᒐᐃᓐᓇᑐᐃᓐᓇᓕᖅᓂᑯ ᓯᑯ ᐊᐅᖕᒪᑦ. What'a: Whà ndè goka tô naeyî t'à kwèwa eyits'ô ewa nìtå'i siì whagwè laàni nîæa siì what'à (kwè ghô shì) weyeh hôt'e. T‡n lu cho nálghi ts'î nítå'ír: Tthe dhíaze-u, thay-u, tú nílîaze to ní yughe nîlî tó tÿnlucho nalghî ts'î nítå'ír.
Euphotic zone	The euphotic zone refers to the upper portion of the water column in which adequate light is present for photosynthesis to occur. ᐱᕈᖅᕕᐅᕙᓐᓇᖅᑐᑦ ᐃᒪᐃᑦ ᐃᑎᓂᖕᒐ ᓇᑎᖅ ᖃᐅᒻᒪᒃᐸᖕᒪᑦ: ᐱᕈᖅᕕᐅᕙᓐᓇᖅᑐᖅ ᖃᐅᒻᒪᒃᐸᖕᓂᖕᒐ ᓇᑎᖅ ᐃᒪᖅᒥ ᐃᑎᓂᖕᒐ ᓈᒪᕙᒥᒃ ᖃᐅᒻᒪᖅᑲᑦᑕᖅᒥ ᐱᕈᖅᕕᐅᕙᓐᓇᖅᑲᑦᑕᖅᓂᖕᒐ. Tamba teè sade t'à asìi dehshe/growth underwater by light Tâbãghe te yé t'õõt'i æñdî t'á huneshe
Eutrophic	Nutrient-rich waters with high primary productivity. ᐱᕈᖅᕕᐅᕙᓐᓇᖅᓂᖕᒋᑦ ᐃᒪᖅᒥ: ᐱᕈᖅᑐᖅᑲᑦᑕᓇᒃᑐᑦ ᐱᐅᕙᒥᒃ ᐱᕈᖅᕕᐅᑭᑦᑕᐊᕙᓐᓇᖅᑐᑦ Ti tå'a asìi yaèshe/plants underwater grow properly Te yé æasíe hûzø dáníye
Eutrophication	Refers to the process by which changes occur in a lake due to nutrient input. Changes which can occur include increased primary producer biomass, major shifts in the composition of primary producers, increased sediment oxygen demand, and winter dissolved oxygen decline. Eutrophication is a global issue, and is the major reason for the use of phosphorus-free detergents and soaps. ᐱᕈᖅᐸᑦᑕᐊᕕᐅᓗᐊᖅᑐᑦ ᐃᒪᐃᑦ: ᐱᕈᖅᕕᐅᕙᖅᑲᓗᐊᑕᖅᑐᑦ ᐃᒪᐃᑦ, ᐃᒪᖅᒥᐅᑕᐃᑦᑐ ᑐᖅᑯᖃᖅᐸᑦᑕᐊᖅᑲᑦᑕᖅᑐᑦ ᐱᕈᖅᑐᖅᑲᓗᐊᑕᖄᖕᒐᑦ. ᓇᑕᒧᕇᒍᓐᓃᖅᑲᑦᑕᖅᑐᑦ ᐱᕈᖅᑐᖅᑲᓗᐊᑕᖄᖕᒐᑦ , ᐱᕈᖅᑐᑦ ᐊᓂᖅᓂᖅᑐᓗᐊᑕᖄᖕᒐᑕ ᐊᓂᖅᓂᖅᑲᑦᑎᐊᖕᒋᓗᐊᑕᖅᑲᑦᑕᖅᑐᖅ. ᓯᑕᖅᕙᐊᖅᒥ ᑕᒪᓐᓇ ᐃᓯᒪᔫᑕᐅᕙᖅ ᐊᒻᒪᓗ ᐱᕝᕙᑕᐅᓂᖅᐸᖕᒍᑦᑐᓂ ᐊᑐᖅᑕᐅᖅᑲᑦᑕᖅᓂᖕᒋᓐᓂ ᐃᖅᒥᐅᑏᑦ ᐅᐊᓴᐅᑎᑦᑐ. Ti tå'a deghaà asìi yaèshe-le/plants underwater does not grow properly Te yé æasíe deæánonélya

Term	Description
Evaporation	*The loss of water from soil, or surface water, by heating of the sun. Nongonik: Hikinemin paniktikpaktot taheetlo aningniaghaklo nunalu. ᐃᒪᖅ ᐳᓪᓚᖑᖅᐸᓪᓚᐊᓂᕐᒧᑦ ᓄᖑᑉᐸᓪᓚᐊᓂᖅ: ᐃᒪᐃᕈᑎᕚᓪᓚᐊᓂᒃ ᓄᓇᒥᒃ, ᑕᓯᕐᓂᒃ ᓯᓚᒥᒡᔪᓐᓃᑦ ᐆᓇᖅᓯᓯᒪᓂᖏᓐᓄᑦ ᓯᕿᓂᕐᒥᒃ. Ti, nîhts'i ts'öeåè: Sadè t'à ti nîhts'i ts'öiåè/because of sun water turns to air Bek'e náreduth: Sa ts'î hadhélé t'á thay-u ts'î bek'enareduth.
Exploration	The search for mineral deposits and the work done to prove or establish the extent of a mineral deposit. ᕿᓂᕐᓂᖅ: ᕿᓂᕐᓂᖅ ᓇᓂᓯᓇᓱᐊᕐᓂᖅ ᓴᕕᕋᔮᒃᓴᕐᑲᖅᑐᓂᒃ ᐃᒐᓚᐅᔭᕐᑲᖅᑐᓂᓘᓐᓃᑦ ᓇᓂᔭᐅᓇᓱᐊᖅᑐᓂᒃ. Kwe hageètah/looking for rocks Tthe kauneta
Explosives	Any rapidly combustive or expanding substance. The energy released during this rapid combustion or expansion can be used to break rock. ᖃᖅᑕᔩᑦ: ᓱᒃᑲᔫᒪᓇᖕᒥ ᖄᕈᓐᓇᖅᑐᑦ ᓱᓇᑐᐃᓐᓇᐃᑦ. ᐆᒪᕐᑯᑎᖃᖅᑐᑦ ᓱᒃᑲᔪᒥᒃ ᖄᖅᑎᖅᑕᐅᔪᓂᒃ, ᓱᖁᒃᑎᖅᓂᐊᕐᒪᑕ ᐅᔭᕋᐃᑦ. Kwe naèk'è/exploting rocks Æeåk'eníåkíth
Extra-fine processed kimberlite (EFPK)	*The EFPK is composed of mostly silts and clays (< 0.1 mm particle size). It makes up approximately 12% by mass of the fine processed kimberlite in the LLCF (35% by volume). This material is carried further in the slurry stream and is washed to the lowest point in the containment cells. ᓯᕐᑲᓪᓚᖅᑎᖅᑕᐅᓯᒪᕐᑎᐊᖅᑐᑦ ᓯᐅᕋᐃᑦ ᓯᑎᔫᒃᓴᔭᐃᑦ ᐊᓪᓘᔭᐃᑦ ᐋᔭᖅᑕᐅᓯᒪᓪᓚᖅᑎᓪᓗᒋᑦ: ᓯᕐᑲᓪᓚᖅᑎᑕᐅᓯᒪᓪᓚᓇᓪᓚᖅᑐᑦ ᓯᐅᕋᓐᖑᖅᓯᒪᔫᑦ ᐅᔭᕋᕕᓃᑦ ᐊᓪᓘᒃᑲᓪᓚᐅᖅᑐᑦ ᒪᕋᖑᖅᓯᒪᓪᓚᖅᑐᑦ ᐅᕙᓗᓐᓃᑦ ᓯᐅᕋᐅᔮᖅᑐᓐᖑᖅᑕᓯᒪᔪᑦ. (<0.1 mm ᐊᖏᓂᓛᑦ). ᑖᒃᑯᐊ ᓯᐅᕋᐃᑦ ᓅᑕᐅᕚᓪᓚᐊᕐᑲᑦᑕᖅᑐᑦ ᑰᖕᒧᑦ ᑯᕕᐅᕐᑲᖅᑕᐅᓪᓗᑎᒡᓗ ᒥᑭᑦᑐᒪᓇᖕᓄᑦ ᐃᓗᓪᓚᖅᑲᕕᖕᓄᑦ ᐃᓚᐅᕐᑲᖅᑕᐅᕚᒃᓯᑎᒃ. Kweåè/rock flour Tthe dháy
Extraction	The process of mining and removal of ore from a mine. ᐱᔭᐃᓂᖅ ᐅᔭᕋᖕᓂᒃ: ᐅᔭᕋᖕᓂᒃ ᐲᔭᐃᓂᖅ ᐊᒨᕐᑲᖅᑕᐅᓯᒪᔪᓂᒃ ᐅᔭᕋᖕᓂᐊᕐᕕᖕᓂᒃ. Edàanì asìi kwe ts'ô haàzhe/extracting things from rock T'at'u tthe ts'î æasíe hílchu
Feasibility	The stage in mining or reclamation when after a go forward plan/option has been selected (in the pre-feasibility stage) it is rigorously evaluated to finalize the scope, budget, and timeline; engineered drawings are developed (if required), the risks and opportunities are established, and a clear defined plan of how it will be executed are put in place. This parallels with the stage of the Final Closure and Reclamation Plan. ᐊᔪᕐᓇᖏᓪᓚᖕᖏᑦ ᐱᔭᒃᓴᐅᖕᒪᖕᖏᑕ: ᐅᔭᕋᖕᓂᐊᕐᓂᕐᒥᒃ ᐅᕙᓗᓐᓃᑦ ᓴᓗᒪᖅᓴᐃᓂᖅ ᑲᔪᓯᔪᓐᓇᕐᓂᕋᖅᑕᐅᓚᐅᕐᓗᑎᒃ ᐊᔪᖏᓐᓂᕋᖅᑕᐅᓯᒪᓪᓚᖅᑎᓪᓗᒍ, ᖃᐅᔨᓴᖅᑕᐅᓪᓚᓇᓪᓚᖅᓯᑎᒃ ᐊᖏᓂᖏᑦ, ᖃᓄᖅ ᑮᓇᐅᔭᕐᑐᕐᓂᐊᕐᒪᖕᖏᑕ ᐊᒻᒪᓗ ᖃᖓᒃᑯᑦ ᐱᔭᐅᓂᐊᕐᒪᖕᖏᑕ; ᑎᑎᕋᖅᑕᐅᓯᒪᔫᑦ ᓴᓇᔭᐅᓯᒪᓂᐊᕐᒥᔫᑦ (ᐱᔭᓇᐊᕐᑲᕈᑎᒃ), ᐃᑲᔫᖅᐸᓪᓚᕈᓐᓇᕐᓂᖏᑦ ᐊᒻᒪᓗ ᐅᓗᓇᐊᓇᕈᓐᓇᕐᓂᖏᑦ ᑐᑭᓯᔭᓂᐊᖅᑐᑦ; ᐊᒻᒪᓗ ᐸᕐᓇᐅᑎᕐᑲᑦᑎᐊᕐᓗᑎᒃ ᖃᓄᖅ ᐱᓕᕆᐊᖑᓂᐊᕐᖕᖏᑕ. ᑖᒃᑯᐊ ᐊᓯᖏᔭᖕᖏᑦ ᑭᖑᓪᓕᖅᐸᕐᒥᒃ ᒪᑐᔭᐅᕕᒃᓴᖕᖏᓐᓂᒃ ᐊᒻᒪᓗ ᓴᓗᒪᖅᑕᐅᓂᐊᕐᓂᖕᖏᓐᓂᒃ ᐸᕐᓇᐅᑎᖕᖏᓐᓂᒃ. Laà hohåè ha dìle/is it possible to do job La xaåé xa dúélé

Term	Description
Fertilizer	Compounds added to the soil to correct nutrient deficiencies. The main purpose is to add nitrogen, phosphorus and potassium to the soil. These are the main nutrients that plants need to grow. ᐱᕈᖅᐸᑦᑕᕈᑎᑦ: ᐃᓚᒃᓴᐃᑦ ᐃᓚᔾᐅᕙᒃᑐᑦ ᓄᓇᒧᑦ ᐱᕈᕐᕕᐅᓂᐊᖅᑐᓄᑦ, ᐱᕈᖅᕕᐅᑦᑎᐊᕐᒋᓗᐊᖅᑐᓂ. ᐃᓚᔾᐅᕙᒃᑐᑦ ᐱᕈᖅᑐᑦ ᓂᕿᒃᓴᖏᑦ, ᐆᒻᒪᒃᑲᓂᕈᑎᒧᑦᑐ ᐊᒻᒪᓗ ᐊᓯᖏᑦ (ᐳᑖᓯᔻ) ᓄᓇᒧᑦ. ᑕᒪᒃᑯᐊ ᐊᑐᖅᐸᒃᑐᑦ ᐱᕈᖅᑐᓄᑦ ᓂᕿᒃᓵᔾᐅᑐᑎᒃ ᐱᕈᒃᑲᓂᕈᓐᓇᕐᓂᐊᕐᒪᑕ. Asìi wet'à dehshe/something that makes something grow Bet’a æasíe æãs neye
Fine-textured soil	*Soil composed mostly of clay and clay loam. From the GNWT Site Remedation Guideline (2003) soil with a median grain size of > 75 µm as defined by the American Society for Testing and Materials. Nuna magluinak ᐱᐅᔪᑦ ᓄᓇᐃᑦ ᓯᕐᑲᑎᖅᓯᒪᑦᑎᐊᖅᑐᑦ ᒪᕋᕈᔪᐃᑦ: ᓄᓇᐃᑦ ᐱᑐᐊᖅᑐᒥᒃ ᐃᓚᕐᑲᖅᑐᑦ ᒪᕋᕐᒥᒃ, ᒪᕋᐃᑦᑐ ᖃᐳᖓᓂᒃ ᓯᕐᑲᑎᖅᓯᒪᑦᑎᐊᖅᑐᑦ. Ehtå’èk'ò
Fine processed kimberlite (FPK)	Processed kimberlite (less than 0.65 mm - fine sand, silt and clay) which is generated during processing and is sent to the LLCF by slurry pipeline. ᓯᕐᑲᓕᖅᑎᖅᑕᐅᓯᒪᔪᑦ ᓯᐅᕋᐃᑦ ᐅᔭᕋᕕᓃᑦ ᓯᑎᔪᒃᓴᔭᐃᑦ ᐊᓕᒨᔭᐃᑦ ᐲᔭᖅᑕᐅᓯᒪᓕᖅᑎᑦᑐᒋᑦ: ᓯᕐᑲᓕᖅᑕᐅᓯᒪᔪᑦ ᐅᔭᕋᕕᓃᑦ ᐊᓕᒨᔭᕐᑲᓚᐅᖅᑐᑦ (ᒥᑭᓐᓂᖅᓴᒥᒃ 0.65 mm-ᒥᒃ ᐊᖏᓂᑖᑦ - ᓯᐅᕋᐃᑦ, ᒪᕋᐃᑦᑐ) ᓴᕿᓯᒪᔪᑦ ᓯᕐᑲᓕᖅᑎᑕᐅᓯᒪᓂᖏᓐᓂ ᐊᒻᒪᓗ ᖚᑕᐅᕐᑲᑦᑕᖅᑐᑦ ᑏᖕ ᑏᒃᒧᑦ ᑕᓯᕐᒧᑦ ᐃᓕᐅᕐᑲᐃᕕᖕᒧᑦ, ᓱᑦᑕᒃᑯᑦ ᑯᕕᔪᓂᒃ ᓯᐅᕋᕐᓂᒃ. Kweåè laanì/like rock flour Thay æaté åus lat’e: Diri thay sí hatå’‡s delgai chu hatå’‡s dhay chu æeåta.
Flocculants	*Chemicals that are used to combine colloids and other suspended particles in liquids to form a floc in a process called flocculation. Flocculants are used in water treatment processes across Canada to improve the sedimentation or filterability of small particles. ᓱᕈᔪᖕᓄᑦ ᐅᕐᑯᒪᐃᑐᑕᐃᑦ ᐃᒪᕐᓂ: ᓴᖏᔪᒻᒪᕇᑦ ᐃᓚᒃᓴᔭᐃᑦ ᐃᓚᔾᐅᕙᒃᑐᑦ ᓱᕈᕐᓄᑦ ᐊᑦᑕᑦᑕᕐᓂᐊᕐᒪᑕ ᑭᕕᔾᔪᑕᐅᑐᑎᒃ ᒪᕋᐃᑦ Asìi wet'à teè tå'a ts'ö neyeèhtå'ì/something that makes it sink to the bottom Æasíe bet’á tetå’aghe nítå’ir
Forb	A broad-leaved herb other than a grass, especially one growing in a field, prairie, or on tundra ᐅᕐᑲᐅᔭᐃᑦ (Forb) ᑐᖑᔪᖅᑐᑦ: ᓂᕈᑐᔪᑦ ᐅᕐᑲᐅᔭᐃᑦ ᐊᓯᖏᑦ ᓄᓇᕋᐃᑦ, ᐱᑐᐊᖅᑐᒥᒃ ᐱᕈᖅᐸᒃᑐᑦ ᓄᓇᒥ, ᓂᕈᑐᓂᕐᒥ ᐅᕙᓅᓐᓃᑦ ᓄᓇᑐᐃᓐᓇᕐᒥ ᑐᐊᑐᑯᑖᖑᖏᑦᑐᑦ Tå'oh Tå’o
Fresh air raise (FAR)	Shaft constructed to bring fresh air from surface to underground workings. ᐊᓂᖅᓵᖅᑑᑎᓚᐅᕈᑦ: ᓱᓗᑯᑖᒃ ᐊᓂᖅᓵᖅᑑᑎᕐᑲᕐᕕᒃ ᐃᓗᐊᓄᑦ ᓄᓇᐅᑉ ᐅᔭᕋᖕᓂᐊᕐᕕᐅᑉ ᐃᓗᐊᓂ, ᐱᓕᕆᔪᑦ ᐊᓂᖅᓵᕈᓐᓇᕐᓂᐊᕐᒪᑕ Nîhts'i ndè goyiì ts'ö niîæa/air that goes into a tunnel Níyé niåts’i nuníæa
Freshet	The increased flow of water over a relatively short period of time, usually during spring, caused by snowmelt. ᐃᒪᓐᖑᖅᓯᒪᓂᖏᑦ ᐊᐳᑎ ᐊᐅᓐᓂᖓᓄ ᐅᐱᖓᒃᑯᑦ: ᐃᒪᖅ ᐳᖅᑐᓯᓯᒪᓂᖓ ᕿᓚᒥᑯᓗᒃ, ᐱᑐᐊᖅᑐᒥᒃ ᐅᐱᖓᒃᑯᑦ, ᐊᐅᒃᐸᑦᑕᐊᓯᒪᓂᖓᓄᑦ ᐊᐳᑦ.

Term	Description
	Zhah naàyîî Yath nalghî
Fugitive dust	Any airborne, uncontrolled particulate matter generated from open sources. ᐳᔪᖅᓘᒃ: ᐳᔪᖅ ᓯᓚᒦᑦᑐᖅ, ᓇᑭᑐᐃᓐᓈᖅᑐᖅ ᓲᕐᓗ ᓄᓇᒃᑯᕈᑎᓂᒃ ᓴᕿᑕᐅᔪ. Ehtå'è dàedì/dust flowing around Tthay dzérétth'ay
Geochemistry	The study of chemical properties of rocks. ᐃᓗᓕᖏᑦ ᐅᔭᕋᐃᑦ ᖃᐅᔨᓴᖅᑕᐅᓂᖏᑦ: ᖃᐅᔨᓴᐃᖃᑦᑕᕐᓂᖅ ᐃᓗᓕᖏᓐᓂᒃ ᐅᔭᕋᐃᑦ Kwe kaæa ghô hoghàdetô/study of various rocks Tthe k'oneta
Geotechnical	Of or pertaining to practical applications of geological science in civil engineering and mining. ᓄᓇᒥᒃ ᖃᐅᔨᓴᐃᓂᖅ ᓴᓇᔭᐅᔪᒃᓴᓂᒃ: ᐱᔾᔪᑎᖃᖅᑐᑦ ᖃᓄᖅ ᐊᑐᖅᑕᐅᔪᓐᓇᕐᒪᖔᑕ ᓄᓇᐃᑦ ᖃᐅᔨᓴᖅᑕᐅᖅᓯᒪᓂᖏᑦ, ᓴᓇᓂᐊᕐᓗᑎᒃ ᐊᒻᒪᓗ ᐅᔭᕋᖕᓂᐊᕐᕕᓕᐅᕐᓂᐊᕐᓗᑎᒃ. Kwe kaæa xè eghàlada/working with various rocks T'at'u tthe beghálada xa sí
*Geotechnical Stability	*The engineering design of an earthen structure to perform as intended and to remain fit for services for a finite time period.
Geology	The science concerned with the study of the rocks that compose the Earth. ᐅᔭᕋᓕᕆᓂᖅ: ᖃᐅᔨᓴᖃᑦᑕᕐᓂᖅ ᐱᔾᔪᑎᖃᖅᑐᓂᒃ ᐅᔭᕋᕐᓂᒃ ᓄᓇᙳᖅᓯᒪᔪᓂᒃ, ᓄᓇᒧᑦ ᐃᓚᒋᔭᐅᔪᓂᒃ, ᐅᔭᕋᐃᑦ ᓱᓇᖃᕐᒪᖔᑕ Kwe kaæa wedanàgetah/researching various rocks Tthe bek'orneta xa net'î
Geomorphology	The study of the classification, description, nature, origin and development of landforms and their relationships to underlying structures, and the history of geologic changes as recorded by these surface features. ᐅᔭᕋᙳᖅᐸᓪᓕᐊᓯᒪᔪᓕᕆᓂᖅ: ᐅᔭᕋᐃᑦ ᓇᒃᑳᕐᓂᑰᖕᒪᖔᑕ, ᖃᓄᕐᓗ ᐅᔭᕋᙳᖅᓯᒪᖕᒪᖔᑕ ᐊᒻᒪᓗ ᖃᓄᐃᑦᑑᖕᒪᖓᑕ ᐅᔭᕋᐃᑦ Edàanì kwe wegohåî/how rocks became to be T'at'u tthe huli æája
Glacial Till	Accumulations of unsorted, unstratified mixtures of clay, silt, sand, gravel, and boulders that are deposited on the land as a glacier recedes. Till is the usual composition of a moraine. ᐱᖃᓗᔭᖅᒥᒃ ᐅᔭᕋᐃᔭᖅᑐᑦ: ᐱᖃᓗᔭᕐᓂᒃ ᓯᕐᒥᖕᓂᒡᓗ ᐅᔭᕋᓪᓛᙳᓂᑦ, ᒪᕋᐃᓪᓗ, ᓯᐅᕋᐃᓪᓗ, ᑐᐊᐸᐃᓪᓗ, ᐅᔭᕋᕐᔪᐊᓪᓗ ᓄᓇᒧᑦ ᐱᔭᖅᐸᓪᓕᐊᓯᒪᔪᑦ ᓯᕐᒥᖕᓂᒃ ᐱᖃᓗᔭᕐᓂᒡᓗ ᐃᖕᒋᕐᕋᕙᓪᓕᐊᓂᖕᒋᓐᓂ, ᐊᐅᒃᐸᓪᓕᐊᓂᖕᒋᓐᓂᓗ. Tô deèdlî Tÿn dédliné nalghî yé harelyû æeåk'éch'a tthe-u, tthay-u beta hûli sí
Global warming	The increase in the earth's temperature and possible climate change. Ndè åadî at'î/ndè hazhô edi adaàde ᓯᓚᐅᑉ ᐆᓇᖅᓯᕚᓪᓕᐊᓂᖓ: ᓄᓇᕐᔪᐊᕐᒥ ᐆᓇᖅᓯᕚᓪᓕᐊᓂᖅ ᐊᒻᒪᓗ ᐃᓛᖓᒐᒍᑦ ᓯᓚᐅᑉ ᐊᓯᔾᔨᖅᐸᓪᓕᐊᓂᖓ. Harelyû nɫné hunídhile

Term	Description
Granite	Coarse-grained, light-coloured, hard igneous rock. ᖃᐅᒪᔪᖅ ᓱᕋᒃᑎᖅᓯᒪᖕᒋᑦᑐᖅ ᐅᔭᕋᒃ: ᐃᓗᐃᑦᑐᑦ ᖃᐅᒪᔪᑦ ᐅᔭᕋᐃᑦ ᓱᖃᓕᑎᒃᓴᐅᑦᑎᐊᖕᒋᑦᑐᑦ Kwe dezhì/kwe nedà Ttthe náltáile
Greenhouse gas	Any of various gases, especially carbon dioxide, that contribute to the greenhouse effect. ᐳᔪᕐᓗᐃᑦ ᐳᓪᓚᐃᑦ: ᖃᓄᐃᑐᐃᓇᐃᑦ ᐳᓪᓚᐃᑦ, ᐱᓗᐊᖅᑐᒥᒃ ᑐᕐᖓᓇᖅᑐᖅᑲᖅᑐᑦ, (carbon dioxide) ᐊᓯᔾᔨᖅᐸᓪᓕᐊᔾᔪᑕᐅᔪᑦ ᐳᓪᓚᐃᑦ ᓯᓚᕐᔪᐊᕐᒧᑦ ᐆᓇᖅᓯᕙᓪᓕᐊᔾᔪᑎᑦ. Dii nèk'e wemôö nawhet'i detô-lèa adaàde/yat'a wemôö nawhet'i detô-le adaàde Tåÿs lÿr
*Groundwater	*All water below the ground surface. ᐃᒪᖅ ᓄᓇᐅᑉ ᐃᓗᐊᓂ ᐳᖅᑐᓂᖅᓴᖅ ᐊᐅᔭᒃᑯᑦ ᑕᑯᒃᓴᐅᓕᕈᓐᓇᖅᑐᖅ ᐊᐅᒃᑳᖕᖓᑦ: ᐃᒫᑦ ᐃᓗᐊᓃᑦᑐᑦ ᐊᖕᒪᔪᖕᒋᓐᓂ ᐅᔭᕋᐃᑦ ᓯᐅᕋᐃᓪᓗ ᓄᓇᐃᑦ ᐳᖅᑐᓂᖕᒋᓐᓂ ᖁᓛᓂ ᖁᐊᖑᓂᐅᔩᑉ Ndè gotì goka Ní da túç Emak kaanganeetok nunap: Emak kaanganeetok nunap engotaghoni kogaliaktok. ᐃᒪᖅ ᓄᓇᐅᑉ ᐃᓗᐊᓂ/ᐊᑖᓂ ᐊᑎᖕᓂᖅᓱᖅ: ᐃᒪᕕᓂᑐᖃᐃᑦ ᐃᓗᐊᓃᑦᑐᑦ ᐊᖕᒪᔪᖕᒋᓐᓂ ᐅᔭᕋᐃᑦ ᓯᐅᕋᐃᓪᓗ ᓄᓇᐃᑦ ᐳᖅᑐᓂᖕᒋᑕ ᐊᑎᖕᓂᖕᒐᓃᑦᑐᑦ, ᐊᑖᓂ ᖁᐊᖑᓂᐅᔩᑉ ᓄᓇᐅᑉ. Ndè tå'a Gotì: Ndè gotå'a ti k'ètå'ò, dehtsoa laàni. Ní yághe tûç
Habitat	Any area that provides food, water and/or shelter for an organism. Nuna naoviohimayok hunutlikaak: Takonaitot hogayat naoveet nunami. ᐅᒪᔪᖃᕝᕖᑦ: ᖃᓄᐃᑐᓇᐃᑦ ᓄᓇᐃᑦ/ᐃᓃᑦ ᐱᑕᖃᖅᑐᑦ ᓂᕿᔅᓴᓂᒃ, ᐃᒥᕐᒥᒃ, ᐊᒻᒪᓗ/ᐅᕝᕙᓗᓐᓃᑦ ᐅᖅᑯᐊᖃᕝᕕᐅᔪᑦ ᐆᒪᔪᓄᑦ Eyi Ndè K'è Ededa: Ndè k'è tich'adi ededa ha dì le siì. T'ok'e æasí náda: T'ok'e æasí hena, te ch'adiye náda-u, æasí niuneshe xúlî sí æats'edi æat'e.
Haul road	A road built to carry heavily loaded trucks at a good speed. The slope is limited on this type of road and usually kept to less than 10% of climb in direction of load movement. ᐅᓯᒃᑕᖃᕝᕖᑦ ᐊᖅᑯᑏᑦ: ᐊᖅᑯᑏᑦ ᐊᑐᕆᐊᑦ ᓴᓇᔭᐅᓯᒪᔪᑦ ᐅᖁᒪᐃᑦᑐᓂᒃ ᐊᖏᔪᓂᒃ ᓄᓇᓯᐅᑏᑦ ᐅᓯᔪᓂᒃ ᐃᖏᕐᕋᕕᐅᔪᓐᓇᖅᑐᑦ ᓱᒃᑲᔪᒥᒃ. ᐳᖅᑐᓂᖓ ᐳᖅᑐᓗᐊᕆᐊᖃᖕᒋᑦᑐᖅ ᑕᐃᒪᐃᑦᑐᓂ ᐊᖅᑯᑎᓂ, ᐊᒻᒪᓗ 10%-ᒦᑦᑐᑦ ᐳᖅᑐᓂᕆᔭᐅᖅᑕᖓ ᖁᒻᒧᑦ ᐃᖏᕐᕋᓂᖓᓂ ᐅᓯᔭᐅᔪᑦ. Tîîlî k'e asìi eht'àezhe Tîlu bek'e æasíe æeåánalyi
Hazardous material	*Chemicals which are persistent and extremely toxic. ᐅᓗᕆᐊᓇᖅᑐᓖᑦ: ᓱᓇᑐᐃᓐᓇᐃᑦ ᐃᓚᔭᐅᖃᑕᖅᑐᑦ, ᑲᔪᓯᓐᓇᖅᑐᒥᒃ ᓱᕈᕐᓇᖅᑐᖃᖅᑐᑦ, ᐊᒥᓱᕈᖅᐸᓪᓕᐊᑐᐃᓐᓇᕈᓐᓇᖅᑐᑦ, ᐊᒻᒪᓗ ᐊᒃᓱᒻᒪᕆᐊᓗᒃ ᑐᕐᖓᓇᖅᑐᓖᑦ. Naèdiåî wets'àehòedzî Æasíe bech'onejÿr
Herbivore	An animal that feeds on plants. ᐱᕈᖅᑐᖅᑐᓲᑦ ᐆᒪᔪᐃᑦ: ᐆᒪᔪᐃᑦ ᐱᕈᖅᑐᓂᒃ ᓂᕆᓲᑦ. Tich'adi tå'oh ede Tech'adíe æasíe huneshe ghâ shélyi

Term	Description
Highwall (open pit)	*The unexcavated face of exposed overburden and or bedrock in a surface mine, located on the uphill side of a contour mine excavation. ᐳᖅᑐᓂᖓ ᓴᓂᕋᐅᑉ ᐅᔭᕋᖕᓂᐊᕐᕕᖕᒥ, ᐃᒪᐅᑉ ᖁᓚᓃᑦᑐᖅ: ᓴᓇᕕᐅᓯᒪᙱᑦᑐᖅ ᐳᖅᑐᓂᖓ ᓴᓂᕋᓚᐊᖑᓯᒪᔪᖅ ᐅᕙᓘᓐᓃᑦ ᐅᔭᕋᖅ ᓴᓂᕋᖅ, ᓄᐃᑕᔪᒥ ᐅᔭᕋᖕᓂᐊᕐᕕᖕᒥ, ᐃᒪᐅᑉ ᖁᓚᓃᑦᑐᖅ. Kwet'a Tthe t'ádhe
HSEC	*Health, Safety, Environment and Community are the key values represented in the BHP Billiton Sustainabilty Policy.
Hydrocarbon	A family of chemical compounds containing carbon and hydrocarbon atoms in various combinations, found especially in fossil fuels. ᐅᖅᓱᐊᓗᐃᑦ ᑳᓴᓖᓪᓗ: ᑕᐃᒃᑯᓇᖕᒐᓴᐃᓐᓈᖅᑐᑦ ᐊᔾᔨᒌᒐᓚᒃᑐᓂ ᐳᓪᓚᓕᖕᓂᒃ, carbon-ᖃᖅᑐᑦ ᐊᒻᒪᓗ hydrocarbon-ᖃᖅᑐᑦ ᐃᓗᓕᖏᓐᓂ, ᐊᔾᔨᒌᙱᑦᑑᑎᓂᒃ ᐊᑯᓯᒪᓪᓗᑎᒃ, ᐱᑕᖃᖃᑦᑕᖅᑐᑦ ᐱᓗᐊᖅᑐᒥᒃ ᓴᐅᓂᕕᓂᕐᓂᒃ ᐅᔭᕋᖕᓂ ᐅᖅᓱᐊᓗᖕᓂᐊᖅᑕᐅᓯᒪᔪᓂᒃ. Tåeh detì Tåÿsdogh-u,tåÿs-u lát'i sí
Hydrocarbon contaminated material	Soil, sand, rock or other substrate materials which have been contaminated with hydrocarbons. ᐅᖅᓱᐊᓗᒃᓴᔭᐃᓐᓇᕈᖅᓯᒪᔪᑦ ᑳᓴᓖᒃᓴᔭᐃᓐᓇᕈᖅᓯᒪᔪᓪᓗ: ᓄᓇᔭᐃᑦ, ᓯᐅᕋᐃᑦ, ᐅᔭᕋᐃᑦ ᐊᓯᖏᓪᓗ ᓯᑎᔪᑦ ᐅᖅᓱᒃᓴᔭᐃᓐᓇᕈᖅᓯᒪᔪᑦ ᑳᓴᓖᒃᓴᕈᖅᕕᐅᓯᒪᔪᑦ, ᑯᕕᕕᐅᓯᒪᔪᑦ. Naèdiåî wets'àehòedzî Ni-u, tthay-u, the-u lat'i beta tåÿsdogh to tåÿs-u t'á ts'ñde
Hydrology	The study of the properties of water and its movement in relation to land. ᐃᒪᓕᕆᓂᖅ: ᖃᐅᔨᓴᖅᑕᐅᖃᑦᑕᕐᓂᖏᑦ ᖃᓄᐃᓖᖑᖕᒪᖔᑕ ᐃᒪᐃᑦ ᐊᒻᒪᓗ ᐊᐅᓚᕝᓕᐊᓂᖏᑦ, ᓄᓇᒧᑦ ᐊᑕᓪᓗᑎᒃ. Ti wedànàgeta Tu k'aúneta
Ice lense	Water which is encapsulated and entrained as ice within processed kimberlite after it has been discharged onto long beach areas. ᓯᑯ ᓄᓇᐅᑉ ᐃᓗᐊᓂ ᖁᐊᖑᓂᕐᒦᑦᑐᑦ: ᐃᒪᕕᓂᖅ ᖁᐊᖅᓯᒪᔪᖅ ᓯᑰᓪᓗᓂ ᐃᓗᐊᓃ ᐊᓕᒎᔭᕐᑲᕐᑐᑦ ᐅᔭᕋᐃᑦ ᐋᔭᖅᑕᐅᓚᐅᖅᑎᓪᓗᒋᑦ ᓯᓈᓄᑦ ᓯᐅᕋᓕᖕᓄᑦ ᐊᒃᑕᖅᑕᐅᓯᒪᔪᑦ. ᐃᒪᐃᑦ ᒪᕋᐃᑦ ᑯᕕᔪᑦ ᐊᓕᒎᔭᕐᑲᖅᑐᓂᖕᒌᖅᓯᒪᔪᑦ ᓄᓇᐅᑉ ᐃᓗᐊᓂᓕᖅᑐᑦ ᖁᐊᖅᐸᓪᓕᐊᓪᓗᑎᒃ. ᓯᑰᓂᑦ ᓄᓇᐅᑉ ᐃᓗᐊᓂ. Ndètå'ah tô yàehtô/patches of frozen ice underground Tu ní yélbî-u tÿn neåé
Indigenous	Originating in, and produced, growing, native, or living naturally in a particular region or environment. ᑕᒫᓃᖏᓐᓇᖅᑐᑦᑲᐃᑦ: ᓱᓇᑐᐃᓇᐃᑦ ᐱᑕᖃᐃᓐᓇᖅᑐᖅ, ᑕᒫᓃᖏᓐᓇᖅᑐᑦ, ᐱᕈᖅᑐᑦ, ᑕᐃᒪᐃᖏᓐᓇᖅᑐᑦᑲᐃᑦ, ᑕᐃᒪᐃᖏᓐᓇᖅᑐᒥᒃ ᓱᓕ ᑲᔪᓯᑐᐃᓐᓇᖅᑐᑦ ᐊᕙᑎᒥᓂ, ᐊᕕᒃᑐᖅᓯᒪᓂᒥᓂᓗᓐᓃᑦ. Sôåî Dÿne dedåîné
Infrastructure	The basic structural installations used for mining operations (e.g., roads, buildings, water supply and sewage treatment facilities, etc.). ᓴᓇᔭᐅᓯᒪᔪᕐᔪᐊᑦ: ᓴᓇᔭᐅᓯᒪᔪᕐᔪᐊᑦ ᓄᓇᓕᓕᐅᕈᑏᑦ, ᐃᓅᔾᔪᑎᒃᓴᐃᑦ ᓄᓇᓕᖕᓂ Kö yahohåè/building being built to live/work Náts'edé xa suhúlye

Term	Description
Invertebrates	A collective term for all animals without a backbone or spinal column. Includes insects, worms, clams, snails, spiders, etc. ᐆᒪᔪᐃᑦ ᑐᓄᒃᑯᑦ ᓴᐅᓂᖃᙱᑦᑐᑦ: ᐊᔾᔨᒌᙱᑦᑐᑦ ᐅᖃᐅᓯᖅᑲᕆᒌᑦ ᐆᒪᔪᓕᒫᓂᒃ ᑐᓂᖁᙱᑦᑐᑦ ᓴᐅᓂᖃᙱᑦᑐᑦ. ᓱᕐᓗ ᕿᑉᑐᓇᐊᑦ, ᖁᐸᕐᕿᐃᑦ, ᐊᒻᒨᒪᔪᐃᑦ, ᐊᒻᒪᓗ ᐋᓯᕙᐃᑦ, ᐊᓯᖏᓘᔭᙱᓪᓗ. Tich'adi wenôhkw'ô whì-le/animal with no backbone Tech'adíe ben‡né dõlile (gu)
Kame	A ridge or mound of stratified sands and gravels left by a retreating ice sheet ᐱᖅᑲᓗᔭᐃᑦ ᐊᖁᑎᕕᓂᙶᓂᒃ ᐳᖅᑐᓃᑦ: ᐳᖅᑐᓃᑦ ᖃᖅᑳᖅ ᐊᖁᑎᖅᑲᕐᓂᕕᓂᙱᓐᓄᑦ ᐱᖅᑲᓗᔭᐃᑦ Tô deèdlî nayîî tå'ahô shìa hohåè/after glacier melts a little hill develops Shéth
Kimberlite	A rock of igneous origin that is forced to the Earth's surface via volcanic pipes. The name is derived from Kimberley, South Africa, where the rock was first discovered. ᐊᓕᒨᔭᖅᑲᖅᑐᑦ ᐅᔭᕋᐃᑦ: ᐅᔭᕋᐃᑦ ᓯᑎᔪᑦ ᓄᓇᒥᙵᖅᓯᒪᔪᑦ, ᐊᐅᓚᐅᖅᓱᑎᒃ ᓄᓇᐅᑉ ᐃᓗᐊᓂ ᖁᒻᒧᒃᑐᕖᓂᑦ. ᐊᓕᒨᔭᖅᑲᖅᑐᑦ ᐃᓗᐊᓂ ᐅᔭᕋᐃᑦ. Lamôökwe nîît'i/ring rock tube Tthe beyé diamond hûlî sí
Kimberlite pipe	A more or less vertical, cylindrical ore body of kimberlite that resulted from the forcing of the kimberlite material to the Earth's surface. ᐊᓕᒨᔭᖅᑲᕐᓂᙱᑦ ᐅᔭᕋᐃᑦ ᓄᓇᐅᑉ ᐃᓗᐊᓅᓐᓂᙱᑦ ᑕᒪᕐᒥᒃ: ᖁᒻᒧᙵᔪᖅ, ᓱᑦᑐᓕᐆᔭᖅᑐᖅ ᐊᓕᒨᔭᖅᑲᖅᑐᖅ ᐅᔭᖅᑲ, ᐊᔭᒃᑕᐅᓯᒪᓂᑰᓐᓂᑦ ᓄᓇᐅᑉ ᐃᓗᐊᓂᒃ ᓯᓚᑳᓄᑦ. Sômbakweè nîît'i/tube of money Tthe (beyé diamond hûli sí) dzérît'i
Lake sediment	Sediment that settles to the bottom of lakes and which is removed from drained lake bottoms prior to mining underlying kimberlite pipes. Tahiop nunaa emmap attaanit: Emaiyaghimayot taheet nunaa emmap attaanit boalgihaktautinago nunap eloanit pihimayok poyogvikot. Kahaghimayok atoktaoyaangan EKATI Diamond Maitkonin. ᑕᓯᐅᑉ ᓯᐅᖃᙵ ᓇᑎᖓ: ᓯᐅᖃᙱᑦ ᑕᓯᐅᑉ ᓇᑎᙵᓂᑦᑐᖅ, ᐄᔭᖅᐸᓪᓕᐊᖅᑲᑦᑕᖅᑐᖅ ᐃᒪᐃᔭᖅᑕᐅᓯᒪᔪᓂ ᑕᓰᑦ ᓇᑎᐊᓂ, ᐄᔭᖅᑕᐅᓚᐅᙱᓐᓂᙱᓐᓂ ᐊᑖᓂᑦᑐᑦ ᐊᓕᒨᔭᖅᑲᖅᑐᑦ ᐅᔭᕋᐃᑦ. Ti tå'a Ehtå'ètì: Ti whetô gots'ô ti hagehka tå'akô dè ti tå'a gots'ô ehtå'è eyits'ô ehtå'ètì t'à, Ekati Diamond Mine ndè goka sinagele ha wek'èhodi hôt'e. Tu tå'ághe ts'î æasí hílchu dé beyaghe sátsán kodh yé ts'î kimberlite nádedh xa náltsi. Æeyÿr ts'î Ekátí tsamba k'e bet'aát'î
Lake dewatering	*The draining or removal of water from lakes. Emaiyaiyok: Eemaiyaiyok tahikmiklooneen katangmitlooneen pupeonmon emaalo kovipkaghogo. ᐃᒪᐃᔭᖅᑕᐅᓂᙱᑦ ᑕᓯᑦ: ᐃᒪᐃᔭᖅᑕᐅᓂᙱᑦ ᑕᓰᑦ. Ti hàts'eèzô: Tåeht'o t'à ti whehtô île siì whìle ats'eh'î. Tu æarêdíl: T'ók'e tu sí hílchu, pump t'á to, sát'u xádíl.
Land use permit	A permit given to a proponent by regulatory agencies to allow a specific project using the land to take place. The permit outlines what specific activities can and cannot take place. ᓄᓇᒥᒃ ᐊᑐᕋᓐᓇᕐᓂᕐᒧᑦ ᐱᔭᓐᓇᐅᑎ: ᐱᔭᓐᓇᐅᑎ ᑐᓂᔭᐅᔭᖅ ᐊᑐᕈᒪᔪᒧᑦ/ᓴᓇᔭᒪᔪᒧᓪᓗ ᑲᒻᐸᓂᐅᔪᒧᑦ, ᐊᔭᙱᓐᓂᐊᕐᒪᑕ ᓴᓇᔭᓐᓇᕐᓂᖅ ᓄᓇᒥ. ᐱᔭᓐᓇᐅᑎᑦ ᓇᓗᓇᐃᖅᓯᓯᒪᕗᑦ ᖃᓄᐃᑦᑐᓂᒃ ᐱᓕᕆᔭᓐᓇᕐᒪᖔᑕ ᖃᓄᐃᑦᑐᓂᓪᓗ ᐱᓕᕆᔭᓐᓈᙱᓐᒪᖔᑕ.

Term	Description
	Ndè wet'àhòt'î gha nîhtå'è Ní xa æerehtå'ís
Landfarm	*Comprises the lined and engineered facility that is designed to contained and treat, using bioremediation, hydrocarbon contaminated sediments and soil with an average diameter of less than 4 cm. ᓱᕈᖅᓯᒪᔪᑦ ᓯᐅᕋᐃᑦ ᐅᔭᕋᕐᓛᓪᓗ ᓴᓗᒻᒪᖅᓴᖅᑕᐅᕕᖓ: ᐃᑳᑎᒥ ᐊᑐᖅᑕᐅᓲᑦ ᓴᓗᒻᒪᖅᓴᖅᑕᐅᓂᖏᓐᓄᑦ ᐅᖅᓱᐊᓗᓕᐃᓐᓇᕈᖅᓯᒪᔪᑦ ᓯᐅᕋᐃᑦ ᐊᒻᒪᓗ ᒥᑭᓐᓂᖅᓴᐃᑦ ᐅᔭᕋᐃᑦ (ᓱᕐᓗ ᓯᖃᓕᖅᑎᑕᐅᓯᒪᔪᑦ ᐅᔭᕋᐃᑦ ᓯᑎᔪᑦ ᓯᐅᕋᐃᓪᓗ, ᐊᖏᓂᕐᒃᖅᑐᑦ ᐊᑖᓂ 4 cm ᓂᐳᑎᓂᒃᑯᑦ). ᓯᐅᕋᐃᑦ ᓴᓗᒻᒪᖅᓴᖅᑕᐅᕐᑲᑕᑦ ᓴᕿᔭᖅᑎᑕᐅᓪᓗᑎᒃ ᓯᓚᒧᑦ, ᓯᕿᓂᕐᒧᑦ, ᐊᒻᒪᓗ ᐊᑐᖅᑕᐅᒃᑲᓐᓂᕈᒫᖅᓱᑎᒃ ᓴᓗᒻᒪᖅᓴᐅᑎᒃᓴᓄᑦ, ᓯᐅᕋᐃᑦ ᓇᒻᒪᖕᓂᖅᐸᑕ ᐱᐅᔪᔭᕆᐊᕐᑲᕐᓂᖏᓐᓂᒃ. ᐃᑳᑎ ᓴᓗᒻᒪᖅᓴᐃᕕᒃ ᓯᐅᖃᕐᓂᒃ ᓂᒋᐊᓅᓪᑐᖅ Panda/Koala/Beartooth-ᑯᑦ ᐊᒃᑕᑯᐃᑦ ᐅᔭᕋᐃᑦ ᑐᖅᑯᖅᑕᐅᓯᒪᕕᖓᓂ. Naèdiåî åaìtå'i k'è xè senàæî/area where soil is reclaimed Ni k'e naídí såine nitå'ir senalye
Landfill	A waste management facility at which waste is disposed by placing it on or in land in a manner that minimizes adverse human health and environmental effects. ᐊᒃᑕᑯᖃᕐᕖᑦ: ᐊᒃᑕᕐᕖᑦ ᐊᒃᑕᑯᓂᒃ ᓄᓇᒥ, ᓱᕈᓗᐊᖅᑕᐃᓪᓕᒪᓪᓗᑎᒃ ᐃᓄᐃᑦ ᖃᓄᐃᓂᖏᓄᑦ ᐊᕙᑎᒧᓪᓗ. Asìi åaìtå'i k'è/dumping area Æasíe ch'ÿl æãådél k'e
Leaching	Chemicals being 'washed' out of the rock by rain and water. ᐃᖅᑭᖅᓯᒪᓂᖅ/ᓴᓗᒻᒪᖅᓯᒪᓂᖅ: ᓱᕈᕐᓇᖅᑐᓂᒃ ᐃᖅᑭᖅᑕᐅᓯᒪᔪᑦ ᓴᓗᒻᒪᖅᑕᐅᓯᒪᔪᑦ ᐅᔭᕋᖕᒥ ᒪᕐᑯᖕᒧᑦᐃᒪᕐᒧᓪᓗ. Chô t'à kwe wenaèdi hàewì/rain washing out chemicals Tthe k'aszñ châ tûç nîlî
Legume	A member of the legume or pulse family, Leguminosae. One of the most important and widely distributed plant families with the ability to fix nitrogen from the air to the benefit of associated plants. Includes species such as clovers, alfalfas, lespedezas and vetches. Legume: Naotiak atoktaoloaghimayok ahinonlo toniyaobloni emaa nitrogen aningnimit ehoaghityotigiblugit aadlanot naotianot. ᐱᕈᖅᑐᖅ ᐱᕈᖅᑐᓄᑦ ᓂᕿᓕᐅᓲᖅ: ᐱᕈᖅᑐᑦ ᐊᑐᖅᑕᐅᓲᑦ ᐅᒻᒪᒃᑲᓂᕈᑕᐅᕗᓇᕐᓂᖏᓐᓄᑦ ᐊᓯᖏᓐᓄᑦ ᐱᕈᖅᑐᓄᑦ, ᐱᕈᕝᐅᒃᑲᓂᕈᓇᖅᓯᓲᖑᒪᑕ. Ît'ö ndè ts'ö nîwà le dehshe: Ît'ö îåè kàæa Leguminosae weyeh siì, ndè ts'ö nîwà le dehshe t'à, ît'ö åadî dehshe ha wenàèdi åadî at'î hôt'e, eyits'ô ît'ö hazô dehshe ha siì wet'àæa hôt'e. Niuneshe: Niuneshe æáts'edi. Æeyíle níuneshe hozû neshe xa níåtsi lat'e t'á yet'óreåthír. Thát'ín k'íz- clovers-u, alfalfa-u, lespedezas-u, vetches-u dólye æat'e.
Lichen	Any plant organism composed of a fungus and an alga in symbiotic association, usually of green, grey, or yellow tint and growing on and colouring rocks, tree trunks, roofs, walls, etc. Naohimayok oyakat kaangani: Naotiak naohimayok tunguyaaktumiklooneen maglungayuklooneen, kugeektaklooneen kalablugit oyakat napaaktotlooneen. ᑎᖏᐅᔭᐃᑦ: ᐱᕈᖅᑐᑦ ᐅᔭᕋᖕᓂ ᑎᖏᐅᔭᐃᑦ Adzîî: Adzîî dehshe siil wehda ît'ö, dehba haànile del dekwo siì, kwè, ts'l eyits'ô ndè k'è dehshe hôt'e. Ttthe tsï: Æeåk'éch'a æát'ñ: déhtå'es-u, delba-u, delthogh-u tthe k'e-u, dechÿn k'e-u, nók'e yatthí t'áah k'e tth'i neshe.

Term	Description
Life of Mine Plan (LOM)	The plan for development of the proposed mine expansion, including the sequencing of the development. Oyagagheogveop Hivomoogotighaa: Hivomoogotighaa oyagagheogveop angigliyaangani maligaghaitlo ehumaleogot. ᐃᖏᕐᓂᐊᕐᓂᖓ ᐅᔭᕋᖕᓂᐊᕐᕕᐅᑉ ᐸᕐᓇᐅᑎᑦ: ᖃᖓᒃᑯᑦ ᓇᓗᓇᐃᔭᐅᑎᑦ ᐅᔭᕋᖕᓂᐊᕐᕕᐅᓂᐊᖅᑐᓂᒃ ᓱᐸᓗ ᐃᓚᖃᕐᓗᑎᒃ ᐅᔭᕋᖕᓂᐊᕐᕕᑦ ᐊᖏᒡᓕᒋᐊᖅᑕᐅᓂᖏᓐᓂ ᐅᕙᓗᓃᑦ ᓄᑖᓂᒃ ᓴᓇᔭᐅᓂᐊᖅᑐᓂ. Edàwa ts'ö sômbak'è weghàlada ha/how long the mine is in operation Tsamba k'é t'aníltha beghálada xa sí
Limnology	The study of fresh water lakes, including biological, geological, physical and chemical aspects. ᑕᕆᐅᙱᖏᑦᑐᒥ ᐃᒪᕐᓂᒃ ᐃᒪᕐᒥᐅᑕᓂᒡᓗ ᖃᐅᔨᓴᐃᓂᖅ: ᖃᐅᔨᓴᖅᑕᐅᓂᖏᑦ ᑕᕆᐅᖏᑦᑐᑦ ᐃᒪᐃᑦ ᑕᓯᕐᓂ, ᐃᓚᒋᑦᑐᒋᑦᑐ ᐅᒪᔪᐃᑦ, ᐱᕈᖅᑐᑦ, ᐅᔭᕋᐃᑦ, ᐊᒻᒪᓗ ᐃᓗᓕᖏᑦ. Ti eyits'ô asìi teè naàde wenàgeta/study of water and underwater animals Harelyû æasíe tu yé dána bek'oneta
Littoral	Region of a lake from the highest water level to the depth at which photosynthesis ceases, usually within the top 10 m. Hinaa ulipkaangneoplo emaiktinegoplo akonnga: Emmap hinaa ulipkaangnigoplo emaiktinegop akonngani 10 meetamot kaanganit tikimayok. ᐱᕈᕐᕕᐅᔪᓐᓇᖅᑐᑦ ᐃᒪᐃᑦ ᐃᑎᓂᖓ ᓇᑎᖅ ᖃᐅᒻᒪᒃᐸᖕᒪᑦ: ᐃᒥᖓ ᑕᓯᐅᑉ ᐳᖅᑐᓂᖅᐹᖑᓂᖓᓂᒃ ᐃᑎᓂᖓᓄᑦ ᑎᑭᑦᑐᒍ, ᖃᐅᒪᕐᑲᕈᓃᕐᕕᐅᔪᒍᑦ, ᐃᓗᐊᓂ ᐊᖏᓂᓕᒃ 10 ᒦᑕᐅᓚᒃᑐᒥᒃ Tamba teè sade t'à asìi dehshe-le/no growth underwater by light Tâbãghe te yé t'õõt'i æñdîle
Processed kimberlite containment areas (PKCA)	*The processed kimberlite containment areas and the associated engineering structures that are designed to contain processed kimberlite and that are regulated through the water licence. Phase 1 and Long Lake are the two processed kimberlite containment areas at EKATI. ᓴᓇᔭᐅᓯᒫᓂᒃᑐᑦ ᐊᓪᓘᔭᖅᑐᑦ ᐅᔭᕋᐃᑦ ᐃᓪᓗᖃᖅᑕᐅᕝᕕᖏᑦ: ᓴᓇᔭᐅᓯᒪᔪᑦ ᐊᓪᓘᔭᖅᑐᑦ ᐅᔭᕋᐃᑦ ᐸᐸᑕᐅᓯᑦ ᑖᕙᓂ ᐊᒻᒪᓗ ᑐᕐᖁᓯᓯᒪᕕᐅᓪᓗᑎᒃ ᓯᖃᓖᑎᖅᑕᐅᓯᒫᓂᒃᑐᓂᒃ ᐊᓪᓘᔭᖅᑲᐅᔪᓂᒃ ᐅᔭᕋᖕᓂᒃ, ᐊᒻᒪᓗ ᓚᐃᓴᓐᓯᖅᓯᑎᒃ ᐊᐅᓚᑕᐅᕙᒃᑐᑦ. Phase 1 ᐊᒻᒪᓗ ᑖᖅ ᓚᒃᒥ ᑕᓯᕐᒥ Long Lake-ᒥ ᒪᕿᖕᓂᒃ ᐱᑕᖃᖅᑐᑦ ᐊᓪᓘᔭᖅᑳᖕᓂᒃ ᓯᖃᓖᑎᖅᓯᒪᔪᓂᒃ ᐃᑳᑎᒥ. Edî sômbakwe k'èhòdi k'è/where kimberlite is contained Tthe beyé diamond hílchu tå'ãghe æâdil k'e
Macro-invertebrate	Invertebrates which are visible to the naked eye. The term macro-invertebrate is generally used to refer to stream and lake benthos. ᓴᐅᓂᖃᙱᑦᑐᑦ ᑕᑯᔅᓴᐅᔾᔪᑦ ᖁᐸᕐᕈᐃᑦ: ᓴᐅᓂᖃᙱᑦᑐᑦ ᑕᑯᔅᓴᐅᔪᑦ ᑕᑐᐃᓐᓇᕐᓗᒋᑦ. ᓴᐅᓂᖃᙱᑦᑐᑦ ᖁᐱᕈᐃᑦ ᐅᖃᐅᓯᐅᓚᐅᔪᑦ ᑕᓯᕐᓂ ᐊᒻᒪᓗ ᑰᓪᓚᖕᓂ. Tehtsà wenôkw'ô gohåî-le wegaàht'î Te yé guæaze dána búret'î
Meromictic	A condition in which a lake doesn't mix completely, and contains permanently stratified layers. The boundaries in a meromictic lake separate an upper layer from a deeper and denser layer or layers. Stratification can be caused by thermal (temperature) and/or density differences (e.g., salinity). Tahik avoloanginami kaligeetektuk ataani: Kaligeektektok tahiop ataani. Kiglingit tahikmi avitpaktaa ataanit oyagak etinitkiangani oonakningmit neglaomanikmitlooneet avitpaktot nunalooneen oyagaklooneen emmap ataanit.

Term	Description
	ᑕᓯᐅᑉ ᐃᒪᖕᒐ ᕿᑲᐃᓇᖅᑐᖅ ᐃᓗᐊᓂ (ᐊᑯᖃᑦᑕᕐᕆᑦᑐᖅ): ᑕᓯᐅᑉ ᐃᒪᖕᒐ ᕿᑲᐃᓇᓲᖅ ᐊᑯᖃᑦᑕᕐᕆᑦᑐᖅ, ᐳᖅᑐᓕᕆᓐᖏᖃᖅᑐᖅ. ᐃᑎᖏᕐᖓᓂ ᐊᒻᒪᓗ ᐃᔾᔪᑎᕐᖓᓂᒃ, ᐳᖅᑐᓕᖏᕐᖓᓂᓗ. ᐊᑯᑦᑐᓐᓇᖃᑦᑕᖅᐳᑦᑕ ᐆᓇᕐᓂᖏᑦ ᐊᓯᔾᔨᕚᖕᒐᑕ ᐊᒻᒪᓗ/ᐅᕙᔫᓐᓃᑦ ᐃᔾᔪᓂᖏᑦ ᐃᒪᐃᑦ ᐊᓯᔾᔨᕚᖕᒐᑕ. Ti åek'e whehtô åadî at'î-le/layer of water don't change Tu t’a tthe æeåk’énítå’ir: -Tu æeåk’e dãåkâ sí æeåta t’íle Nok’e tu æeåtarçlile t’á tthe æeåk’e nítå’ir. Nok’e hadhelé-u, t’exâ dedhay tu ta t’î t’á to.
Metasediments	Metasediments is a geology term, and includes biotite schist. Metasediments are found in the Misery pit and are expected in the future Pigeon pit. They contain low levels of fine grained pyrite or pyrrhotite (mostly < 0.5%) and contains negligible carbonate. Metasediments are known to be potentially acid generating (PAG) under laboratory conditions but have never generated acid rock drainage (ARD) under field conditions. ᓱᐅᕋᕗᓃᑦ ᐅᔭᕋᖕᖑᖅᓯᒪᔪᑦ: ᓱᐅᕋᕗᓃᑦ ᐅᔭᕋᖕᖑᖅᓯᒪᔪᑦ, ᐅᔭᕋᕗᓂᑐᖃᐅᕐᕆᑦᑐᑦ ᐊᓯᖕᖑᖅᓯᒪᔪᑦ. Ehtå'è kwe ehåè/sands that turn into rock Tthay æeåk’edatå’ír ts’îæ‡né tthe neåé
Meteorology	The study and measurement of the weather. ᓯᓚᓕᕆᓂᖅ: ᖃᐅᔨᓴᐃᓂᖅ ᐆᒃᑐᕋᐃᓂᖅ ᓯᓚᒥᒃ. Môht'a edàgôht'e wedànàgeta/studying the weather outside Bñt’as hadhÿl/hak’ath húldzáy
Migration	The regular seasonal movements of birds and animals to and from different areas. ᑐᒃᑐᐃᑦ ᐆᒪᔪᐃᑦᑐ ᐊᐅᓚᓐᓂᕐᕆᑦ: ᐊᕿᒍᑕᒫᖅ ᓅᑉᐸᓪᓚᐊᓂᕐᕆᑦ ᑎᕐᒥᐊᑦ ᐆᒪᔪᐃᑦᑐ ᑎᑭᓐᓂᕐᕆᑦ ᐊᒻᒪᓗ ᐊᐅᓪᓛᕐᓂᕐᕆᑦ ᐊᓯᕐᕆᓐᓄᑦ ᓄᓇᓄᑦ. ᕿᓂᕐᓂᕐᕆᓐᓂ ᓂᕿᓂᒃ ᓄᓕᐊᕕᕐᓂᓗ. Tich'adi nàede k'è/the animals trail Tech’adíe t’óót’i nodal sí
Mine component	A physical area of the mine site treated as an independent unit for reclamation planning and application of reclamation objectives and closure criteria. ᐅᔭᕋᕐᓂᐊᕐᕕᕐᓄᑦ ᐃᓚᒌᔭᐅᔪᑦ: ᖃᓄᐃᓕᕐᒐᓂᕐᕆᑦ ᐅᔭᕋᕐᓂᐊᕐᕕᕐᓂ ᐱᓕᕆᕝᕕᑦ ᐃᕐᒥᒃᑯᑦ ᐊᕝᕕᒃᑐᖅᓯᒪᓪᓗᑎᒃ, ᓴᓗᒻᒪᖅᓴᐅᓂᐊᖅᑐᓄᑦ, ᐸᕐᓇᒃᑕᐅᔪᓄᑦ ᐊᒻᒪᓗ ᐊᑐᖅᑕᐅᓂᕐᖓᓄᑦ ᓴᓗᒻᒪᖅᓴᖅᑕᐅᓂᐊᖅᑐᑦ ᐊᒻᒪᓗ ᒪᑐᔭᐅᓂᐊᖅᑐᓄᑦ ᐱᑕᖃᑎᐊᓖᑦ. Edàanì sômbak'è wedàetî ha/how they will close the mine Tsamba k’é k’éyághe æasíe dõli sí
Minesite	The area of land that is owned, accessed or leased, under recognized mineral licences, for the purpose of mineral extraction, on-site processing, waste treatment and storage. ᐅᔭᕋᕐᓂᐊᕐᕕᐅᔪᖅ: ᓄᓇᐃᑦ ᓇᖕᒥᓂᕆᔭᐅᔪᑦ, ᐊᑐᖅᑕᐅᔪᑦ, ᐊᑐᖅᑐᐊᖅᑕᐅᔪᓐᓂᑦ, ᐃᓕᑕᕆᔭᐅᓯᒪᓪᓗᑎᒃ ᐊᑐᕈᓐᓇᕐᓂᕐᒍᑦ ᐅᔭᕋᒃᓯᐅᕈᓐᓇᕐᓂᕐᒍᑦ ᓚᐃᓴᓐᓯᒃᑯᑦ, ᐅᔭᕋᓐᓂᒃ ᐱᔭᐃᕕᐅᓂᐊᕐᒪᑦ, ᐊᒨᖃᐃᕕᐅᓂᐊᕐᒪᑦ, ᑕᕝᕙᓂ ᓴᓇᔭᐅᓂᐊᕐᒪᑕ, ᐊᒃᑕᕐᕕᖃᕐᓂᐊᕐᒪᑕ ᐊᒻᒪᓗ ᑐᖅᑯᐃᕕᖃᕐᓂᐊᕐᒪᑕ. Sômbak'è/minesite Tsamba k’e n‡né
Mine water	*Includes runoff from facilities associated with the Project (EKATI Diamond Mine operation) and all water or waste pumped or fowing out of any open pit or underground mine. Emak oyagagheovingmin atoktok: Oyaghagheovingmin emap atoktaovaktok pupighimayok emaalooneen maghaktok havagvingmitlooneen aghalootit agyagveanin. ᐅᔭᕋᕐᓂᐊᕐᕕᖕᓂ ᐃᒻᒪᒃᐸᓚᐊᓂᕐᕆᑦ ᓇᑎᐊᓂ: ᐃᒪᖅ ᐊᑐᖅᑕᐅᕙᒃᑐᖅ ᐅᔭᕋᕐᓂᐊᕐᕕᖕᓂ ᐃᒥᖅᑕᖅᑕᐅᓪᓗᓂ ᐳᓪᓚᓕᕐᒍᑦ ᐅᕙᔫᓐᓃᑦ ᑯᑐᒃᐸᓪᓚᐊᕙᒃᑐᖅ ᐃᒻᒪᒃᐸᓪᓚᐊᕐᖓᓇᕐᓂᕐᒐᓄᑦ ᐊᕐᒪᔪᓚᐊᕐᖑᓯᒪᔪᖅ.

Term	Description
	Sômbak'è ts'ô ti ch'ì: Ndè gotì, sômbak'è ti t'à eghàlageda eyits'ô sômbak'è gomô ti k'ètå'ò siì Mine Water Sômbak'è ts'ô ti ch'ì gihdi hôt'e. Tsamba k'‡ tûç hílchu: Ní ts'i-u, tsamba k'é t'a tu hílchu-u, ní-û t'a æeghálada ts'î tu æats'edi.
Mitigation	An activity aimed at avoiding, controlling or reducing the severity of adverse physical, biological and/or socioeconomic impacts of a project activity. Havaak piniangitoklooneen ayoghangnaiyaiyoklooneen ekhinaiyaiyoklooneen: Havaak aghongnaiyaiyoklooneen mighilaangeoklooneen ehoiyagaangat havagvingmi nunamiklooneen. ᓱᕈᓗᐊᖅᑕᐃᓚᒪᑎᑦᑎᓂᖅ: ᐱᓕᕆᐊᖑᔪᑦ ᓱᕈᓗᐊᖅᑕᐃᓚᒪᑎᑦᑎᓂᕐᒧᑦ, ᓱᕋᖅᑕᐃᓚᒪᔾᔪᑏᑦ, ᐱᐅᔪᓃᖅᑎᑦᑎᑕᐃᓚᒪᔾᔪᑏᑦ, ᓱᕈᐃᑎᑦᑎᑕᐃᓚᒪᓂᕐᒧᑦ, ᐊᒃᑐᖅᑕᐅᔪᓐᓇᕐᓂᖏᓐᓂ ᑎᒥᒃᑯᑦ, ᐆᒪᔪᐃᑦᑐ, ᐊᒻᒪᓗ ᐃᓅᓯᕐᒧᑦ ᐱᓕᕆᔪᖃᖅᑎᑦᑐᒍ ᐅᔭᕋᖕᓂᐊᕐᕕᖕᒥ. Åadî wexèidi ha wehoidi: Laà t'à ndè k'è t'asi hazô eda siì wexèidi ha wehoidi. Æedû æane ch'a badi
Model	A physical or numerical tool which uses concept information to explain or describe a complex phenomenon. ᑎᑎᕋᐅᔭᕈᑎ ᓴᓇᕐᕈᑎᓗᓐᓂᑦ ᐃᓯᐊᒐᒃᓴᖅ: ᑎᑎᕋᐅᔭᕈᑎ ᐅᕙᓘᓐᓂᑦ ᓴᓇᕐᕈᑎᑦ ᐆᒃᑕᕋᕈᑎᐅᓪᓗᑎᒃ ᖃᓄᐃᓕᖓᓂᐊᕐᒪᖔᑕ ᓴᓇᔭᐅᓂᐊᖅᑐᑦ ᓴᓇᓯᒪᓂᕆᓂᐊᖅᑕᖏᓪᓗ ᐃᓯᐊᖅᑕᐅᔪᒃᓴᐃᑦ, ᑐᑭᓯᐅᕆᓪᓕᕈᑎᒃᓴᐃᑦ ᐅᓂᒃᑲᕈᑕᐅᓪᓗᑎᒃ ᐱᔭᕆᐊᑐᔪᓂᒃ ᐱᖑᖅᑎᑕᐅᔪᓐᓇᖅᑐᓂᒃ Wexeèt'e/the same as Bêåt'e
Monitoring	Watching and keeping track of changes that are happening on the land (animals, environment). ᖃᐅᔨᓴᕈᑏᑦ: ᖃᐅᔨᓴᕈᑏᑦ ᐊᒻᒪᓗ ᖃᐅᔨᓴᖅᐸᓪᓕᐊᖑᓐᓇᕐᓂᖅ ᐊᓯᔾᔨᖅᐸᓪᓕᐊᔪᓂᒃ ᓄᓇᒥ (ᐆᒪᔪᐃᑦᑐ, ᐊᕙᑎᖓᓗ). Wexòedi/monitoring Ni k'e nádhÿr badi
Natural colonization	The process of revegetation of a disturbed area by naturally dispersing seeds, spores or vegetative propagules from local plant populations. Naotingnik naotianik naolailgomi: Nuna naotianik naolaikmat havaktaobloni naotiligiangani naotiaghat nunap naohimayainit. ᐱᕈᕐᕕᐅᒃᑲᓪᓚᖅᑐᑦ ᐃᖕᒥᓃᓐᓇᖅ: ᐱᕈᕐᕕᐅᒃᑲᓪᓚᖅᑐᑦ, ᐱᕈᕐᕕᐅᔪᓐᓃᓚᐅᖅᑐᒥ, ᐃᖕᒥᓃᓐᓇᖅ ᑕᐃᒪᐃᓪᓗᑎᒃ, ᐱᕈᖅᓯᐊᑦ, ᐱᕈᖅᓯᐊᒃᓴᐃᑦᑐ ᐱᕈᖅᑐᑦᑐ ᐱᕈᒃᑲᓂᑐᐃᓐᓇᖅᑲᑦᑕᖅᑐᑦ ᓄᓇᓕᖕᓂ ᐱᕈᖅᑲᑦᑕᖅᑐᑐᖅᑲᐅᕙᒥᒃ. Ndè kah ît'ô nadehshe: Ndè naehdô k'è weît'ö ndè k'è nats'ehshe ats'ehæî Ni naåenelye
Nutrient	Any substance that provides essential nourishment for the maintenance of life. Inuuningmot nekit: Nekighak inuujutauyuk inungnunlo, naotianutlo hogayanotlo. ᐆᒪᔾᔪᑏᑦ/ᐱᕈᕈᑏᑦ ᐃᓅᔾᔪᑏᑦ ᓂᕿᒃᓴᐃᑦ: ᖃᓄᐃᑐᑐᐃᓇᐃᑦ ᓱᓇᑐᐃᓐᓇᐃᑦ ᐱᑕᖅᑲᕈᑎᒃ ᐆᒪᔾᔪᑕᐅᖅᑲᑦᑕᖅᑐᑦ ᐱᕈᕈᑕᐅᖅᑲᑦᑕᖅᑐᑦ. Wet'à asìi eda/you need it to live Tlena xa bét'óreæa: Æasí hena xa yet'óreåæa sí.

Term	Description
Oligotrophic	Nutrient-deficient waters with low primary productivity. The vast majority of Arctic lakes in the EKATI area are oligotrophic. ᐱᑭᑐᕐᑲᕈᓐᓇᑦᑎᐊᖏᑦᑐᑦ / ᐆᒪᔪᕐᑲᕐᕕᐅᑦᑎᐊᖏᑦᑐᑦ ᑕᓰᑦ: ᐱᑭᖅᑐᕐᑲᕈᓐᓇᑦᑎᐊᖏᑦᑐᑦ ᐆᒪᕕᐅᓗᐊᕈᓐᓇᖏᑦᑐᑦ ᐃᕐᑲᓗᕐᑲᑦᑎᐊᖏᑦᑐᓗ. ᐊᒥᓱᒻᒪᕇᑦ ᐅᑭᐅᖅᑕᖅᑐᒥ ᑕᓰᑦ ᐃᑳᑎᒥ ᐱᑭᖅᑐᕐᑲᕈᓐᓇᑦᑎᐊᖏᑦᑐᑦ ᐆᒪᔪᕐᑲᑦᑎᐊᕈᓐᓇᕐᑎᒃᓗ. Ti yìì tå'oh lô gohåî-le/not enough plants/food in the water Tu beyé æasíe hena xa húrenile.
Open pit mine	A mine where excavation happens on the surface. ᒪᑐᐃᖓᔪᖅ ᓯᓚᒥ ᐅᔭᕋᖕᓂᐊᕐᕕᒃ ᓄᓇᒥ ᒥᒃ ᑕᑯᒃᓴᐅᔪᑦ: ᐅᔭᕋᖕᓂᐊᕐᕕᒃ ᐅᔭᕋᖕᓂᐊᕐᕕᐅᔪᖅ ᓄᓇᐅᑉ ᕐᑲᖓᓃᑦᑐᖅ Ndè yììgôöæa/hole in the land Ni yéúniæa
Organic matter	The organic fraction of the soil that includes plant and animal residues at various stages of decomposition, cells and tissues of soil organisms, and substances synthesized by the soil population. Kopilgot takonaitot kihiani eekot: Nunami naotiatlo hogayatlo eghinagait nungoligaangat honavaloitlo kopilgotot itot havakpagait nunami. ᐱᕈᖅᑐᕕᓃᑦ ᐆᒪᔪᕕᓂᑦᓗ ᐆᒪᔫᓃᖅᑐᑦ ᓂᕿᒃᓴᐃᑦ: ᐱᕈᖅᑐᕕᓂᑦ/ᐆᒪᔪᕕᓃᑦ ᓄᓇᒥᓕᖅᑐᑦ ᐆᒪᔫᓃᖅᑐᑦ ᓰᕈᖅᓯᒪᓕᖅᑐᑦ, ᐊᒻᒪᓗ ᓂᕿᒃᓴᐅᓕᕈᓐᓇᖅᑐᑦ, ᐊᒻᒪᓗ ᓄᓇᒧᑦ ᐱᕈᕈᑕᐅᔫᓐᓇᑦᑐᑦ. Wet'à ehshe/it helps to grow Huneshe Ts'éní: Æasí nezû neshe xa t'ãchay dhay to, te ch'áduyé ts'î bet'auneshe xa bet'a àt'î.
Overburden material	Layers of soil, till, lake sediments covering an ore body which are removed prior to surface mining. ᐱᕈᖅᑐᑦ, ᓇᖄᖅᑐᐃᑦ, ᓄᓇᐃᑦ, ᐅᔭᕋᐃᑦ, ᓯᐅᕋᐃᑦᑐᓐᓃᑦ ᓄᓇᐅᑉ ᕐᑲᖓᓃᑦᑐᑦ, ᐊᓕᔫᔭᕐᑲᖅᓯᑎᒃ ᐊᑖᓂ ᐃᑐᐊᓂ: ᓄᓇᐃᑦ, ᓯᐅᕋᐃᑦ, ᓱᓇᑐᐃᓐᓇᐃᑦᑐ ᓄᓇᒥᑦᑐᑦ (ᐱᕈᖅᑐᑦ ᓇᖄᖅᑐᐃᑦᑐ) ᕐᑲᖓᓂᑦᑐᑦ ᐊᓕᔫᔭᓖᑦ ᕐᑲᓕᓇᓕᖅᓯᒪᔪᑦ ᓄᓇᒥ, ᐲᔭᖅᑕᐅᓚᐅᖏᓐᓂᖏᓐᓂ ᓄᐃᓂᐊᕐᒪᑕ ᐅᔭᕋᖕᓂᐊᖅᑕᐅᔪᒪᔪᑦ ᓄᓇᒥᑦᑐᑦ. Sômbakwe kah ndè whetå'ì/land on top of kimberlite pipe Tthe dághe ní neåe
Panda Diversion Channel (PDC)	A 3.4 km artificial stream that connects the northern basin of Upper Panda Lake to Kodiak Lake to facilitate drainage flow, fish passage, and enhance fish habitat. Completed in 1997, this channel provides compensation for fish habitat lost as a result of mine development. ᐹᓐᑕᒥ Panda-ᒥ ᐅᔭᕋᖕᓂᐊᕐᕕᖕᒥ ᓴᙳᑎᕝ ᐊᖅᑯᑎᖓ ᐃᒪᕐᓄᑦ ᐃᒪᐃᔭᖅᑕᐅᕙᓪᓕᐊᔪᓄᑦ ᑰᒃ: ᑕᑭᓂᓕᒃ 3.4 ᑭᓛᒥᑐᒥᒃ ᑰᓕᐊᙳᓯᒪᔪᖅ ᓴᓇᔨᓄᑦ, ᑎᑭᐅᒪᓂᐊᖅᑐᒍᑦ ᑲᓇᖕᓇᖓᓂ ᐹᓐᑕᐅᑉ ᑕᓯᐊᓂᒃ, ᑎᑭᓪᓗᒍ Kodiak ᑰᑎᔫᒃᑯᑦ ᑕᓯᕐᒍᑦ, ᐃᒪᖅ ᐃᖏᕐᕋᕝᕙᕐᑲᕐᓂᐊᕐᒪᑦ, ᐃᕐᑲᓗᐃᑦᑐ ᐃᑳᕝᕙᕐᑲᓂᐊᕐᒪᑕ ᑕᓯᕐᓄᑦ, ᐊᒻᒪᓗ ᐊᒥᓯᑭᕐᑯᓪᓗᒋᑦ ᐃᕐᑲᓗᕐᑲᕐᓂᖏᑦ. ᓴᓇᔭᐅᓯᒪᔪᖅ 1997-ᒥ, ᑕᓐᓇ ᑰᓕᐊᙳᓯᒪᔪᖅ ᐃᕐᑲᓗᖕᓂᒃ ᐱᑭᖅᑎᑦᑎᕝᕕᐅᒃᑲᓐᓂᕋᓯᐊᖅᑐᖅ ᐱᑕᕐᑲᕈᓂᖅᓯᒪᓂᖏᓐᓄᑦ ᐅᔭᕋᖕᓂᐊᕐᕕᒃ ᓴᓇᔭᐅᓯᒪᓂᖓᓄᑦ. Panda gots'ô ti åadî ts'ö haïzô/diverting water from Panda Panda bets'î tu hútå'ir xa destsÿlaze xáli
Parameter	A constant or variable in a mathematical expression that distinguishes various specific situations. ᐊᖏᓂᖓᓂᒃ ᐆᒃᑐᕋᐅᑦ: ᑕᐃᒪᐃᖏᓐᓇᖅᑐᑦ ᐊᖏᓂᖏᑦ ᐆᒃᑐᕋᐅᑦ, ᓈᓴᖅᑕᐅᓯᒪᓂᒃᑯᑦ ᐋᕿᒃᓯᒪᔪᖅ, ᓇᓗᓇᐃᒃᑯᑕᐅᓪᓗᓂ ᐊᔾᔨᒌᖏᑦᑐᓂᒃ ᐊᖏᓂᕐᓂᒃ Asìi xiìdzà/something that measures Æasíe húldzáy

Term	Description
Particulates	Small liquid or solid particles in the air like dust pollen, spores, soot smoke or spray. ᓴᓃᑦ (ᐳᔦᕐᓂ, ᐊᓯᖕᖏᓐᓂᓗ): ᒥᑭᑦᑑᑎᒻᒪᕇᑦ ᐃᒪᐃᓗᓐᓃᑦ ᓯᑎᔪᓗᓐᓃᑦ ᓯᓚᒥ ᐊᓂᕐᓂᒦᑦᑐᑦ, ᓱᕐᓗ ᓱᑭᐃᑦ, ᐳᔦᐃᑦ, ᐅᕙᔫᓐᓃᑦ ᒪᖅᑮᑦ ᐊᒻᒪᓗ ᓯᕿᖅᓯᒪᔦᑦ. Asìi daèle/something that floats Tu tsÿl
Parts per million	Concentration of a foreign substance for every million molecules of a naturally occurring liquid. ᐊᖏᓂᖏᑦ ᓴᓂᐊᓂ ᒥᓚᔾᓐᓃᑐᓂ ᐃᓚᖅᑲᖅᑐᓂ: ᐊᖏᓂᖏᑦ/ᐊᒥᓲᓂᖏᑦ ᐃᓚᒋᔭᐅᖏᑦᑐᑦ ᒥᓂᔾᖕᖏᓃᑦᑐᓂ ᐊᕕᒃᑐᖅᓯᒪᔦᓃᑦᑐᑦ, ᐃᒪᕐᓂ ᑯᕕᔪᓂᓗᓐᓃᑦ. Edàanì asìi xèæiìdzà/how things are measured T'at'u æasíe húldzáy
Permafrost	*A layer of soil, sand or bedrock that has been continuously frozen for at least 2 years and as long as ten thousand of years. In the tundra area at EKATI permafrost begins at the bottom of the active layer (approximately 1.5 m) and continues to approximately 400 m. Kikomayok nunap ataani: Nunalooneen oyagaklooneen kikomayok nunap ataani malgoknik ikionik. ᖁᐊᖑᐃᓐᓇᕐᓂᖓᓂ ᓄᓇᐅᑉ ᐃᓗᐊ: ᓄᓇᐃᑦ ᐅᕙᔫᓐᓃᑦ ᐅᔭᕋᖅᑲᕐᓂᐅᔦᑦ ᖁᐊᖑᓪᓗᑎᒃ ᒪᕐᕉᖕᓂᒃ ᐊᕐᕌᒍᓂ, ᐅᖓᑖᓂᓗᓐᓃᑦ. Ndè Ehtô: Ndè haànile dè kwè nàke xo weæô gots'ô wheli sìì ndè ehtô gihdi hôt'e. Tthay náltÿn: Thay to tthe to náke ghay húk'e heåtÿn sí
Permeable rock	A porous rock that allows fluid to seep through. ᐃᒪᖅᑲᖅᑐᑦ ᐅᔭᕋᐃᑦ ᐊᖕᒪᔦᖅᑲᓪᓛᔦᑦ: ᐃᒻᒪᒍᓐᓇᖅᑐᑦ ᐅᔭᕋᐃᑦ ᐃᒪᕐᒧᑦ ᐊᖅᑯᑕᐅᔦᓐᓇᖅᑐᑦ. Kwe weghàewì/seeping through rock Tthe tu beghâlbi
pH	The pH scale is generally presented from 1 (most acidic) to 14 (most alkaline). It measures the hydrogen ion concentration of a substance. ᐆᑕᕐᓇᖅᑐᖅᑲᖅᑎᒋᓂᖓ ᐱᐅᖏᑦᑐᓂᒃ ᓯᐅᕋᕐᒥ: ᐆᑕᕐᓇᖅᑐᖅᑲᖅᑎᒋᓂᖏᑦ ᓇᓗᓇᐃᖅᑕᐅᓯᒪᒐᔦᒃᑐᑦ ᐊᑕᐅᓯᕐᒥᒃ (1-ᒥᒃ ᐆᑕᕐᓇᖅᑐᖅᑲᕐᓂᖅᐹᖑᔪᒥᒃ) 14-ᒧᑦ (ᐃᓚᖅᑲᓪᓚᓐᓇᒃᑐᒥᒃ). ᐆᑑᑕᐅᖅᑲᑦᑕᖅᑐᑦ ᖃᐅᔨᒪᓂᖅ hydrogen ion-ᖅᑎᒋᓂᖏᓐᓂᒃ ᓱᓇᑐᐃᓇᐃᑦ. Ahsï ti eyits'ô ndè nezîlìì gha xìiæihdzà/measuring water and soil to check if it's good. Æasíe begháre tu cho ní chu t'at'e sí xa búldzáy
Physical stability	An area which has no significant wind and water erosion, or hazards. The surface is contoured to meet land capability objectives and there is surface drainage. Engineered structures perform the function for which they were designed. ᒪᑭᑕᔪᓐᓇᕐᓂᖓ ᓄᓇᐅᑉ ᐊᐅᓚᕝᕕᐅᔪᓐᓇᕐᓂᐊᕐᒪᑕ: ᓄᓇᐃᑦ ᐊᓯᔾᔨᕿᑕᓗᐊᕋᔭᖏᑦᑐᑦ ᐊᓄᓈᖏᓐᓂᖓᓄᑦ, ᐅᕙᔫᓐᓃᑦ ᐃᒪᕐᒧᑦ ᓱᑉᐸᓪᓕᐊᓗᐊᖏᑦᑐᖅ. ᖃᖓ ᐋᕿᐅᒪᑦᑎᐊᖅᑐᖅ ᓄᓇᐅᑉ ᐊᑐᖅᑕᐅᔪᓐᓇᕐᓂᖓᓄᑦ, ᐊᒻᒪᓗ ᐃᒪᐃᔭᕝᕕᖅᑦᑎᐊᖅᓱᓂ. ᓴᓇᔭᐅᓯᒪᔦᑦ ᑕᐃᒪᐃᑦᑐᑦ ᐋᕿᐅᒪᑦᑎᐊᖅᑐᑦ ᐊᑐᕈᓐᓇᑦᑎᐊᖅᓱᑎᒃ ᓴᓇᔭᐅᓯᒪᓂᖏᓐᓄᑦ. Ndè nezî nìì/is the land good to travel on Ni t'át'i xa nezu
Pioneer Plant Species	Plants which are the first to colonize a newly created environment Naotiat naolgaaghimayot: Naotiat naolgaaghimayot nunami naoyivighami. ᐱᕈᖅᑳᖅᐸᒃᑐᑦ ᐱᕈᖅᑐᑦ: ᐱᕈᖅᑐᑦ ᓯᕗᓪᓕᐅᓲᑦ ᓄᓇᒥ ᐱᕈᓕᓵᕝᕕᐅᔪᓂ. Akweåö ndè k'e ît'ô dehshe: Ît'ö îåè kàæa dakweåô eyi ndè k'e dehshe.

Term	Description
	T'atthe t'õchay nílye: T'ãchay ní godhé k'e neshe xa suhúlya.
Plant cover	The percentage of substrate in any area that is covered by living plant biomass. Nuna elanga taliteghimayok: Pasannga nuna taliteghimayok naotiat oghoitot itonin. ᐱᕈᖅᑐᖃᖅᑐᐃᓐᓇᐃᑦ ᓄᓇᐃᑦ: ᐱᖁᖅᑐᖃᖅᑐᐃᓐᓂᖅ ᓄᓇ ᐊᒥᓱᓂᒃ. Ndè kah ît'ô dehshe: Ndè kah ît'ö dehshe. T'áchay huneshe: Ní ts'î t'ãchay-u daníshe, súghaurelyã ts'ÿn.
Plug	A watertight seal in a shaft formed by removing the lining and inserting a concrete dam, or by placing a plug of clay over ordinary debris used to fill the shaft up to the location of the plug. ᓯᒥᒃ: ᐃᓐᖓᓇᒃᑯᑎ ᐅᕙᓅᓐᓃᑦ ᐃᑲᓇᒃᑯᑎ ᓯᒥᒃ ᓄᖃᖓᔾᔭᑎ ᓲᕐᓗ ᕿᑯᖕᒥᒃ/ᖁᐊᖅᑎᑕᐅᓯᒪᔪᒥᒡᓗᓐᓃᑦ ᓴᓇᓯᒪᔭᖅ ᓯᒥᒃ, ᐅᕙᓅᓐᓃᑦ ᓱᓗᑯᑕᖕᒥ ᐃᑎᓯᕚᐅᓯᒪᔭᖅ ᓯᒥᒃᑕᐅᓂᐊᕐᒪᑦ ᒪᕿᒃ, ᖄᖓᒍᑦ ᓴᓂᑐᐃᓐᓇᐃᑦ ᑕᑕᑕᐅᓯᒪᔪᑦ ᑎᑭᑦᑐᕆᑦ ᓯᒥᖕᓄᑦ. Wedaèdzè/sealing it Bedâreldze
Porewater	*Water that is contained within rocks or within processed kimberlite. ᐃᒪᐃᑦ ᐅᔭᕋᐃᑦ ᐊᑯᓐᓂᖕᒋᓃᑦᑐᑦ: ᐃᒪᐃᑦ ᐃᓗᐊᓂ ᐅᔭᕋᐃᑦ ᐊᑯᓂᖕᒋᓐᓂ. Ti kwetô whehtå'ì/water between the rocks Tthe gaze tú
Portal	The structure surrounding the immediate entrance to a mine - the mouth of a tunnel. ᐃᑎᕐᕖᒃ/ᐃᓯᕐᕖᒃ: ᐊᕙᓗᐊ ᐃᓯᕐᕖᐅᔪᖅ ᐅᔭᕋᖕᓂᐊᕐᕕᖕᒍᑦ - ᒪᑐᐃᖓᕖᖓ ᐃᑎᕐᓂᐊᕐᓗᓂ ᓄᓇᐅᑉ ᐃᓗᐊᓄᑦ. Weyìigôôæà k'è/at the entrance of the hole Ní yéúniæa k'é
Predator	Any organism that consumes other organisms. ᐆᒪᔪᖅ ᐱᕈᖅᑐᕐᓗᓐᓃᑦ ᓂᕆᓲᖅ ᐅᒪᔪᒥᒃ ᐱᕈᖅᑐᒥᒡᓗᑕᓐᓃᑦ: ᖃᓄᐃᑐᐃᓇᖅ ᐆᒪᔪᖅ ᐱᕈᖅᑐᕐᓗᓐᓃᑦ ᐊᓯᖏᓐᓂᒃ ᐆᒪᔪᖅᑐᓲᖅ ᐱᕈᖅᑐᖅᑐᓲᕐᓗᓐᓃᑦ. Tich'adi eåègedè Tech'âdíe æeåeldél
Pre feasibility	Follows after the conceptual stage. The stage in a mining or reclamation project when a single plan has been demonstrated through a supportive body of knowledge and assessment of alternatives as the best option to go forward. ᓯᕗᓂᐊᒍᑦ ᐊᔪᕐᓇᖕᒋᒻᒪᖕᒪᑦ: ᐊᑐᖅᑕᐅᓲᖅ ᑭᖑᓂᐊᓂ ᐃᓱᒪᒋᔭᐅᕝᑲᓚᐅᖅᑎᑦᑐᒍ ᐱᒋᐊᕋᔭᖅᑐᖅ. ᐅᔭᕋᖕᓂᐊᕐᕕᒃ ᐅᕙᓅᓐᓃᑦ ᓴᓗᒻᒪᖅᓴᖅᑕᐅᓂᐊᓕᖅᑐᖅ ᐊᑕᐅᓯᖅ ᐸᕐᓇᐅᑎᓂ ᑐᑭᓯᔭᐅᓯᒪᓕᖅᑎᑦᑐᒍ ᖃᐅᔨᒪᔭᐅᓂᖓ ᐊᒻᒪᓗ ᖃᐅᔨᓴᖅᑕᐅᓯᒪᓕᖅᑎᑦᑐᒍ ᐊᓯᖏᓐᓂᒃ ᐊᑐᖅᑕᐅᓕᕈᓐᓇᖅᑐᓂᒃ, ᑲᔪᓯᓐᓂᐊᓕᕐᓗᑎᒃ. Nadâ segots'ehæî/preparing ahead of time Natthe sets'úde
Probability	The chance that something might happen. ᐱᔭᓐᓇᕐᓂᐊᕐᓂᖓ: ᐱᔭᓐᓇᖅᓯᑐᐃᓇᓇᐊᖃᕐᓂᖓ ᓯᓇᑐᐃᓐᓇᖅ ᓴᕿᑦᑐᓐᓇᕐᓂᐊᕐᓂᖓ, ᑲᔪᓯᑐᐃᓐᓇᓇᐊᖃᕐᓂᖕᒐᓗᓐᓃᑦ. Ahxô/maybe Haxâ

Term	Description
Process plant	Where the diamonds are extracted from kimberlite. ᐊᓕᒫᔮᐃᕝᒃ: ᐊᓕᒫᔮᐃᑦ ᐙᔮᖅᑕᐅᕝᖕᒐᑦ ᐊᓕᒍᔮᖅᑲᖅᑐᓂᒃ ᐅᔮᕋᖕᓂᒃ. Lamôökwe haàzhe kö/taking diamonds out place Diamonds hílchu xa tthe náldeth k’é
Processed kimberlite	*Material rejected from the Process Plant after the recoverable diamonds are extracted. Oyagak daimaiyaghimayok: Elakok pihimayok oyakanit daimayageeghimayot. ᐊᒃᑕᑰᓕᖅᑐᑦ ᐊᓕᒍᔮᖅᑲᖅᑲᐅᕙᑦ ᐅᔮᕋᐃᑦ: ᐊᒥᐊᒃᑯᖕᒋᑦ ᐊᒃᑕᑯᐃᑦ ᐅᔮᕋᐃᑦ ᐊᓕᒫᔮᐃᔮᖅᑕᐅᓯᒪᕙᑦ ᓯᑎᕙᑦ ᐊᓕᒫᔮᐃᑦ ᐙᖅᑕᐅᓪᓗᑎᒃ. Ejakwè naedo: Ejakwè ts’ö diamond kàgîla siì Prossessed Kimberlite gihdi hôt’e. Theluze bedhay: Kimberlite æate sélya-u bet’á ttheluze xálî bedhay sí.
Professional Engineer	*Means a Professional Engineer that is registered with the Association of Professional Engineers, Geologists and Geophysicists of the NWT and whose principal field of specialization is appropriate to the work at hand. ᑎᑎᕋᐅᔮᖅᑏᑦ ᓴᓇᔮᐅᓂᐊᖅᑐᓂᒃ: ᑎᑎᕋᐅᔮᖅᑏᑦ ᐊᑎᓕᐅᖅᑕᐅᓯᒪᕙᖅ ᐃᓕᑕᕆᔮᐅᓯᒪᕙᓂ ᖃᐅᔨᒪᔨᑕᕐᓂᒃ ᑎᑎᕋᐅᔮᖅᑎᓂᒃ ᓴᓇᔮᐅᓂᐊᖅᑐᓂᒃ. Asìi yàetsîdô/person that builds things Ye dánecha dághâ dy̌ne
Progressive reclamation	Process by which reclamation of mine site disturbances begins soon after mine operations cease, rather than delaying reclamation until mine closure. Aghoot Nuna Ehoaghataoyok:Oyagaghiogoigaangata nuna havahogo ihoaghaghogo naoviofaagiangani. ᐃᕙᓪᓕᐊᕋᐅᔮᖅᑐᒥᒃ ᓴᓗᒻᒪᖅᓴᐃᕙᓪᓕᐊᓂᖅ: ᐱᓕᕆᕙᓪᓕᐊᓂᖅ ᓴᓗᒻᒪᖅᓴᐃᓂᕐᒥᒃ ᐅᔮᕋᖕᓂᐊᕐᕝᖕᓂ ᐃᓂᖕᒋᓐᓂᒃ ᑕᐃᒪᐃᕐᑎᐊᕈᓃᖅᑐᓂᒃ, ᑭᖑᓂᐊᓂ ᐅᔮᕋᖕᓂᐊᕐᕚᑦ ᐊᐅᓚᑕᐅᕙᓐᓃᖅᑎᓪᓗᒋᑦ, ᐅᑕᕿᖕᒋᖕᒎᕐᓗᑎᒃ ᓴᓗᒻᒪᖅᓴᐃᓂᐊᕐᓂᕐᒥᒃ ᑭᓯᐊᓂ ᒪᑐᔮᐅᓪᓚᕆᒃᐸᑦ. Sômbak’è Ndè Sìnaæî: Sômbak’è laà t’à ndè naehdô siì ndè k’e eghàlageda ghô nôget’e gots’öt’ì ndè sìnaæî. Ts’étái ní sénalne: Tsamba k’e t’oke bet’aátî nohøt’e dené selne hunidhír. Åy̌reká yeghálahena æate darç ch’á nohereåîle
Quarry	A surface excavation for extracting stone, or sand materials. The quarry at EKATI is the Airstrip Esker ᐅᔮᕋᖕᓂᒃ ᐅᓯᒃᖅᑕᕐᕝᒃ: ᓄᓇᒥᑦᑐᖅ ᐅᔮᕋᖕᓂᒃ ᐅᓯᕝᒃ, ᐙᔮᐃᕝᒃ, ᐅᕙᓗᐧᓃᑦ ᓯᐅᕋᒃᑕᕐᕝᒃ. ᐅᔮᕋᐃᑐᕐᕝᒃ ᓯᐅᕋᖅᑕᕐᕝᒡᓗ ᐃᑳᑎ ᒥᑦᑕᕐᕝᓂᑦᑐᖅ Esker-ᒥ (ᐃᐊᔅᑯᒥ). Kwe haàzhe/taking rocks out Tthe dhay æeåk’edadzáy
Reclamation	*Activities which return affected areas to viable and, wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment, human activities, and the surrounding environment. Nuna Ehoaghaktaoyok: Nuna ehoaghataogaangat, nayogaaktot ilifaaghoni oyagaghiolektinagit. Emaa tailekpagait, nuna piyaofaagami taimaniton iliyok. ᐅᑎᖅᑎᑎᕆᓂᖅ: ᐱᓕᕆᐊᑦ ᓄᑖᕈᖅᑎᕈᑕᐅᕙᑦ, ᐃᖕᒥᓂᒃ ᐱᕈᒃᑳᓂᕈᓇᖅᓯᓂᐊᕐᒪᑕ, ᖃᓄᐃᖕᒋᓪᓗᑎᒃ ᐊᕙᑎᖕᒐᓂ ᐊᒻᒪᓗ ᐃᓄᖕᓄᑦ, ᐱᕐᑯᓯᑐᕐᑲᕐᒥᓄᑦ ᐅᑎᖅᑎᑕᐅᓇᓯᐊᕐᓗᑎᒃ. Ndè Sìnaæî: Sômbak’è gòæô t’à ndè naehdô siì sômbak’è hòlî kwè ndè edaàni île laàni anagele ha hogehdza ha. Ní senalne: Ní t’at tthe hîle sí xat’u senálne hureldzá xa. Bet’aát’î tthe senálne hureldza xa. Reclamation sní sí North America chu Europe ts’î hólye æat’e

Term	Description
Reclamation Goal	*The goal of reclamation is to return the EKATI Minesite to viable, and wherever practicable, self sustaining ecosystems that are compatible with a healthy environment, human activities, and the surrounding environment. Ndè sìnaæî gha wek'e eghàlada/reclaiming land to use again ᐅᑎᖅᑎᑦᑎᕙᓪᓚᐊᓂᕐᒥᒃ ᐱᖁᓯᓇᓚᐅᖅᑐᓄᑦ ᑐᕌᒐᔪᓇᔭᐅᔪᑦ: ᑐᕌᒐᔪᓇᔭᐅᔪᑦ ᐅᑎᖅᑎᑦᑎᕙᓪᓚᐊᓇᓱᐊᕐᓂᖅ ᑕᐃᔅᓯᒪᓂᐅᓚᐅᖅᑐᒧᑦ ᖃᓄᐃᓚᐅᕐᓂᖏᓐᓄᑦ, ᓲᕐᓗ ᐃᑳᑎᒥ ᐅᔭᕋᖕᓂᐊᕐᕕ, ᐱᕈᖅᕕᐅᒃᑲᓐᓂᕈᓐᓇᕐᑯᓪᓗᑎᑦ ᖃᓄᐃᓐᓂᐊᖏᓪᒪ ᐊᕙᑎᖓ ᐊᒻᒪᓗ ᐃᓄᐃᑦ ᑕᐅᕙᓂ. Ni bet'át'î xa senalye ts'‡n æeghálada
Reclamation Objective	Describes what the reclamation activities intend to achieve for each mine component (e.g., Stable landforms, protection of water resources and re-establishment of productive use of land - Aboriginal and wildlife). ᐅᑎᖅᑎᑦᑎᕙᓪᓚᐊᓂᕐᒥᒃ ᑎᑭᑕᐅᔪᒪᔪᑦ: ᐅᖃᐅᓯᐅᔪᑦ ᐱᓕᕆᐊᑦ ᑎᑭᑕᐅᔪᒪᔪᑦ ᐅᑎᖅᑎᑎᕙᓪᓚᐊᔪᒪᓂᕐᒧᑦ ᑕᒪᐃᓐᓄ ᐅᔭᕋᖕᓂᐊᕐᕕᖕᓂ ᐊᕕᒃᑐᖅᓯᒪᓂᐅᔪᓂ (ᓲᕐᓗ ᒪᑭᑕᑦᑎᐊᕈᓐᓇᕐᓂᖏᑦ ᓄᓇᐃᑦ, ᓴᐳᒪᓂᖏᑦ ᐃᒪᐃᑦ ᐊᒻᒪᓗ ᐆᒪᔪᕐᑲᓪᓚᒃᑲᓐᓂᕈᓐᓇᕐᓂᖏᑦ ᐊᒻᒪᓗ ᐃᓄᖅᑲᒃᑲᓐᓂᕈᓐᓇᖅᓯᓂᖏᓐᓄᑦ). Ndè achî wet'àts'et'î gha sìnaæî /working towards reclaiming land to use again Ní t'at'ú súghá ts'‡n senalye
Reclamation Option	One or more proposed reclamation activities for mine components. ᐅᑎᖅᑎᑦᑎᕙᓪᓚᐊᔪᓐᓇᕐᓂᕐᒧᑦ ᐊᑐᕈᓐᓇᖅᑐᑦ ᐊᔾᔨᒌᙱᑦᑐᑦ: ᐊᑕᐅᓯᖅ ᐊᒥᓲᓂᖅᓴᐃᓪᓗᓐᓃᑦ ᐅᑎᖅᑎᑦᑎᕙᓪᓚᐊᓂᕐᒧᑦ ᐱᖁᓯᑐᕐᑲᓇᓚᐅᖅᑕᖏᓄᑦ ᐱᓕᕆᐊᒃ, ᐅᔭᕋᖕᓂᐊᕐᕕᖕᓂ ᐊᕕᒃᑐᖅᓯᒪᓂᖏᓐᓂ. Ndè sìnaæî kaæa gohåî/options available to reclaim land Ní senalye xa æeåk'élch'a la
Residual effects	Effects that persist after mitigation measures have been applied. ᐊᒥᐊᒃᑯᐃᑦ ᐊᔾᔨᒌᖅᑕᐅᔪᓐᓇᐃᓕᔪᑦ ᐱᐅᓴᖅᑕᐅᓚᐅᖅᓯᑎᒃ: ᖃᓄᐃᓕᕖᓪᓕᕈᑕᐅᔫᑦ ᐱᑕᖃᐃᓇᕐᓂᐊᓕᖅᑐᑦ ᑭᖑᓂᐊᓂ ᐱᓗᐊᖅᑕᐃᓕᒪᕐᑯᓪᓗᑎᑦ ᐱᓕᕆᐊᖑᓚᐅᖅᑎᓪᓗᑎᑦ. ᐊᔾᔨᒌᖅᑕᐅᔪᓐᓇᐃᓕᔪᑦ ᐱᐅᓴᖅᑕᐅᓯᒪᓕᖅᑎᓪᓗᑎᑦ. Sìnaæî weèdzà tå'ahô/after trying to fix T'at'u sughâ ts'‡n senalye xa huts'éldzáy
Restoration	The return of the land to the same pre-mining contours, surface and groundwater patterns and plant and animal ecosystems. This implies that there is no difference between pre-mining and post-mining land conditions. In practice there are few instances where 100% restoration would be possible. Ehoaghaktaunik: Nuna ehaoghatauhimayok kangagaaloktot ilibloni nagooyomik naofaalighoni. Ehoaghikpiagaangat 100 pasanmot tikitpaktok nuna naofaagaangami nagooyomik. ᐅᑎᖅᑎᑦᑎᓂᖅ ᑕᐃᒪᐃᓚᐅᖅᑐᓄᑦ: ᐅᑎᖅᑎᑕᐅᓂᖏᑦ ᓄᓇᐃᑦ ᑕᐃᒪᐃᓕᖓᓚᐅᕐᓂᖏᓐᓄᑦ ᓯᕗᓂᐊᒍᑦ ᐅᔭᕋᖕᓂᐊᕐᕕᒃᑖᓚᐅᖏᓐᓂᖏᓐᓂ ᐋᕿᐅᒪᓚᐅᕐᓂᖏᓐᓄᑦ, ᓯᓚᑎᕙᓂᓇᓚᐅᖅᑕᖏᓐᓄᑦ, ᐊᒻᒪᓗ ᓄᓇᐃᑦ ᖃᓄᐃᓚᐅᕐᓂᖏᓐᓄᑦ, ᐆᒪᔪᕐᑲᓚᐅᕐᓂᖏᓐᓄᓪᓗ, ᐱᕈᖅᕕᐅᔪᓇᓚᐅᕐᓂᖏᓐᓄᓪᓗ. ᑕᒪᓇ ᑐᑭᖃᖅᑐᖅ ᐊᔾᔨᒌᑐᐃᓇᕐᓂᖏᓐᓂᒃ ᓯᕗᓂᐊᒍᑦ ᐊᒻᒪᓗ ᑭᖑᓂᐊᒍᑦ ᐅᔭᕋᖕᓂᐊᕐᕕᖅᑲᓚᐅᖅᑎᓪᓗᑎᑦ ᓄᓇᐃᑦ. ᐱᓪᓚᑦᑖᖅᑐᓂᒃ ᖃᔾᔫᓐᓇᒪᓇᐊᓘᕙᒃᑐᑦ100%-ᒧᑦ ᐅᑎᖅᑕᐅᓯᒪᔪᓐᓇᖃᑦᑕᖅᑐᑦ ᓲᕐᓗ ᐊᒃᑐᖅᑕᐅᓚᐅᖅᓯᒪᓗᑎᑐᑦ. T'asi sìnats'ehæî: Sômbak'è gòæô gokwe, ndè goka edaàni wègoht'î île, edaàni ti k'ètå'ô île eyits'ô, ît'ö eyits'ô tich'adi haàni edaàni eyi ndè k'è gòåî île anagehæî. Ní senalne: Tsamba k'é nûhøt'â tthe ní t'at'e k'íze senalne xa. Tu-u, te ch'ádiye hûlî-u, harelyû æeåçåt'e xa beghalada xa. 100% ts‡n senálne bureníle.

Term	Description
Return Air Raise	Shaft constructed to remove spent or dirty air from underground workings to the surface ᐊᓂᕿᓃᔭᐅᑦ ᐊᓂᖅᑎᓇᕕᒃ ᐊᓂᖅᓵᖅᑐᖅᑕᐅᓯᒪᔪᒥᒃ: ᓱᓪᓗᓕᒃ ᐊᓂᖅᑎᓇᕕᒃ ᐊᑐᖅᑕᐅᓯᒫᓂᒃᑐᓂ ᐊᓂᖅᓵᖅᑐᖅᑕᐅᓯᒫᓂᑐᓂ, ᓄᓇᐃ ᐃᓗᐊᓂ, ᓄᓇᐅᑉ ᖃᖓᓄᖓᐅᓪᓗᓂ. Nîhts'i môht'aà ts'ö niîæa/air that goes out of tunnel Yayí tñlts'î
Revegetation	Introduction of new vegetation on disturbed or barren ground. Naotifaangnik: Nuna naoviolifaaghoni. Ahegoktektaohimayoogaloak havaktonit. ᐱᕈᖅᑎᑦᑎᒃᑲᓂᕐᓂᖅ: ᓄᑖᓂᒃ ᐱᕈᖅᓯᐊᒃᓴᓂᒃ ᐃᓕᐅᖅᑲᐃᓂᖅ ᓄᓇᒥ ᐊᑐᖅᑕᐅᓯᒪᔪᕕᓂᕐᒥ ᐅᕙᓘᓐᓃᑦ ᓄᓇᑐᐃᓐᓇᕐᒥ ᓇᐹᖅᑐᖅᑲᖏᑦᑐᒥ. Ndè k'è ît'ö nats'ehshe: Ndè naehdô île siì wek'è ît'ö nats'ehshe. K'ai-u, niúneshe nanelye xa æasí nílye: T'oke niúneshe-u, ní k'e así ts'çldé, sí-u, æasí nílye, bet'á æasí nanelye t'a ní t'at'e hîle k'íz senalne hureldza xa.
Riparian	Refers to streams, their channels, banks and the habitats, and plants associated with them. Kooganoet: Kooganoet hinait mayokaitlo naotiatlo ᐱᕈᖅᑐᑦ ᐃᒪᕐᒥ: ᐅᖃᐅᓯᖃᖅᑐᖅ ᐃᒪᕕᖕᓂ, ᑰᖕᓂ, ᑕᓯᕐᓂᓗ ᐅᒪᔪᐃᑦ ᐱᕈᖅᑐᓪᓗ ᑕᒪᒃᑯᓇᖓᑦ. Tamba ît'ô yaeshe: Dehtsoa gàà taba ît'ö yaehshe. Tu-u, dez-u xát'î æasí: Tu-u déz tsÿnlaze-u déz-u, tabã-u, æasí dána-u, æats'edi.
Risk	A factor, thing, element, or course involving uncertain hazard to people, wildlife or the environment. ᐅᓗᕆᐊᓇᖅᑐᑦ: ᓱᓇᑐᐃᓐᓇᐃᑦ, ᐅᓗᕆᐊᓇᖅᑐᑦ ᐅᓗᕆᐊᓇᕈᓐᓇᖅᑐᓘᓐᓃᑦ ᐃᓄᖕᓄᑦ, ᐆᒪᔪᓄᑦ ᐅᕙᓘᓐᓃᑦ ᐊᕙᑎᒧᑦ. Wets'ehdzà/trying some X/horeåi
Risk Assessment	Reviewing risk analysis and options for a given site, component or condition. Risk assessments consider factors such as risk acceptability, public perception or risk, financial cost, socio-economic impacts, benefits and technical feasibility. ᐅᓗᕆᐊᓇᕐᓂᖏᓐᓂ ᑐᑭᓯᓂᐊᕐᓂᖅ: ᕿᒥᕐᕈᐊᖅᑕᐅᓂᖏᑦ ᐅᓗᕆᐊᓇᖅᑐᑦ ᐊᓯᖔᖏᓪᓗ ᐊᑐᖅᑕᐅᓕᕈᓐᓇᖅᑐᑦ, ᐅᔾᔨᕐᓂᐊᕐᕕᖕᒥ, ᐊᕕᒃᑐᖅᓯᒪᓂᖓᑕ ᐃᓗᐊᓂ, ᐅᕙᓘᓐᓃᑦ ᓱᓇᑐᐃᓐᓇᕐᓂ. ᐅᓗᕆᐊᓇᕈᓐᓇᖅᑐᑦ ᖃᐅᔨᓴᖅᑕᐅᓂᖏᑦ ᐃᓚᖃᖅᐸᒃᑐᑦ ᓱᕐᓗ ᐊᖏᖅᓯᒪᓂᖅ ᐅᓗᕆᐊᓇᕈᓐᓇᕐᓂᖏᓐᓄᑦ, ᐃᓄᐃᑦ ᐃᓱᒪᖃᕐᓂᖏᑦ ᐅᓗᕆᐊᓇᖅᑐᓄᒃ, ᑮᓇᐅᔭᒃᑯᑦ ᐊᑭᖏᑦ, ᐃᓅᓯᕐᒧᑦ ᑮᓇᐅᔭᓕᐅᖅᑕᐅᕙᓪᓚᕐᓂᕐᒧᓪᓗ ᐊᒃᑐᖅᑕᐅᓯᒪᔪᓐᓇᕐᓂᖏᑦ, ᐃᑲᔫᑎᒋᔭᐃᑦ ᐊᒻᒪᓗ ᓴᓇᔭᐅᓯᒪᔪᓐᓇᕐᒪᖔᑕ ᑐᑭᓯᓯᒪᓂᖅ ᐊᔪᕐᓇᔾᔪᖕᒋᕐᒪᖔᑕ. Asìi wets'ehdzà weghàts'èda/looking at risk T'óreåi xa net'î
Runoff	Water that is not absorbed by soil and drains off the land into bodies of water. ᐃᒪᖅ ᑯᕕᔪᖅ ᐃᒪᕕᖕᒧᑦ: ᐃᒪᖅ ᓄᓇᒧᐊᖅᐸᓪᓕᐊᖕᖏᑦᑐᖅ, ᑯᕕᖅᑦᑕᖅᑐᖅ ᑰᒃᓯᓂ ᓄᓇᒥᒃ ᐃᒪᕐᓄᑦ. Ti ndè k'e haïlî/water flowing over land Ní tûç tu yélbi
Run of mine	Raw material as it exists in the mine; average grade or quality. ᖃᖅᑎᑕᐅᓯᒪᔪᑦ ᒃ ᐅᔭᕋᐃᑦ: ᐅᔭᕋᐃᑦ ᐊᖏᓂᖏᑦ ᐊᒃᑕᑯᒃᓴᐃᑦ ᖃᖅᑎᑕᐅᓚᐅᖅᓯᑎᒃ. Kwe nàk'è tå'ahô/after rock being blasted Tthe æeåk'enílk'ath tå'ãghe

Term	Description
Saline Soil	A soil containing soluble salts in such quantities that they interfere with the growth of most crop plants. Nuna Tagiolik: Nuna tagiyoinangogaangat naolimaikpaktot naotiaghat. ᓄᓇᐃᑦ ᑕᕆᐅᓖᑦ: ᓄᓇ ᑕᕆᐅᓕᒃ ᐊᐅᔪᓐᓇᖅᑐᒥᒃ, ᐊᖏᔪᒥᒃ ᐱᑕᓕᒃ ᐱᕈᑦᑎᐊᕈᓂᕈᑕᐅᕙᒃᑐᑦ ᐱᕈᖅᐸᒃᑐᓄᑦ. Ehtå'è tah dewa Ehtå'è dewa wets'öelî t'à, edaàni ît'ö dehshe xèidi. Thay dedháy åâ: Thay beyé dedhay åâ t'á æasí neshe húreníle.
Salvageable materials	Are materials or equipment recovered from the dismantling or demolition of a plant, buildings or structures which can be removed from the site and re-cycled or re-used in another location. ᐊᑐᖅᑕᐅᒃᑲᓐᓂᕈᓐᓇᖅᑐᑦ ᐱᖁᑎᑦ: ᐱᖁᑏᑦ ᐊᑐᖅᑕᐅᒃᑲᓐᓂᕈᓐᓇᖅᑐᑦ ᓯᓇᒃᑯᑖᓗᓐᓃᑦ ᐲᔭᖅᑕᐅᓯᒪᓕᖅᑐᑦ ᐊᑐᕈᓐᓃᖅᑐᑦᓗᓐᓃᑦ ᐅᔭᕋᕐᓂᐊᕐᕕᖕᒥ ᐃᒡᓗᕕᓃᑦ ᐱᖁᑏᑦᓗᓐᓃᑦ ᐲᔭᖅᑕᐅᓗᑎᒃ ᐃᓂᒥᓂᒃ ᐊᑐᒃᑲᓐᓂᕈᓐᓇᖅᑐᑦ ᐊᓯᐊᓂ. Achî asìi wet'aànàhot'ì/using things again Æasíe nánelya tå'ãghe bet'át'î xa t'a ghãdhÿr
Scarification	With respect to landscape, the act of loosening the soil without actually turning it over, by dragging a pronged implement across the surface. With respect to seeds, a process of mechanically or chemically compromising the hard exterior of the seed to facilitate water uptake and subsequent germination of the seed. Komigangnik nuna: Nuna komigaghimayok komigaotmon. Nunap kaanga naptovangmat komigaghogo havakpagait naoveofaaligiangani. ᒪᓂᕋᐅᔭᓐᓃᖅᓱᓐᓂᖅ: ᓄᓇᓕᓇᔭᓂ, ᓄᓇ ᐃᔾᔭᖅ ᐊᒃᑲᖅᑕᐅᓯᒪᔭᖅ ᖄᖓ, ᐃᓂᒃᓴᖄᕕᐅᓂᐊᕐᒪᑦ ᖃᓱᖓᓕᖅᑎᑕᐅᓗᓂ, ᓱᕐᓗ ᐊᒃᑲᒍᒃᑯᑦ ᒪᓂᕋᐅᔮᖅᑎᑕᐅᔭᖅ. ᐱᕈᖅᓯᐊᒃᓴᓕᕆᓂᕐᒥ: ᑕᒪᑯᐊ ᐱᕈᖅᑐᒃᓴᐃᑦ ᓴᐅᓂᖏᑦ ᐱᕈᖅᑐᑦ ᒪᓂᕋᐅᔮᖅᓴᔭᐅᓂᖏᑦ ᓯᓚᑖᒍᑦ, ᐊᒦᔭᖅᑕᐅᔾᔫᒥᓂᐊᕐᒪᑕ Ndè kah hats'eèts'o/scatching top of the land Ndè kah asìi nàeshe ha Ní daghe nálchul: Ní t'at'e ghare selne huréldzá t'a sátsán bek'e dzéredlúdh, æasí huneshe xa nílye ní hureyÿr lat'e xúlí. Tu tth'i bek'e æalæî.
Sedimentation Ponds	A containment structure where mine water is sent so that sediments can settle and contaminants are prevented from being transported into the receiving environment. ᓴᓂᓐᓇᕐᑲᖅᑐᑦ ᐃᒪᕖᑦ: ᐃᒪᕐᑲᕐᕕᑦ (ᐃᒪᕖᑦ) ᐅᔭᕋᕐᓂᐊᕐᕕᖕᓂ ᐃᒪᕐᔫᑏᑦ ᐃᒥᖅᑕᖅᑕᐅᕙᒃᑐᑦ ᑖᒃᑯᖓ ᒪᕋᕐᑲᖅᑐᑦ, ᓴᓃᑦ ᐃᓗᐊᓂ ᑭᕕᓂᐊᕐᒪᑕ ᑖᕙᓂ. Edî titå'ah ehtå'è negeèhtå'ì/area where they dump muddy waters T'óót'i xatå'‡s tûç nidil
Seepage	*Water that drains through or escapes from any structure designed to contain, withhold, divert or retain water or waste, including Waste Rock Storage Areas. ᓯᐊᒻᒪᒃᑎᕐᓂᖅ: ᐃᒪᖅ ᓯᐊᒻᒪᒃᐸᓪᓚᐊᓯᒪᔭᖅ ᓇᑭᑐᐃᓐᓇᖅ ᐃᒪᖅᑲᕐᓂᕐᒥᒃ ᓲᕐᓗ ᐅᔭᕋᒃ, ᐅᕙᔫᓐᓃᑦ ᐊᒃᑕᑯᕈᖅᐸᓪᓚᐊᔭᓂᒃ ᐃᒪᕐᓂᒃ ᐃᑎᑕᐅᔪᓇᕐᑲᖅᑐᓂᒃ. Ti haìtå'ì/water seeping out T'óót'i tu xáíli
Soil	The loose, un-cemented minerals and organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants; in this definition, soil only extends to the depth important for plant growth. Nuna: Nunap kaanga naoviohimayok naotianik emaalo naoveotaaghonilo.

Term	Description
	ᓄᓇᔭ ᐃᑉᐹᖅ: ᓄᓇᐃᑦ ᐃᑉᐹᐃᑦ ᓯᑎᕚᖏᑦᑐᑦ ᓄᓇᐅᑉ ᖃᖓᓂᑦᑐᑦ, ᐱᕈᕝᕚᓐᓇᖅᑐᑦ ᐱᕈᖅᑐᓄᑦ, ᑖᒃᑯᐊ ᑐᑭᖏᓐᓂ, ᓄᓇᐃᑦ ᑭᓯᐊᓂ ᐱᒻᒪᕆᐅᓇᔭᖅᑐᑦ ᐱᕈᕈᓐᓇᕐᓂᖏᓐᓄᑦ ᐱᕈᖅᑐᑦ. Ndè Ehtå'è: Ndè k'è t'asi hazô kàæa îhjì at'î siì wet'à t'asi naehshe hôt'e. Ît'ö eyits'ô dechî dehshe ha, ehtå'è siì wet'àæa hôt'e. Huneshe xa ni/thay: Thay-u, tthe dhíaze-u, æasí dhay-u, ní daghe bet'á t'ãchay-u neshe xa. T'at'u t'achay neshe æasí dinaálti.
Source Lake	A lake from which water is removed over a period of time, and used for the purpose of flooding open pits. ᐃᒥᖅᑕᕝᕙᒃ ᑕᓯᖅ: ᑕᓯᖅ ᐃᒪᖅᑕᕝᕙᐅᕙᖅ ᐃᒪᐃᔭᖅᑕᐅᕙᓪᓚᐊᖏᓐᓇᖅᑐᖅ, ᐊᑐᖅᑕᐅᓂᐊᖅᑐᖅ ᐅᓚᑕᐅᓂᖏᓐᓄᑦ ᒪᑐᐃᖓᕙᑦ ᐅᔭᕆᓂᐊᕝᕕᑦ. Edî ts'ô tiì agehæî/where we take water from T'óót'i ts'î tu hílchu
Species	A group of highly similar plants or animals that is part of a genus and that can reproduce fertile offspring only among themselves; for example: *Festuca rubra* is the botanical name of creeping red fescue, a common revegetation grass. *Festuca* is the genus, and *rubra* is the species. Several species belong to the genus *Festuca*. Adlatkeet hogayatlooneen naotiatlooneen: Aadlatkeet hogayatlooneen naotiatlooneen. Festuca rubra naotiangobloni avaleetomik. Onataok Festuca genusmik taivagait rubra avaleetomik naotiangoyoktaok. Festucamot elagiyaoyok. ᐆᒪᕙᐃᑦ ᐱᕈᖅᑐᓘᓐᓂᑦ: ᑲᑎᖓᕙᑦ ᐊᔾᔨᒌᖓᓚᐃᑦ ᐱᕈᖅᑐᑦ ᐆᒪᕙᐃᓪᓘᓐᓂᑦ ᐃᓚᒌᒃᑐᑦ ᐊᒻᒪᓗ ᐃᖕᒥᓃᓐᓇᖅ ᕿᑐᕐᖑᕈᓐᓇᖅᑐᑦ ᑖᒃᑯᓇᓃᓐᓇᖅ: T'asi îåè kàæa: Ît'ö haànile dè tich'adi îåè kàæa siì t'asi t'à eåexèht'e eyits'ô eåexè dzô dehshe, di laàni: Festuca rubra tå'o haiyeh siì ndè k'e eåexè îwhâ dehshe hôt'e. Æîlaghe hárelæa æasíe dána
Stockpile	A temporary accumulation or surplus of ore built up when demand slackens or when the process plant is temporarily unable to handling the mine output, or kept in reserve for future loading or other purposes. ᐅᔭᕋᐃᑦ ᖁᓪᓕᓪᓕᖅᑎᖅᑕᐅᓯᒪᕙᑦ ᑐᖅᑯᖅᑕᐅᓯᒪᑲᐃᓇᖅᑐᑦ: ᖁᓪᓕᓪᓕᖅᑎᖅᑕᐅᓯᒪᕙᑦ ᑲᑎᑕᐅᕙᑦ ᐊᒥᐊᒃᑯᐃᓪᓘᓐᓂᑦ ᐅᔭᕋᕝᕖᓐᓂᑦ ᓯᕗᓂᒃᓴᒥ ᓴᓇᔭᐅᕙᓖᖅᑐᑦ, ᐅᐸᓘᓐᓂᑦ ᐸᐸᑕᐅᓂᐊᖅᑐᑦ ᓯᕗᓂᒃᓴᒥ ᐅᓯᔭᐅᓂᐊᕐᒪᑕ ᐊᓯᖏᓄᓪᓘᓐᓂᑦ ᐊᑐᖅᑕᐅᓗᑎᒃ. Ewà nègehtå'ì/reserve rocks for a while Tthe æeåk'edáldzáy bek'áni xa
Stratification	Forming or depositing in layers in water and on the land. E.g., the sequence of rocks on top of each other. ᖁᓪᓕᓪᓕᖅᓯᒪᓂᖏᑦ: ᖁᓪᓕᓇᓕᖅᑎ ᖅᓯᒪᓂᖏᑦ ᖁᓪᓕᓇᓕᖅᑎᖅᑕᐅᓯᒪᓂᖏᓘᓐᓂᑦ ᐃᒪᕐᒥ ᓄᓇᒥᓗ. ᐋᕐᓗ ᐆᒃᑑᑎᒋᓗᒍ, ᐅᔭᕋᐃᑦ ᖁᓪᓕᓪᓕᖅᑎᖅᑕᐅᓯᒪᕙᑦ. Kwe eåekadawhela/layers of rock Æasíe æeåk'édathela

Term	Description
Subsidence	The gradual sinking, or sometimes abrupt collapse, of the rock and soil layers above deposited material or over an underground mine. Structures and surface features above the subsidence area can be affected. ᑭᕕᕋᓪᓚᐊᓂᖅ: ᑭᕕᕋᓪᓚᐊᓂᖅ, ᐅᕙᓘᓐᓃᑦ ᐃᓛᓐᓂᒃᑯᑦ ᑲᑕᒃᐸᓪᓚᐊᓂᖏᑦ ᐅᔭᕆᐃᑦ ᐊᒻᒪᓗ ᓄᓇᐃᑦ ᖁᓚᓈᓚᖅᓯᒪᓗᑎᒃ, ᐃᓚᐅᖅᑲᖅᑕᐅᓯᒪᔪᕕᓃᑦ ᓄᓇᐃᑦ, ᖁᓛᓂᓪᓗᓐᓃᑦ ᐅᔭᖕᓂᐊᕐᕕᐅᑉ. ᐱᖁᑏᑦ ᓄᓇᐃᓪᓗᓃᑦ ᖃᖓᓃᑦᑐᑦ ᑭᕕᕕᐅᓯᒪᓚᖅᑐᓂ ᐊᓯᔾᔨᕈᓐᓇᕐᒥᔪᑦ. Ndè wogyìità'ì/land sinking in Ni yé ghús xáæâ
Substrate	In the context of reclamation, this refers to mineral materials forming the ground surface and implies that the original soil material is no longer present. Nunap kaangani naoyut: Mineralmik taivagait nunami naolighimayot emaalo nunaloagaloanga peeghonilo ᓄᓇᐅᑉ ᖃᖏᑦ ᐱᕈᕐᕕᐅᔪᓐᓇᖅᑐᑦ (ᓯᐅᕆᐃᑦ, ᐅᔭᕆᐅᓗᓐᓃᑦ): ᓴᓗᒻᒪᖅᓴᖅᑕᐅᔪᖅᑲᕐᓂᐊᖅᑎᓪᓗᒍ, ᐅᖅᑲᐅᓯᖅᑲᖅᑐᑦ ᓄᓇᓂᒃ ᓄᓇᒦᓚᖅᑐᓂᒃ, ᐃᓯᒪᓇᖅᑐᖅ ᓄᓇᑐᖅᑲᖏᑦ ᑕᐅᕋᓂᑦᑐᓐᓃᕐᒪᑕ. Ndè k'e asìi dehshe ha dìle/you can grow on the land Ní bek’e huneshe xa dúéle: T’atthe ní t’at’e-u, t’a bek’e hûlî-u, æeyí xa ní senálne-u, ní tth’í senálne huzeldza xa.
Surface water	*Water (including snow and ice) on the ground or in a stream, river, lake or ocean. Surface water on the tundra also includes that water in the active layer (frozen or unfrozen), above the permafrost which melts and runs off the land in the summer. ᐃᒪᐃᑦ ᑕᒃᓴᐅᔪᑦ ᓄᓇᒥ: ᐃᒪᐃᒪᑦ ᑕᒃᓴᐅᔪᑦ ᓄᓇᒥ, ᖃᖓᑕᓲᕐᒥ ᐃᑭᒻᒪᓪᓗᓂ ᑕᑯᔭᐅᓇᔭᖅᑐᑦ, ᑕᓯᑦ, ᑕᓇᐅᑉ, ᑰᓪᓗ. Ndè kah ti/water on top of lake K’édaghe tú
Sustainability	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. ᐊᒥᐊᒃᑯᖅᑲᐃᓐᓇᕐᓂᖅ ᐅᕙᓘᓐᓃᑦ ᐃᑯᐱᖕᓂᖅ: ᓴᓇᓂᖅ ᐅᓪᓗᒥᐅᔪᖅ ᐃᓅᔪᑕᐅᓂᐊᖅᑐᓂᒃ ᐅᓗᓇᐊᓇᓕᖅᑎᑦᑎᑕᐃᓕᒪᓗᒋᑦ ᓯᕗᓂᒃᓴᒥ ᐃᓅᔪᑕᐅᓂᐊᕐᒥᖕᒪᑕ. Wet'à edets'eèda ha dìle/we can survive with it in the future Æasíe tthá ts’‡n bet’óreæa
Talik	Unfrozen zones that can exist within, below, or above permafrost layers. They are usually located beneath deep water bodies. ᐃᒪᐅᑉ ᐊᑖᓂ ᖁᐊᖑᖏᓐᓂᖅ ᓄᓇ: ᖁᐊᖑᖏᑦᑐᑦ ᓄᓇᐃᑦ ᐃᒪᐃᑦ ᐊᑏᓃᑦᑐᑦ. ᐊᑏᓂᒐᔪᒃᑐᑦ ᐃᒪᐃᑦ ᐊᖏᔪᑏᑦ ᓰᕐᓗ ᑖᓯᑦ ᓇᑎᖓᑕ ᐊᑖᓂ ᐊᐅᒪᐃᓐᓇᖅᓰᖅ. Ti gotå'a ts'ö etî-le/water that never freezes at bottom of lake Ní te yághe hetÿníle
Temporary suspension of operations	*When a mine temporarily delays, or puts on hold, operations with the intent of resuming activities in the future. ᓄᖃᖓᑎᑦᑎᑲᐃᓐᓇᕐᓂᖅ ᐊᐅᓚᑕᐅᔪᓂᒃ: ᐅᔭᕐᓂᐊᕐᕕᖕᒥ ᑕᒪᐃᓐᓂᒃ ᐃᓚᐃᓐᓇᖓᓂᓗᓐᓃᑦ, ᓄᖃᖓᑎᑦᑎᑲᐃᓐᓇᕐᓂᖅ, ᐱᓕᐊᒃᑲᓐᓂᕈᒫᕐᓗᑎᒃ ᓯᕗᓂᐅᓂᐊᖅᑐᒥ. Wexöeæà/stopping for a little while Tsamba k’é æeghálada buríåæa

Term	Description
Terms of Reference	Instructions that ensure the required information is provided. ᑎᓕᔾᐅᓯᒪᔾᔪᑏᑦ: ᑎᑎᖅᑲᐃᑦ ᐱᓕᕆᐊᖑᓂᐊᖅᑐᓄᑦ ᑎᓕᔾᐅᓯᒪᔪᓂᒃ ᒪᓕᒡᓴᐃᑦ. Enîhtå'è weghaà eghàlahòda/paper you work by Yati thela begháre æeghálada
Thermocline	Layer in a thermally stratified body of water in which temperature changes rapidly relative to the remainder of the water column. ᐊᔾᔨᒌᙱᓐᓂᖏᑦ ᐆᓇᕐᓂᖏᑦ/ᓂᒡᓚᓱᙱᓂᖏᓪᓗ ᐃᒪᐃᑦ ᐃᑎᓂᖓ ᒪᓕᓗᒍ: ᐃᑎᓂᖓᓂ ᐊᔾᔨᒌᙱᑦᑐᓂᒃ ᐆᓇᕐᓃᑦ/ᓂᒡᓚᓇᕐᓃᑦ ᐃᒪᕐᒥ, ᐊᓯᔾᔨᖅᑕᖅᑐᑦ, ᒪᓕᒃᓯᒋᑦ ᐃᒪᐃᑦ ᐃᑎᓂᖏᑦ. Ti åek'edawhela åadî edi/different temperture levels in the lake Tu dhÿlé harelyû æeåeåt'eíle
Thermokarst	A process by which characteristic landforms result from the thawing of ice-rich permafrost. Naohimayot mahakaangat hiko, nunap ataani Nuna naohimayok hiko mahaktiligangat nunap ataanit. ᐊᐅᙱᖓ ᐊᐅᔪᐃᑦᑐᖅ ᓄᓇᐅᑉ ᐃᓗᐊᓂ: ᓄᓇᐃᑦ ᐊᓯᔾᔨᖅᓯᒪᓂᖏᑦ ᐊᑖᓂ ᐊᐅᔪᐃᑦᑐᑦ ᓄᓇᐃᑦ ᐃᓗᐊᓂ ᐊᐅᒃᑳᖓᑕ. Ndè Ehtô naìyîî/frozen land thaw out Ní nalghi ts'îæ‡né ní nálker
Thermosyphon	An engineering installation which causes heat transfer from the internal structure of a dam to the outside environment, assisting and maintaining internal freezing. ᓱᑦᑐᓕᒃ ᓇᐸᔪᖅ ᓂᒡᓚᓇᖅᑐᒥᒃ ᐊᓄᓈᒥᒃ ᑲᐃᕚᑦᑐᖅ ᖁᐊᖑᓂᐊᕐᒪᑦ: ᓴᓇᔾᐅᓯᒪᔪᖅ ᓱᑦᑐᓕᒃ ᓴᕙᕋᔾᔭᒃ ᓂᒡᓚᓇᖅᑐᓕᐅᕈᑦ ᖁᐊᖑᐃᓐᓇᕐᓂᐊᕐᒪᑦ ᓯᒥᒍᑎᐅᓗᓂ ᐃᒪᕐᒧᑦ. Ndè gotå'à wenîhts'ik'ò/undergrounds cold Ní yaghe ts'i niåts'i k'ath t'a æéå xaåé xa hetÿn
Thermistor	An engineering installation which measures the internal temperature of WRSAs, Dams and bedrock ᓱᑦᑐᓕᒃ ᓄᓇᒦᑦᑐᖅ ᖃᐅᔨᓴᐅᑦ ᓄᓇᐅᑉ ᓂᒡᓚᓱᙱᙳᓂᒃ: ᖃᐅᔨᓴᕈᑏᑦ ᖃᐅᔨᒪᔾᔪᑕᐅᓲᖅ ᓂᒡᓚᓱᙱᙶᓐᓂ ᓄᓇᐃᑦ ᐃᓗᓕᙱᑦ, ᓯᒥᒃᑎᖅᑕᐅᓯᒪᔾᔪᑏᑦ, ᐊᒻᒪᓗ ᐅᔭᕋᐃᑦ Ndè gotå'a wenîhts'ik'ò xèæiìdzà/measures underground temperature Tsâk'oth bet'á ní yaghe hak'ath húldzáy
Till	Un-stratified rock material deposited directly by glaciers, consisting of a mixture of clay, silt, sand, gravel and boulders ranging widely in size and shape. Naohimayot hiko mahakaangat magluklo, heogaklo oyagaliaklo oyakatlo katimayonik: Naohimayot hiko mahakaangat magluklo, heogaklo oyagaliaklo oyakatlo katimayonik. ᑲᑕᒫᑦ: ᓱᓇᑐᐃᓇᐃᑦ ᑲᑕᒐᖅᓯᒪᔪᑦ ᐅᔭᕋᐃᑦ, ᓯᕐᒥᙵ, ᐱᖃᓗᔭᕐᓂᓗ, ᓯᕐᓗ ᒪᕋᐃᑦ, ᓯᐅᕋᐃᑦ, ᓴᓃᑦ, ᐅᔭᕋᐃᓪᓗ, ᐊᔾᔨᙱᑦᑑᑏᑦ. Ndè ka tô nayîî: Ndè ka tô nayî eyits'ô natî t'à ehtå'è, ewà eyits'ô kwè ndè k'è whela at'î. Tÿn lu cho ts'ñ æasí nítå'ír: Tÿn lu cho ts'î æasí hatå'ÿs gaí-u, tthe-u, tthe dhiaze harelyû æeåtá tå'ír.
Topsoil	The original dark-coloured upper soil layer, usually containing organic matter, and used to top-dress sites to be reclaimed. Nuna daaktok kaanoangani nunap atoktaovaktok nuna naoyaangani: Nuna daaktomik kalalik kaanoangani nunap atoktaovaktok naofaangmiyaangani. ᓄᓇ ᖃᒥ: ᓄᓇᐅᑉ ᖃᖓ ᕿᕐᓂᖅᑐᖅ ᖁᓪᓕᖅᐹᖅ, ᐱᕈᖅᑐᕕᓂᖃᖅᑐᖅ, ᐊᑐᖅᑕᐅᓲᖅ ᖃᒃᓴᖓᓄᑦ ᓄᓇᒥ ᐅᑎᖅᑎᑎᖅᑕᐅᓇᓱᐊᖅᑐᒥ.

Term	Description
	Ehtå'è: Ti tah satsö eyits'ô nàèdi hazô kàæa gòåî agihdi. Ní dághe bet'aát'î: Ní dághe thay deghíl bet'á æasí neshe xa nezû-u, tth'i ní senálne xa bet'aat'î.
Total Dissolved Solids (TDS)	The concentration of dissolved ions (principally calcium, magnesium, potassium, sodium, bicarbonate, chlorides and sulfates) in a known volume of water (e.g., mg/L). Amigaingnik nongopkaghimayot emangmi: Nongopkaghimayok ionsit calciumlo, magnesiumlo potassiumlo sodiumiklo biconrbonat,iklo kloridmiklo sulfeetmiklo elalgit emangmi itot. ᑲᑎᓪᓗᒋᑦ ᑕᒪᕐᒥᒃ ᐊᐅᒃᓯᒪᓂᒍᑦ ᓱᓇᑐᐃᓇᐃᑦ: ᐃᒪᕐᒥᐅᑕᐃᑦ ᐊᐅᒃᓯᒪᓂᑦᑐᑦ, ᓲᖅᓗ ᑕᕆᐅᑦ, ᐊᓯᖏᓪᓗ ᐃᓚᖏᑦ (calcium, magnesium, potassium, sodium, bicarbonate, chlorides, sulfates-ᓗ) Ti tah t'asi nayîî: Ti tah t'asi satsö eyits'ô nàèdi hazô kàæa wets'öelî siì agihdi (calcium, magnesium, paotassium, sodium, bicarbonate, chlorides eyits'ô sulfates haàni). Tu t'a æasíe nálghí: Dírí ions húlye, calcium-u magnesium-u, potassium-u, sodium-u xat'I tu yé nálghí æat'e.
Total suspended particulates (TSP)	Airborne particles with a diameter of less than 30 microns, collected by a high-volume air sampler and recorded as micrograms per cubic meter of air ($\mu g/m^3$). ᓯᓚᒥ ᐳᖅᑖᓲᑦ, ᓲᖅᓗ ᐳᔪᐃᑦ: ᓯᓚᒥᑦᑐᑦ ᐳᔪᐃᑦ, ᓴᓃᓪᓗ ᓯᓚᒥ ᐊᓂᕐᓂᒥ ᐳᖅᑖᖅᑐᑦ Dàedì/floating Æasíe dzérétth'ay
Total suspended solids (TSS)	The weight of solids suspended in a known volume of water (e.g., mg/L). ᐃᒪᕐᒥ ᐳᖅᑕᖅᑐᑦ ᓴᓃᑦ: ᐅᖅᑯᒪᐃᓐᓂᖏᑦ ᓴᓃᑦ ᐃᒪᕐᒦᑦᑐᑦ ᐳᖅᑖᖅᑐᑦ ᐃᒪᕐᒥ (ᐆᒃᑐᕋᖅᑕᐅᓯᒪᔪᒥ (ᓲᖅᓗ ᖃᑦᑕᕐᒥ mg/L). Ti yìì dàele/floating in the water tu yé dzérélay
Toxicity	The inherent potential or capacity of a material to cause adverse effects in a living organism. ᑐᖅᑯᓇᖅᑐᑦ: ᐅᓗᑎᐊᓇᖅᑐᑦ ᐅᓗᑎᐊᓇᕈᓐᓇᖅᑐᓐᓂᑦ ᓱᕈᖅᓇᖅᑐᑦ ᐃᓄᔪᓂ ᐅᒪᔪᓂᓗ. Asìì weghô hòejî/something dangerous Æasíe bech'o nejÿr
Traditional knowledge	A cumulative body of knowledge, values and beliefs, handed down from one generation to another, which has been learned through experience and observation from the land and from oral tradition. ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ: ᖃᐅᔨᒪᔭᐅᔪᖅᑲᐃᑦ, ᐱᒻᒪᕆᐅᔪᑦ ᐃᓅᓯᕐᒥ, ᐅᖃᐅᓯᕆᔭᐅᑦ ᐃᑦᑕᓂᐊᖅᑎᑕᐅᔭᐅᑦᑐᓪᓗ ᐃᓅᕆᐊᓪᓚᐊᔪᓂᒃ ᐃᓅᕆᐊᓪᓚᐊᔪᓄᑦ, ᖃᐅᔨᒪᓂᕐᒧᑦ ᖃᐅᔨᒪᔭᐅᔪᑦ ᖃᐅᔨᔭᐅᓯᒪᔪᓪᓗ ᖃᐅᔨᓴᕐᓂᕐᒥᒃ ᓄᓇᒥᒃ ᑲᔪᓯᑎᑕᐅᔭᐅᑦᑐᑦ ᐅᖃᐅᓯᒃᑯᑦ. Dône naawo/the dene way Dÿne ch'anie k'óreja
Trend	A relatively consistent change in a measured variable over time. ᐱᕆᓪᓕᐊᑐᐃᓐᓇᖅᑐᑦ / ᒪᓕᒃᑕᐅᕆᓪᓕᐊᑐᐃᓐᓇᖅᑐᑦ / ᓴᕿᐸᓪᓕᐊᑐᐃᓐᓇᖅᑐᑦ: ᐊᓯᔾᔨᖅᐸᓪᓕᐊᑐᐃᓐᓇᖅᑐᖅ ᖃᐅᔨᓐᓇᖅᑐᖅ ᑕᐃᒪᐃᐸᓪᓕᐊᓯᒪᓂᖕᖑᓄᑦ Yazèa åadî at'î/gradual change Húdhir

Term	Description
Tributary streams	Streams feeding, joining or flowing into a larger stream. ᑰᕿᓛᑦ ᐊᖏᓂᖅᓴᓄᑦ ᑰ ᑰᒃᐸᓪᓕᐊᔪᑦ: ᑰᕿᓛᑦ ᑰᒃᐸᓪᓕᐊᔪᑦ ᐊᖏᓂᖅᓴᓄᑦ ᑰᖕᓄᑦ. Ti eåeèts'ö nàïlî/water flowing to each other Tu æeåk'îli
Tundra	Habitat typically found in the Arctic, north of the treeline, that is adapted to cold temperatures, a short growing season and low precipitation. Typical tundra vegetation includes moss, lichen, Labrador tea and small shrubs. Nuna napaaktoilgok: Nuna napaktoilgok neglaomablonilo naotaingit naitot. Tuktut nekigilekpagait nunap kaanoangani naovangmiyotaok, eveetlo teegelikpagait inuit. ᓄᓇᐃᑦ ᓇᐹᖅᑐᖃᖕᒋᑦᑐᑦ: ᓄᓇᐃᑦ ᐅᑭᐅᖅᑕᖅᑐᒥ, ᓇᐹᖅᑐᖃᖕᒋᑦᑐᑦ, ᐃᒃᐲᕐᓇᖅᑐᑦ, ᐱᕈᑯᑖᖕᓇᖕᒋᑦᑐᑦ, ᒪᕐᑯᓗᐊᕈᓐᓇᖕᒋᑦᑐᑦ. ᓄᓇᒥᐅᑕᕐᑲᖅᑐᑦ ᓄᓇᔭᒥᒃ, ᑎᖕᒋᐅᔭᓂᒃ, ᐊᓯᖕᒋᓐᓂᓗ ᐱᕈᖅᑐᓂᒃ ᒥᑭᔫᑎᓂᒃ. Hoezì: Edzanè k'è dechîla gots'ô chîk'èda hozì k'è edza, wha gots'ö t'asi dehshe le eyits'ô ch'ô at'î laàni le. Hozì k'è kw'ah, adzîî, gots'agoò eyits'ô k'òò haàni zô dehshe hôt'e. Hazúk'e Hazúk'e t'a hûlî sí, hak'ádh nátsÿr xél thá æasí neshele-u, hazóghe tth'i dek'á-u. T'a kúzí daníshe xadé, tth'ÿl-u, tthe ts'î-u, Labrador lídí-u, tth'i k'ai ní ts'çnídháile neshe.
Turbidity	A condition of reduced transparency in water caused by suspended colloidal or particulate material; measured by a turbidimeter and recorded as nephelometric turbidity units (NTU). ᒪᕋᐃᓐᓇᖅ ᐃᒪᖅ: ᐃᒪᖅ ᑕᑯᒃᓴᐅᖏᑦᑐᖅ ᒪᕋᐃᓇᐅᕙᒥ, ᓯᓇᕐᑲᕋᒥᓗᓐᓃᑦ Ehtå'ètìì/muddy water Xatå'ÿs túç
Underground mine	An excavation underground to extract ore or minerals. ᓄᓇᐅᕐ ᐃᓗᐊᓂ ᐅᔭᕋᖕᓂᐊᕐᕕᒃ: ᐅᔭᕋᐃᔭᐃᕕᒃ ᓄᓇᐅᑉ ᐃᓗᐊᓃᑦᑐᖅ Ndè gotå'a/underground
Valued Ecosystem Component (VEC)	An environmental attribute or component having scientific, social, cultural, economic or aesthetic value. For instance, caribou are a VEC; so too are fish and water quality. ᐱᒻᒪᕆᐅᓂᖕᒋᑦ ᓄᓇᒦᑦᑐᑦ ᓄᓇᒥᐅᑕᐃᓪᓗ ᓴᐳᓐᓂᐊᖅᑕᐅᓯᒪᔭᓇᐊᓖᑦ: ᐊᕙᑎᒥ ᓯᓇᑐᐃᓐᓇᐃᑦ ᐱᒻᒪᕆᐅᔪᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ, ᐃᓄᓯᕐᒧᑦ, ᐃᓕᖅᑯᓯᕐᒧᑦ, ᐃᓅᓯᓕᐅᕈᓐᓇᕐᓂᕐᒧᑦ ᐅᕙᓘᓐᓃᑦ ᑕᑯᕋᓐᓂᕐᓂᖕᒋᓐᓄᑦ. ᓱᕐᓗ ᐆᒃᑑᑎᒋᓗᒍ, ᑐᒃᑐᐃᑦ ᐱᒻᒪᕆᐅᕗᑦ, ᐊᒻᒪᓗ ᐃᖃᓗᐃᑦ, ᐊᒻᒪᓗ ᐃᒪᐃᑦ ᐱᐅᔫᓂᖕᒋᑦ. Asìi wet'aæà wexòedi/something important being looked after Ni k'e æasíe bet'óreæa badi
Vascular plant	Plants that have true roots, leaves and stems and an internal structure capable of actively taking up water and nutrients from the soil (e.g., trees, grasses, and shrubs). These plants are also capable of transporting products derived from the sun through the plant. Naotiat naovelgit mahongnik: Naotiat maholgit iloanit naovakiblotik emakmiklo negiblotiklo nunamit. Hapkoat napaaktotlo evgitlo kongoleetlo naovangmiyot. Emaalo hikinekmit engilgablotik naotiatigot. ᐱᕈᖅᑐᑦ ᐊᐃᕋᖅᑲᖅᑐᑦ ᐃᒪᖅᑐᖅᑐᑦ: ᐱᕈᖅᑐᑦ ᐃᒪᖅᑐᖅᑐᑦ, ᐊᐃᕋᐃᑦ, ᐅᖅᑲᐅᔭᓖᑦ, ᐃᒥᖅᑐᑦ ᓂᕆᔪᓪᓗ ᓄᓇᒥ (ᓇᐹᖅᑐᐃᑦ, ᓇᐹᖅᑐᔭᐃᑦ, ᐅᖅᑲᐅᔭᐃᓪᓗ). ᑕᒪᒃᑯᐊ ᓯᕿᓂᖕᒥᒃ ᐆᒻᒪᓂᖅᑲᖅᑐᑦ. Ndè ts'ô ît'ö ti edô: Dechî k'è ît'ö, wechï eyits'ô wexo gòåî sìi wet'à ti ìchì t'à eda sìi agihdi (ts'i, tå'o eyits'ô k'òò laàni). Eyits'ô dechî di laàni sìi sadè t'à sìi dehshe hôt'e. T'âchay ní túç hedâgh

Term	Description
Vertebrate	A collective term for all animals with a backbone or spinal column ᐆᒪᔪᐃᑦ ᓴᐅᓂᓖᑦ ᕿᒥᕐᓗᖃᖅᑐᑦ: ᐆᒪᔪᐃᑦ ᐊᔾᔨᒌᖕᒋᑦᑑᑎᑦ ᓴᐅᓂᖃᖅᑐᑦ ᑐᓄᖕᒥᒍᑦ ᕿᒥᕐᓗᓖᑦ. Wenôhkw'ô/backbone Tech’adie ben‡ne hûli
Waste rock	*All unprocessed rock materials that are produced as a result of mining operations. Oyakat hoongitot oyagaghioktonot atoktaolimainmatta: Oyakat hoongitot oyagaghioktonot atoktaolimainmatta. ᐊᒃᑕᑯᒃᓴᐃᑦ ᐅᔭᖁᐃᑦ: ᐅᔭᖁᐃᑦ ᐃᓗᓕᖃᖕᒋᓗᐊᖅᑐᑦ ᐱᔪᒪᔭᐅᔪᓂᒃ ᐱᓕᕆᐊᖑᓂᐊᖕᒋᑦᑐᑦ, ᐊᑐᖅᑕᐅᔮᓇᑎᒡᓗ ᓴᓇᓂᕐᒧᑦ. Kwè ch’ì: Kwè ch’ì wedê siì agihdi Tthe bet’óre æáíle: Tthe bet’óreæaíle to náldeth xa hunédíle to æasí xa bet’aát’î xa æâîle sí.
Water balance	The difference between the amount of water going in and amount of water leaving. ᐃᒪᐃᑦ ᐃᒻᒪᕈᖅᐸᓪᓕᐊᔪᑦ ᐃᒪᐃᔭᖅᐸᓪᓕᐊᔪᓪᓗ ᓇᓕᒧᒌᖕᓂᖕᒋᑦ: ᐊᔾᔨᒌᖕᒋᓐᓂᖕᒋᑦ ᐃᒪᕈᖅᐸᓪᓕᐊᓂᖕᒋᑦ ᐊᒻᒪᓗ ᐃᒪᐃᔭᖅᐸᓪᓕᐊᓂᖕᒋᑦ Ti edàtåô ek'eètå'ì/how water flows to another lake T’anílt’e tu æeåk’énaretå’ir
Water Licence	A licence given by regulatory authorities (for example, the Mackenzie Valley Land and Water Board) to allow a specific project to use or dispose of water. The licence outlines what specific activities can and cannot take place. ᐃᒪᓕᕆᓂᕐᒧᑦ ᓚᐃᓴᓐᓰᑦ: ᓚᐃᓴᓐᓰᑦ ᑐᓂᔭᐅᔪᑦ ᐊᖓᔪᖅᑳᕐᓂᒃ (ᓲᕐᓗ ᐃᒪᓕᕆᔨᒃᑯᑦ ᑲᑎᒪᔨᖕᒋᓐᓂᒃ) ᐱᓕᕆᓂᐊᕐᒪᑕ ᑐᓂᔭᐅᔪᑦ ᐊᑐᕈᓐᓇᕐᓂᐊᕐᒪ ᐃᒪᕐᓂᒃ ᐊᒻᒪᓗ ᐊᒃᑕᖅᑕᐅᔪᓐᓇᕐᓗᑎᒃ ᐃᒪᐃᑦ, ᐃᒪᕐᔫᑏᓪᓗ. ᓚᐃᓴᓐᓯᒥᒃ ᐅᖃᖅᓯᒪᕙᒃᑐᑦ ᖃᓄᖅ ᐱᓕᕆᔪᓐᓇᕐᒪᖔᑕ ᖃᓄᕐᓗ ᐱᓕᕆᔪᓐᓇᖕᒋᓪᓚᑖᕈᓐᓂᑦ. Ti nîhtå'è/water licence Tu xa æerehtå’ís
Watershed	A region or area bordered by ridges of higher ground that drains into a particular watercourse or body of water. ᐃᒪᖃᖄᑦ ᐊᕙᑎᖕᒋᓪᓗ: ᐊᕕᒃᑐᖅᓯᒪᔪᑦ ᓄᓇᐃᓪᓗ ᐳᖅᑐᓂᐅᔪᑦ ᖃᖃᔫᑦ ᐃᒪᐃᔭᖃᑦᑕᖅᑐᑦ ᖃᓂᒋᔭᖕᒋᓐᓄᑦ ᐃᒪᕕᖕᓄᑦ ᑕᓯᕐᓄᓪᓗᓐᓃᑦ. Ti nîhtå'è/water licence Tu thekâ
Weathering	The natural process which breaks down rock and other substrate by chemicals, wind and water. ᓯᓚᒧᑦ ᓄᖑᑉᐸᓪᓕᐊᓂᖅ: ᓯᓚᒧᑦ ᓱᕋᒃᑎᖅᐸᓪᓕᐊᔪᑦ ᓄᖑᑉᐸᓪᓕᐊᔪᓗᓐᓃᑦ ᐅᔭᖁᐃᑦ ᐊᓯᖏᓄᓪᓗ ᓱᓇᑐᐃᓐᓇᓄᑦ, ᐊᓄᓂᒧᑦ ᐊᒻᒪᓗ ᐃᒪᕐᒧᑦ. Naàza/getting worn down Názas
Wetland	A swamp, marsh, or other land that is usually water-saturated. ᓄᓇᐃᑦ ᐃᒪᐃᓐᓇᕐᑏᑦᑐᑦ: ᐃᒪᐃᑦ ᒪᓴᐃᑦ, ᓄᓇᐃᓗᓐᓃᑦ ᐃᒪᐅᓂᕐᑏᑦᑐᑦ. Ndèhtì/water land Níæél

Term	Description
Zone of instability	**Also known as zone of influence, or subsidence zone. A zone in which re-distribution stresses may occur to rock that accompanies the development of underground mine operations. This can cause local areas of failure at open pit edges and/or subsidence above underground mines. Limits of the zone are determined by local experience and numerical modeling.** ᓄᓇᐅᑉ ᐳᐊᕐᕆᔭᕐᑕᐅᓯᒪᓂᖓᓂ ᑲᑕᒐᓕᕈᓐᓇᕐᓂᖓ: ᓄᓇᐅᓂᖓ ᑲᑕᒐᑐᐃᓐᓇᕆᐊᓕᒃ ᒪᑭᑕᔪᓐᓃᑐᐃᓇᕆᐊᓕᒃ ᐅᔾᔨᕐᑐᕐᑕᐅᑦᑎᐊᕆᐊᓕᒃ ᓄᓇᐅᑦ ᐃᓗᐊᓃᑦᑐᕐ ᓯᑎᓂᕐᐸᓕᒃ ᐃᓗᐊᓂ, ᓱᓪᓗᓕᐅᔮᕐᓯᓂ. ᐊᖏᓂᖓ ᓯᕋᑐᐃᓐᓇᕆᐊᓕᒃ ᓄᓇ, ᐊᕐᑭᐅᒪᓲᕐ ᐊᕙᓗᖓᓂᒃ ᐊᖕᒪᔩᑉ, ᐅᔭᕋᐅᑉ ᖃᓄᐃᓂᖏᓐᓂᒃ ᐊᒻᒪᓗ ᐃᓗᑐᓂᖓᓂᒃ ᐅᔭᕋᖕᓂᐊᕐᕕᐅᔩᑉ. Ndè weyììgôöæa wemôö wexòedi/cautious around the hole their working on Ni yéoniæa náre horehåi

Appendix 1.1-3

Terms of Reference for the EKATI ICRP

Engineers and Scientists

Appendix 1.1-3. Terms of Reference for the EKATI ICRP

Preface

The following Terms of Reference (TOR) were prepared by BHP Billiton and reviewed by a Working Group established by the Wek'èezhìi Land and Water Board (WLWB). The Working Group included representatives of the communities, regulatory agencies, the Independent Environmental Monitoring Agency (IEMA) and BHP Billiton. The TOR were approved by the WLWB in May 2006.

In this appendix, the TOR were presented in the form of a table of contents for the ICRP. They contain the major tasks and components of the ICRP, and those reclamation requirements that are outlined in the two Class A Water Licenses MV2003L2-0013 and MV2001L2-0008. References are provided throughout the document to the specific requirements outlined in each of MV2003L2-0013 (0013 Part J) and MV2001L2-0008 (0008 Part L).

Terms of Reference

EXECUTIVE SUMMARY

The Executive Summary section will include a company overview.

INTRODUCTION

The Introduction section will outline the stages of closure planning, objectives of the ICRP and a cost estimate summary.

Closure Plan Requirements

Regulatory Requirements

This section will open with a discussion on the development of the ICRP since 1995 when the Environmental Impact Statement was submitted to Environmental Assessment Review Panel. There are a number of regulatory requirements that affect the content and development of the ICRP. BHP Billiton is required to prepare and submit for approval an updated ICRP under the two Class A Water Licenses MV2003L2-0013 and MV2001L2-0008. As a condition of the original Class A Water License N7L2-1616, the ICRP was submitted to the Mackenzie Valley Land and Water Board (MVLWB) in October 1997 and subsequently approved by the Board in February 1998. The Plan was later updated in 2000 and approved in 2002.

Regulatory documents which have specific reclamation and closure requirements for the EKATI Diamond Mine have been listed below. The requirements for each of these will be summarized in the ICRP.

- Class A Water License MV2003L2-0013. The license is a renewal of the N7L2-1616 Class A Water License and covers the main EKATI mine site, including Panda, Koala, Fox and Misery Pits. The license was issued October 2005, and expires October 2013.

- Class A Water License MV2001L2-0008, Sable, Pigeon, Beartooth expansion. The license was issued in August 2002 and expires in August 2009.
- Environmental Agreement. Issued in January 1997.
- Class B Water License MV2001L2-0004, Sable Haul Road, Falcon Road Watering Station. The license was issued in October 2001, and expired in October 2006.
- Class B Water License MV2001L2-0002, Lac de Gras Area, Misery Road Watering. The license was issued in July 2002 and expires in July 2013.
- Class B Water License MV2002L2-0003, Misery Area, Experimental Water Treatment Project. The license was issued in March 2003 and expired in March 2008.
- Class A Land Use Permits MV2002C0040 (EKATI Claim Block); MV2001F0032 (EKATI mine site); MV2001X0071 (Sable Pipe); and MV2001X0072 (Pigeon Pipe).
- Land Leases: 76D-9-3-2; 76D-9-4-2; 76D-10-2-2; 76D-10-3-2; 76D-10-4-2; 76D-10-5-2; 76D-10-7-2; 76D-15-4-2.
- Authorization for the Harmful Alteration, Disruption or Destruction of Fish Habitat (Fisheries Authorizations, Fish Habitat Compensation Agreements): SCA96021, SC00028, SCO1111, and SCO1168.

Regulatory Conformance

A summary table and cross reference document will be developed and included to demonstrate how and where the specific regulatory requirements for closure are considered in the ICRP. This section will also include a description of the measures required, actions taken, and how success of reclamation measures will be evaluated, to achieve the objectives stated in the January 2006 Indian and Northern Affairs Canada (INAC) "Mine Site Reclamation Guidelines for the NWT" **[0013 Part J.1,a) & d); and 0008 Part L. 1, c)]**.

BHP Billiton Closure Standards

BHP Billiton has a Closure Standard that guides and assists the company in achieving a number of objectives with respect to responsible reclamation and closure worldwide. There are seven Requirements within the Closure Standard which are mandatory for all BHP Billiton investment opportunities and controlled operations. The Closure Standard does not take the place of legislative or regulatory requirements. Therefore, when applying the procedures set out in the Closure Standard, relevant legal frameworks shall also be complied with.

The seven Requirements in the BHP Billiton Closure Standard are as follows:

- Closure plans are required for all investment opportunities.
- Closure plans are required for all operations.
- Identification of risks and potential outcomes.
- Estimation of the expected cost of closure.
- Timely and efficient execution of closure plans.
- Reporting, auditing and governance procedures.
- Application of project management practices.

SCOPE

Terms and Definitions

Closure and reclamation terms and definitions are identified as important information when discussing the primary activities and purpose of conducting reclamation planning and operations. The following are selected terms and definitions included in this Terms of Reference and the ICRP:

- ***Reclamation***. Activities which return affected areas to viable and, wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment and with human activities.
- ***Closure***. When a mine ceases commercial production (in whole, or in part through progressive closure of mine components) without the intent to resume mining activities in the future.
- ***Mine Component***. A physical area of the mine site treated as an independent unit for reclamation planning and application of reclamation goals and closure criteria.
- ***Closure Options***. One or more proposed reclamation activities for mine components.
- ***Goal***. The goal of reclamation is to return the EKATI mine site to viable and, wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment and with human activities.
- ***Objectives***. Describes what the reclamation activities intend to achieve for each mine component (e.g., Stable landforms, protection of water resources and re-establishment of productive use of land – Aboriginal and wildlife).
- ***Closure Criteria***. Closure criteria are used to define specific performance requirements for progressive reclamation and closure of mine components. They are also used to determine successful reclamation and the completion of monitoring programs (e.g., water license discharge criteria).

A comprehensive list of acronyms and a glossary of reclamation related terms, together with corresponding Aboriginal Glossary for each of Inuinnaqtun, Tlicho, and Chipewyan terms will be included in Appendix A [now Appendices 1.1-1 and 1.1-2].

Community

Community Strategy and Consultation

A strategy for incorporation of traditional knowledge will be included, as well as a summary of the community and stakeholder consultation that has taken place in the development of closure objectives and the ICRP. An overview of traditional knowledge incorporation, participating communities, consultation meetings, and topics of discussion will be covered in Appendix B [now Appendix 2.1-1]. Locations and activities where Traditional Knowledge has been used for reclamation will be provided.

Social and Economic Benefits

A number of social and economic benefits to the local and regional communities have been provided through the development and operation of EKATI. There are also similar issues regarding closure of the mine that will be addressed such as ongoing employment during reclamation and closure, alternative uses for the facilities, long-term ownership of the site and business opportunities during closure.

PROJECT BACKGROUND

General

A brief summary providing the history of the EKATI mine site from exploration through development will be included in this section.

Location and Access

This section will contain a brief description of the region and logistics, including maps and figures.

Climate

Historical (where possible) and current regional climate data will be summarized and presented, along with trends, and any predicted changes.

Terrestrial Environment

The physical environment within the EKATI project area will be described including landscape, vegetation and permafrost features.

Aquatic, Flora and Fauna Environment

The aquatic, flora and fauna environment within the EKATI project area will be described.

Land Use

The pre-mining and current land use within the EKATI project area will be described. This will include a detailed description, including maps and other visual presentations, of the pre-disturbance conditions for each mine component. **[0013 Part J. 1, e); and 0008 Part L. 1, d)]**. A summary of historical and current land use in the EKATI lease area by Aboriginal peoples, and other users will be included. The current predominant land use is wildlife habitat. Land use by Valued Ecosystem Components (VECs) that were defined by communities during the EKATI environmental assessment will be described. These VECs include animals such as the Bathurst Caribou which migrate through the area to access spring calving and winter forage grounds; Grizzly bears, wolves, foxes, wolverines and small mammals. Most bird species are only summer residents but include loons, sandpipers, passerines, and a few raptor species. Ravens and snowy owls are present year round. The lakes support predominantly lake trout, round whitefish, and arctic grayling.

Lessons Learned

The Lessons Learned section will include examples and lessons learned in successful planning throughout BHP Billiton and from other northern mines.

The Environmental Impact Statement for the EKATI Diamond Mine (1995) outlined the Reclamation, Decommissioning and Closure Plan for EKATI. This section will also include a comparison summary of the reclamation objectives covered in the 1995 EIS, and the subsequently approved Abandonment and Reclamation Plan compared to the updated ICRP. Results from research studies, mining experience, updated Life of Mine Plans, and changes in the regulatory regime will be included as part of a section on lessons learned and the evolution of the ICRP through operational life of the mine. The 2000 Interim Abandonment and Reclamation Plan is the most recent plan approved by the MVLWB, in 2002. This approved plan will serve as the basis for development and comparison of the updated ICRP.

MINE OVERVIEW

Mine Components

The following list of mine components will be covered in the ICRP:

- Open Pits (Sable, Pigeon, Beartooth, Panda, Koala, Fox and Misery).
- Underground Mines (Koala North, Panda and Koala).
- Waste Rock Storage Areas (Sable, Pigeon, Panda/Koala/Beartooth, Fox and Misery).
- Long Lake Containment Facility.
- Dams, Dikes and Channels (Two Rock Dam and Dike, Pigeon Stream Diversion, Bearclaw Dam, Beartooth Pipeline, Panda Dam, Panda Diversion Channel, Outlet Dam, King Pond Dam, Waste Rock Dam and East/West Coffer Dams).
- Buildings and Infrastructure (equipment, petroleum and chemical storage facilities, borrow pits (quarry sites), landfills and waste disposal sites, sedimentation ponds, laydown and camp pads, ore storage pads, surface structures and buildings, roads and airstrip, satellite facilities and exploration camps).

[0013 Part J.1, c); and 0008 Part L.1, a), & g)].

Mining

An overview of the mining process will be included in this section. The general steps involved in both the open pit and underground mining operations will be summarized. This summary will provide a layman's description of the various processes required to mine and deliver kimberlite ore for processing and diamond recovery.

Kimberlite Processing

An overview of the kimberlite processing facilities and operation will be provided. The relationship and effects of the kimberlite processing operation on the Long Lake Containment Facility (LLCF) will be discussed.

Facilities and Infrastructure

The support and ancillary facilities will be discussed, including camp accommodations, sewage treatment, maintenance/truck shop, power generation, offices and warehouse, and fuel storage.

Materials/Waste Management

The program of managing waste and waste materials (hydrocarbon impacted soils, non hazardous wastes) during mine operations will be summarized. The details for remediation of remaining wastes will be presented, along with volumes of waste materials produced and stored by type and location (to the extent possible), with attention to materials requiring mitigative measures **[0013 Part J. 1, l); and 0008 Part L .1,l)].** Also included will be land fill locations and expected volumes of demolition materials at mine closure. Maps showing sources and stockpile locations of present and future materials proposed for reclamation needs will be included **[0013 Part J.1,f); and 0008 Part L.1,3)]**.

Life of Mine Plan

The current corporate approved Life of Mine (LOM) Plan will be presented as the basis for future disturbance and progression of the operation. The LOM Plan is a dynamic, living document and it is expected to change during the period of time that the ICRP is being prepared. The Fiscal Year 2005 LOM Plan will form the basis for the progressive reclamation schedule, decommissioning and closure monitoring schedule.

Organization Structure

The management and reporting system (organization chart), qualifications, and company position of BHP Billiton employees, as well as consultant companies responsible for reclamation planning and closure, conducting reclamation activities and closure monitoring will be provided **[0013 Part J. 1,o); and 0008 Part L. 1,o)]**.

SUMMARY OF CLOSURE REQUIREMENTS

Open Pits

Pre-Disturbance Conditions

A detailed description including maps and other visual representations where available will be included to show the pre-disturbance condition of the Open Pits components **[0013 Part J.1,e); and 0008 Part L.1,d)]**. In addition to the landscape and physical features, aquatic habitat and chemical (water quality) conditions will be summarized and presented.

Development Status

A visual representation and written summary of current disturbance and development of the Open Pits components will be provided.

Projected Development and Final Landscape

A visual representation and written summary of the expected development of each individual open pit at the end of the mine life will be presented. This will include expected pit dimensions, areas and volumes, a description of the final landscape, including connecting streams and surface drainage into and adjacent to open pits, and how aesthetic concerns will play a role in reclamation **[0013 Part J.1,e), & n); and 0008 Part L.1,d) & n)]**. Considerations and examples of designing for closure during the mining operations phase will also be covered, as well as an assessment of long term climate change effects in the closure planning of open pits.

Closure Objectives and Criteria

Reclamation closure objectives and criteria will be provided for the Open Pits mine components. Closure criteria will be used to measure reclamation success **[0013 Part J. 1, a)]**, **[0013 Part J.1,a) & c); and 0008 Part L.1,a)]**. A complete list of closure objectives and criteria for all mine components will be located in Appendix C [now Appendix 5.1-1].

Engineering and Environment Work

The selected closure options identified for the Open Pits mine components will be presented in this section, including a summarized description of the physical reclamation activities undertaken to close mine components and achieve closure objectives and closure criteria. Because closure options may vary between open pits, this section will include the list of activities associated with each of the selected options.

Identified Risks and Contingencies

Identified high level closure and reclamation risks, including any identified residual risks and effects will be summarized for the Open Pits mine components. Contingency measures will be included for the identified risks. This will be an integrated approach in which monitoring results will be used to review and update risk registries and contingency measures, as well as measure the effectiveness and performance of the closure criteria.

An example of a potential risk for open pits (should they be filled with water) is that meromictic conditions may result in water quality which does not meet discharge criteria. **[0008 Part L.1,b)]**. Monitoring results from water quality sampling will assess the ability to meet this criterion. An example of a contingency measure for this potential risk would include description of any post-closure treatment potentially required for drainage water that is not acceptable for discharge from the mine component or involve the identification of alternative closure methods. **[0013 Part J.1,h); and 0008 Part L.1,a) & b) & h)]**. Pit water quality predictions for each open pit will be provided for pit closure options and contingency measures for meromictic conditions in possible pit lakes **[0013 Part J.1,l); and 0008 Part L.1,l)]**. A complete list of identified risks and contingencies for all mine components will be located in Appendix E [now Appendix 5.1-3].

Reclamation Research

This section would include a summary of opportunities that require further investigation. Because this is an Interim Closure Plan continuing research studies will be identified for alternative closure methods and identified reclamation projects for open pits. Analysis of pit closure options will include a literature review and summary of converting open pits into pit lakes, an evaluation of flooding alternatives, primarily natural and pump flooding, effects on source lakes, and evaluation to minimize effects on source lakes. A research study that assesses the water quality trends in existing pit waters as well as predicted models for pit water quality post closure will be outlined and included as part of the Reclamation Research Plan in Appendix F [now Appendix 5.1-4A].

Post-Closure Monitoring

A list of monitoring requirements and monitoring schedule for the Open Pit mine components will be provided. Monitoring parameters and schedule to measure and assess reclamation success against closure criteria and provide triggers for maintenance and contingency actions will also be included. Because closure options may vary for each or a combination of the open pits, the post-closure monitoring will pertain to the closure option identified. Pit wall geochemistry and potential for acid/alkaline rock drainage and metal leaching is an example of one of the monitoring components which may be included in this section **[0013 Part J.1,l); and 0008 Part L.1,l)]**. The complete list of monitoring requirements and schedule for all mine components will be provided in Appendix G [now Appendix 5.1-5].

Cost Estimate

A table will be provided that summarizes the reclamation cost estimate for the Open Pits mine components. A complete summary of the reclamation cost estimates for all mine components will be located in Appendix H [now Appendix 5.1-6].

Underground Mines

Pre-Disturbance Conditions

A detailed description including maps and other visual representations where available will be included that shows the pre-disturbance condition of the Underground mine components **[0013 Part J.1,e); and 0008 Part L.1,d)].**

Development Status

A visual representation and written summary of the current disturbance and development of this reclamation unit will be provided.

Projected Development and Final Landscape

A visual representation and written summary of the expected development of each individual underground mine at the end of the mine life will be presented. This will include a description of the final landscape, and how aesthetic concerns will play a role in reclamation **[0013 Part J.1,e), & n); and 0008 Part L.1,d) & n)]** as well as predicted groundwater quality and quantities, and status of talik (if available). Considerations and examples of designing for closure during the mining operations phase will be covered.

Closure Objectives and Criteria

Reclamation closure objectives and criteria will be provided for the Underground mine components. Closure criteria will be used to measure reclamation success **[0013 Part J. 1, a)]**, **[0013 Part J.1,a) & c); and 0008 Part L.1,a)]**.

Engineering and Environment Work

The selected closure options identified for the Underground mines components will be presented in this section, including a summarized description of the physical reclamation activities undertaken to close mine components and achieve closure objectives and closure criteria.

Identified Risks and Contingencies

Identified high level closure and reclamation risks, including residual risks and effects will be summarized for the Underground mine components. Contingency measures will be included for the identified risks. This will be an integrated approach in which monitoring results will be used to review and update risk registries and contingency measures, as well as measure the effectiveness and performance of the closure criteria.

Reclamation Research

This section would include a summary of opportunities that require further investigation. Because this is an Interim Closure Plan continuing research studies will be identified for alternative closure methods and identified reclamation projects for underground mines.

Post-Closure Monitoring

A list of monitoring requirements and monitoring schedule for the Underground mine components will be provided. Monitoring parameters and schedule to measure and assess reclamation success against closure criteria and provide triggers for maintenance and contingency actions will also be included.

Cost Estimate

A table will be provided that summarizes the reclamation cost estimate for the Underground Mine components. A complete summary of the reclamation cost estimates for all mine components will be located in Appendix H [now Appendix 5.1-6].

Waste Rock Storage Areas (WRSA)

Pre-Disturbance Conditions

A detailed description including maps and other visual representations where available will be included to show the pre-disturbance condition of the WRSA mine components **[0013 Part J.1,e); and 0008 Part L.1,d)]**. In addition to the landscape and physical features, biological, vegetation and wildlife conditions will be summarized and presented.

Development Status

A visual representation and written summary of the current disturbance and development of the WRSA mine components will be provided. Areas, heights, slope angles, relevant topography **[0013 Part J.1,l); and 0008 Part L.1,l)]** and methods of storing potentially acid generating (PAG) materials in waste rock storage facilities/dumps will be included.

Projected Development and Final Landscape

Volumes of waste materials produced and stored by type and location will be included, with particular attention to materials requiring measures to mitigate impacts from water that is not acceptable for discharge. Wildlife considerations will be addressed. The section will also include considerations of other potential uses of waste rock during closure. Also included will be a description of the final landscape, and surface drainage from the WRSA mine components, and how aesthetic concerns will play a role in reclamation **[0013 Part J.1,e), & n); and 0008 Part L.1,d) & n)]**. Information about temperature trends and ice content in waste rock storage areas will be provided. The efficacy of waste rock pile designs will be described. An assessment of the long term trends and potential for impacts on physical stability (related to temperature or re-handling) and water quality and quantity will be presented, as well as an assessment of long term climate change effects in the closure planning of WRSA. Considerations and examples of designing for closure during the mining operations phase will be covered.

Closure Objectives and Criteria

Reclamation closure objectives and criteria will be provided for the WRSA mine components. Closure criteria will be used to measure reclamation success **[0013 Part J. 1, a)]**, **[0013 Part J.1,a) & c); and 0008 Part L.1,a)]**.

Engineering and Environment Work

The selected closure options identified for the WRSA mine components will be presented.

Identified Risks and Contingencies

Identified high level closure and reclamation risks, including residual risks and effects will be summarized for the WRSA mine components. Contingency measures will be included for the identified risks. This will be an integrated approach in which monitoring results will be used to review and update risk registries and contingency measures, as well as measure the effectiveness and performance of the closure criteria.

Water quality trends in the WRSA, coarse kimberlite rejects and low grade kimberlite stockpiles will be provided **[0013 Part J.1,l); and 0008 Part J.1,l)].** The potential for metal leaching characteristics and/or ARD from waste rock storage material will be assessed, and a description of any contingency treatment required for waste rock seepage will be included **[0013 Part J.1,h), l);and 0008 Part L.1,h) & l)].**

Reclamation Research

This section would include a summary of opportunities that require further investigation. Because this is an Interim Closure Plan continuing research studies will be identified for alternative closure methods and identified reclamation projects for WRSA mine components.

Post-Closure Monitoring

A list of monitoring requirements and monitoring schedule for the WRSA mine components will be provided. Monitoring parameters and schedule to measure and assess reclamation success against closure criteria and provide triggers for maintenance and contingency actions will also be included.

Cost Estimate

A table will be provided that summarizes the reclamation cost estimate for the WRSA mine components. A complete summary of the reclamation cost estimates for all mine components will be located in Appendix H [now Appendix 5.1-6].

Long Lake Containment Facility (LLCF)

Pre-Disturbance Conditions

A detailed description including maps and other visual representations where available will be included to show the pre-disturbance condition of the LLCF mine component **[0013 Part J.1,e); and 0008 Part L.1,d)].** In addition to the landscape and physical features, aquatic habitat and chemical (water quality) conditions will be summarized and presented.

Development Status

A visual representation and written summary of the disturbance and development of the LLCF unit will be provided. This serves as the basis for developing closure alternatives. The general operating parameters and conditions of the LLCF will be described. Topics including access, water reclaim system and operation, intermediate dikes, spring freshet, water management and ice entrainment will be discussed to set the framework for the operational issues of the LLCF. The historic tonnage and volume placement by area within the LLCF will be presented along with a potential sequential filling schedule and timeline for the remaining cells and capacity in the LLCF.

Projected Development and Final Landscape

The basis of the LOM Plan development for the LLCF will be the design and management plan developed as a result of the Multiple Accounts Analysis (MAA) completed in August 2004 (Option 3aM). A visual representation and written summary of the expected development of the LLCF at the end of the mine life will be presented, along with a description of the final landscape, and how aesthetic concerns will play a role in reclamation **[0013 Part J.1,e), & n); and 0008 Part L.1,d) & n)]**. The methods, timing and details respecting the placement of a rock cover (if selected as the closure option) and the development of permafrost in processed kimberlite will be discussed as part of the reclamation process **[0013 Part J.1,l); and 0008 Part L.1,l)].**

Areas of processed kimberlite beaches and consolidated slurries will be included in a projected layout of the facility at the end of operations **[0013 Part J.1,l)].** Methods for stabilization of processed kimberlite from water and wind erosion during operations and post closure will be covered. The construction and stability of surface drainage channel(s) over reclaimed processed kimberlite will be included in this section as part of the long-term conditions of the closed facility **[0013 Part J.1,l); and 0008 Part L.1,l)].** Permafrost development, expected changes in geochemistry and water quality trends will also be covered, as well as an assessment of long term climate change effects in the closure planning of the LLCF. Considerations and examples of designing for closure during the mining operations phase will be covered.

Closure Objectives and Criteria

Reclamation closure objectives and criteria will be provided for the LLCF mine component. Closure criteria will be used to measure reclamation success **[0013 Part J. 1, a)]**, **[0013 Part J.1,a) & c); and 0008 Part L.1,a)]**.

Engineering and Environment Work

The selected closure options identified for the LLCF mine component will be presented in this section, including a summarized description of the physical reclamation activities undertaken to close the LLCF and achieve closure objectives and closure criteria.

Cover design options will be discussed as well as the methods, timing, and details respecting the placement of material or water or vegetation (if selected).

Identified Risks and Contingencies

Identified high level closure and reclamation risks, including residual risks and effects will be summarized for the LLCF mine component. Contingency measures will be included for the identified risks. This will be an integrated approach in which monitoring results will be used to review and update risk registries and contingency measures, as well as measure the effectiveness and performance of the closure criteria. An example of an identified risk is metals uptake by wildlife and humans. A Tier 1 risk assessment is currently being conducted to assess the feasibility of vegetation as a cover material for processed kimberlite. The results from this assessment will assist in determining the future reclamation approach for the LLCF. Also, in the event the long-term chemical stability and water quality performance in the LLCF is not acceptable, then treatment contingency and management plans will be presented to ensure acceptable discharge water quality from this facility **[0008 Part L.1,b)].**

Reclamation Research

This section would include a summary of opportunities that require further investigation. A reclamation research schedule and the questions which the research intends to answer will also be included. Because this is an Interim Closure Plan continuing research studies will be identified for alternative closure methods and identified reclamation projects for the LLCF.

Post-Closure Monitoring

A list of monitoring requirements and monitoring schedule for the LLCF mine component will be provided. Monitoring parameters and schedule to measure and assess reclamation success against closure criteria and provide triggers for maintenance and contingency actions will also be included.

Cost Estimate

A table will be provided that summarizes the reclamation cost estimate for the LLCF mine component. A complete summary of the reclamation cost estimates for all mine components will be located in Appendix H [now Appendix 5.1-6].

Dams, Dikes and Channels

Pre-Disturbance Conditions

A detailed description including maps and other visual representations where available will be included to show the pre-disturbance condition of the Dams, Dikes and Channel mine components **[0013 Part J.1,e); and 0008 Part L.1,d)].** In addition to the landscape and physical features, biological, vegetation and wildlife conditions will be summarized and presented.

Development Status

A visual representation and written summary of the disturbance and development of the Dams, Dikes and Channels mine components will be provided.

Projected Development and Final Landscape

The projected status, development and location of the dams, dikes and channels located throughout the site will be presented. Considerations and examples of designing for closure during the mining operations phase will be covered, as well as how aesthetic concerns will play a role in reclamation **[0013 Part J.1,n); and 0008 Part L.1, n)]**.

Closure Objectives and Criteria

Reclamation closure objectives and criteria will be provided for the Dams, Dikes and Channels mine components. Closure criteria will be used to measure reclamation success **[0013 Part J. 1, a)]**, **[0013 Part J.1,a) & c); and 0008 Part L.1,a)]**.

Engineering and Environment Work

The selected closure options identified for the Dams and Dikes and Channels mine components will be presented in this section, including a summarized description of the physical reclamation activities undertaken to close mine components and achieve closure objectives and closure criteria. Breach locations and sizes for dams and dikes (if required) will also be provided **[0008 Part L.1,a)].**

Panda Diversion Channel (PDC)

The PDC was constructed between 1995 and 1997 as a temporary means of bypassing natural runoff around the Panda and Koala Pits as they were developed and mined. One closure option is to leave the PDC in place as a permanent landscape feature and fish passage channel. Modifications and design requirements for long-term use of the PDC will be presented as will an option for permanent closure. Constructability and permafrost issues will be included in the analysis. Effects on Fisheries Authorizations and the current aquatic habitat of the channel will also be discussed.

Pigeon Stream Diversion

The Pigeon Stream Diversion has not yet been constructed. It is anticipated to be a temporary means of bypassing natural runoff around the Pigeon pit as it is developed and mined. Closure options will be evaluated.

Beartooth Pipeline

The Beartooth pipeline was constructed as a temporary means of transferring natural runoff, and flow from the Bearclaw Lake around Beartooth pit, to Upper Panda Lake as it is developed and mined. Closure options for the pipeline will be discussed in this section.

Identified Risks and Contingencies

Identified high level closure and reclamation risks, including residual risks and effects will be summarized for the Dams, Dikes, and Channels mine components. Contingency measures will be included for the identified risks. This will be an integrated approach in which monitoring results will be used to review and update risk registries and contingency measures, as well as measure the effectiveness and performance of the closure criteria.

Reclamation Research

This section would include a summary of opportunities that require further investigation. Because this is an Interim Closure Plan continuing research studies will be identified for alternative closure methods and identified reclamation projects for dams, dikes and channels.

Post-Closure Monitoring

A list of monitoring requirements and monitoring schedule for the Dams, Dikes and Channels mine components will be provided. Monitoring parameters and schedule to measure and assess reclamation success against closure criteria and provide triggers for maintenance and contingency actions will also be included.

Cost Estimate

A table will be provided that summarizes reclamation cost estimate for the Dams, Dikes and Channels mine components. A complete summary of the reclamation cost estimates for all mine components will be located in Appendix H [now Appendix 5.1-6].

Buildings and Infrastructure

Pre-Disturbance Conditions

A detailed description including maps and other visual representations where available will be included that shows the pre-disturbance condition of the Buildings and Infrastructure mine components **[0013 Part J.1,e); and 0008 Part L.1,d)].** In addition to the landscape and physical features, aquatic habitat and chemical (water quality) conditions will be summarized and presented.

Development Status

A visual representation and written summary of the disturbance and development of these mine components will be provided. This serves as the basis for developing closure alternatives.

Projected Development and Final Landscape

A description and representation of the anticipated development and status of all buildings and infrastructure will be provided. Considerations and examples of designing for closure during the mining operations phase will be covered, as well as how aesthetic concerns will play a role in reclamation **[0013 Part J.1,n); and 0008 Part L.1,n)]**.

Closure Objectives and Criteria

Reclamation closure objectives and criteria will be provided for the Buildings and Infrastructure mine components. Closure criteria will be used to measure reclamation success **[0013 Part J. 1, a)]**, **[0013 Part J.1,a) & c); and 0008 Part L.1,a)]**.

Engineering and Environment Work

The selected closure options identified for the Buildings and Infrastructure mine components will be presented in this section, including a summarized description of the physical reclamation activities undertaken to close mine components and achieve closure objectives and closure criteria.

Selected closure and demobilization options for all building and facilities, equipment, petroleum and chemical storage areas, quarry sites, sedimentation ponds, laydown and camp pads, and roads and the airstrip will be provided in this section.

Identified Risks and Contingencies

Identified high level closure and reclamation risks, including residual risks and effects will be summarized for the Buildings and Infrastructure mine components. Contingency measures will be included for the identified risks. This will be an integrated approach in which monitoring results will be used to review and update risk registries and contingency measures, as well as measure the effectiveness and performance of the closure criteria.

Reclamation Research

This section would include a summary of opportunities that require further investigation. Because this is an Interim Closure Plan continuing research studies will be identified for alternative closure methods and identified reclamation projects for buildings and infrastructure.

Post-Closure Monitoring

A list of monitoring requirements and monitoring schedule for the Buildings and Infrastructure mine components will be provided. Monitoring parameters and schedule to measure and assess reclamation success against closure criteria and provide triggers for maintenance and contingency actions will also be included.

Cost Estimate

A table will be provided that summarizes the reclamation cost estimate for the Buildings and Infrastructure mine components. A complete summary of the reclamation cost estimates for all mine components will be located in Appendix H [now Appendix 5.1-6].

TEMPORARY CLOSURE MEASURES

Temporary Closure Measures

Details of closure measures proposed in the event of a premature or temporary shutdown at any time during the term of the License will be included in this section **[0013 Part J.1,m); and 0008 Part L.1,m)].**

Safety, Security, Access

The ICRP will discuss safety procedures for reclamation activities, as well as security and access considerations during both the active reclamation and closure period and the post-closure period.

ENVIRONMENTAL ASSESSMENT

Overview

The environmental assessment section will provide the reader with an assessment of the predicted environmental condition in the receiving environment, including any predicted residual risks and effects at the mine site for the post closure period. The assessment assumes that the proposed physical reclamation has been fully completed.

Predictive Water Quality Modelling

A site-wide predictive water quality model will be presented as the basis for the environmental assessment section and the prediction of water quality in the receiving environment post closure. Inputs for the model will be identified, as well as the steps taken to obtain the information outlined.

Aquatic Resources

Reclamation of aquatic habitat for all areas will be discussed **[0008 Part L.1,a)].** This will include pit lakes, and staging areas for water intake should the open pits be reclaimed by pump flooding.

Terrestrial Resources

The potential and predicted impacts to the terrestrial resources and VECs will be presented.

Other Resource Users

Impacts to other resource users within the localized area of the mine site will be presented in this section.

Environmental Impacts

Methods and procedures to stabilize and mitigate potential impacts to wildlife, terrestrial and aquatic environments during the reclamation process will be included for the overall mine site. These will include management of erosion, remediation of contaminated sites, groundwater contamination, impacts to aquatic environments, and wildlife safety.

PROGRESSIVE RECLAMATION

Progressive Reclamation Completed

Selected reclamation activities have been conducted at the EKATI mine site since the commencement of mining operations. Descriptions of the reclamation work, locations, including the lessons learned from past reclamation work will be provided.

Progressive Reclamation Planning

The section on progressive reclamation planning will include a description of the processes employed for progressive reclamation, a progressive reclamation schedule and the procedures for coordinating reclamation activities with the overall mine plan/mining sequence and materials balance **[0013 Part J.1,g); and 0008 Part L.1,f)].** Because the reclamation and closure planning process is in the interim phase and final mine site closure is planned for 2020, the ICRP will include conceptual, feasibility and execution plans for closing mine components.

LITERATURE CITED

This section will include literature referenced in the ICRP.

APPENDIX A – TERMS AND DEFINITIONS

Acronyms and Definitions

A list of acronyms and definitions for mining and closure related terms will be provided. Since many of the sections and topics in the ICRP can be highly technical in nature, these will assist in the review process.

Aboriginal Terms Glossary

An Aboriginal Glossary of Terms will also be included in the Tlicho, Innuiaqtun and Chipewyan languages.

APPENDIX B – COMMUNITY CONSULTATION

This appendix will include a record of participating communities, consultation meetings, and a summary of discussions that have taken place, including issues raised and BHP Billiton's response, that have taken place in development of the ICRP.

APPENDIX C – CLOSURE OBJECTIVES AND CRITERIA

A summary of closure objectives and criteria for mine components will be included.

APPENDIX D – ENGINEERING SUMMARY

The appendix will include a table which outlines the stage of closure planning (conceptual, pre-feasibility, feasibility and execution) for each of the mine component areas. Engineering design detail for mine components will also be included.

APPENDIX E – RISKS AND CONTINGENCIES

This appendix will include a summary of the identified high level closure and reclamation risks, including residual risks for each of the mine components, and for the general mine site. The ranking system for low, medium and high risks used in the assessment will also be included. Contingency measures will be provided for the identified risks. This will be an integrated approach in which monitoring results will be used to review and update risk registries and contingency measures, as well as measure the effectiveness and performance of the closure criteria.

APPENDIX F – RECLAMATION RESEARCH PLAN

Reclamation Research Summary

A reclamation research plan will be provided that outlines current and future research needs for reclamation and summarizes reclamation research to date. The reclamation research plan will include discussion on how the results will inform the reclamation planning **[0013 Part L.1,p); and 0008 Part L.3,a)];** a timetable of future requirements **[0008 Part L.3,b)];** details of further reclamation research the company will undertake to resolve the needs identified **[0013 Part J.1,p) & ,k)];** a description of a process to ensure that the reclamation procedures that might result from the research are ecologically, socially responsible and appropriate, viable and achievable, and a description of how the research will incorporate objectives relating to the reclamation or creation of viable wildlife (terrestrial and aquatic) habitat (if this was selected as a closure option)**[0013 Part J.1,p); and 0008 Part L.3, c) & d)]**.

A description of QA/QC protocols for conducting research, how research progress will be monitored, and how results may affect the operational reclamation program will also be provided in this section

[0013 Part J.1,p); and 0008 Part L.3,g)]. The success of applying reclamation research will be discussed **[0013 Part J.1,l); and 0008 Part L.1,l)].**

A comprehensive assessment of materials suitability will form part of the Reclamation Research Plan, including geochemical and physical characterization and availability for reclamation needs, with attention to top-dressing materials **[0013 Part J.1,f); and 0013 Part L.l,d)]**.

Metals Uptake Research

Results of metal uptake studies in revegetation and a description of how metal uptake in re-vegetated plant communities will be monitored will be included in this section. This research will guide decision making and reclamation planning for various mine area components, most notably the LLCF **[0013 Part J.1,p); and 0008 Part L.3,e)]**.

Revegetation Plans

Revegetation plans to stabilize disturbed sites, will be included in the ICRP. These will include a description of proposed revegetation plans, incorporating a description of the manner in which invasive non-indigenous plant species in the re-vegetated areas will be addressed, how initial vegetation cover will promote successional development on reclaimed landscape units, what the expected progression and time-frame will be, biodiversity issues, and how it will be compatible with local ecosystem characteristics **[0013 Part J.1,j); and 0008 Part L.1,k)].** Techniques for assisting natural recovery, application methods, amendments, projected areas and descriptions of plant ecosystems will also be included.

APPENDIX G – POST CLOSURE MONITORING

Inspections and Monitoring

A summary of monitoring requirements and monitoring schedule for all mine components will be provided, including a process used to identify what is in the Monitoring Plan. Monitoring parameters and schedule to measure and assess reclamation success against closure criteria and provide triggers for maintenance and contingency actions will also be included.

A description of how the potential for post-closure groundwater contamination will be assessed and monitored during the term of the License will also be included **[0013 Part J.1,i); and 0008 Part L.1,j)].**

Reporting

An environmental reporting program will be presented in this section to report on the results of the environmental management system.

APPENDIX H – EXPECTED COST OF CLOSURE AND RECLAMATION

Overview

The expected cost of closure will be determined in accordance with international financial reporting requirements for publicly traded companies. The BHP Billiton Closure Standards and other related documents described below were developed to meet these international requirements and collectively these define a clear methodology for the determination of the expected cost of closure.

Supporting documents will include BHP Billiton's Investment Standards, Investment Evaluation Standards, Corporate Accounting Policies, BHP Billiton Guidelines for the Development and Management of Contingency and Guidelines for Capital Cost Estimating. The 2002 Mine Site Reclamation Policy for the Northwest Territories will also be used as a reference document.

Cost Basis

Where possible, actual operating costs based on experience at EKATI will be used. Third-party cost factors will be applied to the EKATI costs. Included will be a description of how the cost model is linked to individual reclamation measures for mine components and how contingency has been applied.

The expected cost of closure will include an estimate of the annual cost of progressive reclamation during the mine life as well as costs for the closure execution phase post mining as well as post closure monitoring costs. Contingencies and risked based factors will be incorporated where appropriate.

Cost Model

In the absence of a clearly defined framework or methodology for determining the cost of closure in the NWT, BHP Billiton will apply international financial standards to develop this estimate. The RECLAIM model will not be used. Rather, the liability estimate for EKATI will involve the use of a risk-based model with both deterministic and probabilistic estimation techniques to determine the long term expected cost of closure. This section will include a description of the how the above risk-based model works.

Liability Reduction Schedule

A set of reclamation criteria will be developed for each mine component to determine exactly when any specific mine components have been successfully reclaimed and included as part of a security reduction schedule.

The Mine Site Reclamation Policy for the NWT, produced by INAC in 2002 will be used as a reference document for securities release. However, there is currently no mechanism available to release security as liability is reduced and mine reclamation and closure work is completed to agreed standards and criteria. This creates a circumstance where interim and progressive reclamation may be completed without recognition that liability has been reduced as progressive reclamation is completed to agreed standards. This will be addressed in this section.

APPENDIX I – PLAIN LANGUAGE SUMMARY

A Plain Language Summary will be included in this appendix. It will be a useful document for Aboriginal communities and it will summarize the major sections of the Interim Closure and Reclamation Plan.

Appendix 1.1-4

Tables of Conformance for EKATI's Regulatory Requirements

Appendix 1.1-4. Tables of Conformance for EKATI's Regulatory Requirements

List of Tables

TABLE **PAGE**

Table 1.1-4a. Table of Conformance Between EKATI ICRP and Water Licenses

Brown Text denotes MV2003L2-0013 License text.
Blue Text denotes MV2001L2-0008 License text.
Black Text denotes common text.

MV2003L2 -0013	MV2001L2 -0008	ICRP Requirement	ICRP Conformity
Part J	Part L		
# 1	# 1	**MV2003L2-0013** - Within ninety (90) days of the effective date of this License, the Licensee shall submit to the Board for approval a Terms of Reference for an Interim Closure and Reclamation Plan. The Terms of Reference shall, at a minimum, consider the following:	Complete
		MV2001L2-0008 - The Licensee shall submit to the Board for approval within nine (9) months of issuance of this Licensee, an update to the Interim Abandonment and Reclamation Plan in accordance with the Board's "Guidelines for Abandonment and Restoration Planning for Mines in the Northwest Territories, September 1990", and shall provide the following additional elements to address abandonment and reclamation concerns:	Complete
# 1. a)		Reclamation objectives and closure criteria for the site in general and for individual mine components. This is to include the factors the license will use to develop the objectives and criteria,	Chapter 1, Appendix 5.1-1.
# 1. b)		how the success of reclamation measures will be evaluated	Appendix 5.1-1, Appendix 5.1-5.
# 1. c)	# 1. a)	identification of all mine components including but not be limited to:	
		Specific abandonment and reclamation objectives for each mine component, which shall include, but not limited to, the following:	
# 1. c) (i)	# 1. a) (i)	open pits	Section 5.2, Appendix 5.1-1.
# 1. c) (ii)	# 1. a) (ii)	underground workings	Section 5.3, Appendix 5.1-1.
# 1. c) (iii)		Processed Kimberlite and Sewage containment facilities	Section 5.5, Appendix 5.1-1.
# 1. c) (iv)	# 1. a) (iii)	waste rock storage facilities/areas	Section 5.4, Appendix 5.1-1.
# 1. c) (v)	# 1. a) (iv)	water management structures (dams, diversion channels, intake and delivery systems, treatment plants)	Section 5.6, Appendix 5.1-1.
# 1. c) (vi)	# 1. a) (v)	Sumps and Settling and Collection Ponds	Section 5.7, Appendix 5.1-1.
		sedimentation ponds	Section 5.6.
# 1. c) (vii)	# 1. a) (vi)	borrow pits, ore (storage) stockpiles, and other disturbed areas	Section 5.7, Section 5.4, Appendix 5.1-1.

(continued)

Table 1.1-4a. Table of Conformance Between EKATI ICRP and Water Licenses (continued)

MV2003L2 -0013	MV2001L2 -0008	ICRP Requirement	ICRP Conformity
# 1. c) (viii)	# 1. a) (vii)	surface structures and buildings (process plant, camps, roads, airstrip)	Section 5.7, Appendix 5.1-1.
# 1. c) (ix)	# 1. a) (viii)	all petroleum and chemical storage areas	Section 5.7, Appendix 5.1-1.
# 1. c) (x)	# 1. a) (ix)	any other areas potentially contaminated with hazardous materials	Section 5.7, Appendix 5.1-1.
# 1. c) (xi)	# 1. a) (x)	any facilities or areas which may have been affected by development such that potential pollution problems exist	
	# 1 a) (xi)	contingency measures for pit water treatment during closure	Section 7.0, Appendix 5.1-3.
	# 1 a) (xii)	dyke breach locations and sizes, and	Section 5.6, Appendix 5.1-2.
	# 1 a) (xiii)	reclamation of aquatic habitat in all areas	Chapter 5.0.
	# 1 b)	development of more detailed plans (including existing examples) for the creation of the proposed meromictic lakes, along with alternative closure methods. As well as a description of contingency measure in the event that the restored lake does not maintain a meromictic character as planned, and there is mixing/upwelling of water from the kimberlite/water interface at the bottom that rises up into the upper water column.	Section 5.2, Chapter 7.0, Appendix 5.1-3.
# 1 d)	# 1 c)	a description of the measures required, or actions to be taken, to achieve the objectives stated in the NWT Water Board's "Guidelines for Abandonment and Reclamation Planning for Mines in the Northwest Territories, September 1990" or any subsequent editions, and in part J, item 1(a), and Part K (L), Item 1 a) [and b)] for each mine component.	Chapter 1.0, Chapter 5.0, Appendix 5.1-1.
# 1 e)	# 1 d)	a detailed description, including maps and other visual representations, of the pre-disturbance conditions for each site, accompanied by a detailed description of the final desired landscape, with emphasis on the reclamation of stream banks and surface drainage over the reclaimed units.	Chapter 5.0.
# 1 f)	# 1 e)	a comprehensive assessment of materials suitability, including geochemical and physical characterization and availability for reclamation needs, with attention to top-dressing materials, including maps where appropriate showing sources and stockpile locations of all borrow materials	Section 5.4.
# 1 g)	# 1 f)	a description of the process to be employed for progressive reclamation, plus details of progressive reclamation scheduling and procedures for coordinating reclamation activities with the overall mine plan/ mining sequence and materials balance,	Chapter 8.0.
	# 1 g)	a detailed set of reclamation criteria, or targets for each mine component to determine exactly when any specific liability unit has been successfully reclaimed	Appendix 5.1-1

(continued)

Table 1.1-4a. Table of Conformance Between EKATI ICRP and Water Licenses (continued)

MV2003L2 -0013	MV2001L2 -0008	ICRP Requirement	ICRP Conformity
# 1 h)	# 1 h)	a description of any post-closure treatment potentially required for drainage water that is not acceptable for (Seepage, surface runoff, Acid/Alkaline Rock Drainage or any other waters that are not acceptable with the overall mine plan and materials balance.) discharge from any of the reclaimed mine components,	Chapter 7.0.
	# 1 i)	a description of proposed means to provide long term maintenance of the water collection system and Pigeon Diversion Stream	Section 5.6.
# 1 i)	# 1 j)	a description of how the potential for post-closure groundwater contamination will be assessed and monitored during the term of the License,	Chapter 7.0.
# 1 j)	# 1 k)	a detailed description of proposed revegetation plans, incorporating a description (of the manner in which invasive non-indigenous plant species in the re-vegetated areas will be addressed) of how initial vegetation cover will promote successional development on reclaimed landscape units, what the expected progression and time-frame will be, and how it will be compatible with local ecosystem characteristics,	Chapter 5.0, Chapter 7.0.
# 1 k)		an identification of the research needs for reclamation	Appendices 5.1-4 and 5.1-5.
# 1 l)	# 1 l)	a description of the monitoring program to be employed in recording the progress of mining activities as they relate to on-going reclamation needs. The relevant components of the reclamation monitoring program should be designed to generate data in forms suitable for use in the RECLAIM Model or its equivalent. The License shall provide the Board annually with an updated estimate of the current mine reclamation liability and the projected maximum liability to closure. Sampling and testing protocols for determining the success of reclamation measures undertaken should be documented. The programs shall include, but not be limited to, the following:	Appendix 5.1-6. In Progress
# 1 l) (i)	# 1 l) (i)	pitwall geochemistry and potential for acid/alkaline rock drainage and metal leaching	Chapter 7.0.
# 1 l) (ii)	# 1 l) (ii)	water quality trends in pit water, and Seepage from Waste Rock Storage Facilities and ore stockpiles; water quality trends in pit water, waste rock dump and ore stockpile seepage	Chapter 7.0.
# 1 l) (iii)	# 1 l) (iii)	volumes of waste materials produced and stored by type and location, with particular attention to materials requiring measures to mitigate impacts from water that is not acceptable for discharge,	Section 5.4.
# 1 l) (iv)	# 1 l) (iv)	areas, slope angles, and relevant topography of waste rock storage facilities/dumps;	Section 5.4.
# 1 l) (v)		areas of Processed Kimberlite beaches and consolidated slurries,	Section 5.5.
# 1 l) (vi)	# 1 l) (v)	methods, timing, and details respecting the placement of rock cover and the development of permafrost in Processed Kimberlite material as part of Processed Kimberlite reclamation,	Section 5.5, Chapter 8.0.

(continued)

Table 1.1-4a. Table of Conformance Between EKATI ICRP and Water Licenses (continued)

MV2003L2 -0013	MV2001L2 -0008	ICRP Requirement	ICRP Conformity
# 1 l) (vii)	# 1 l) (vi)	stability of surface drainage channel(s) over reclaimed processed kimberlite,	Section 5.5.
# 1 l) (viii)	# 1 l) (vii)	success of applying reclamation research results	Appendix 5.1-1; 5.1-4; and 5.1-5.
# 1 m)	# 1 m)	details of closure measures proposed in the event of a premature or temporary shutdown at any time during the term of the License	Chapter 6.0.
# 1 n)	# 1 n)	an explanation of how aesthetic concerns will play a role in reclamation	Chapter 5.0.
# 1 o)	# 1 o)	the qualifications, status and authority of those individuals who will be responsible for, and who will conduct, reclamation activities during the term of the License,	Chapter 4.0.
	# 2	The Licensee shall provide the Board within nine months of the issuance of this license, and on March 31, annually a yearly schedule of proposed progressive reclamation activities, and corresponding yearly expenditures for completed activities. This information should be used to develop yearly and cumulative reclamation credits that can be anticipated.	In Progress
# 1 p)	# 3	reclamation research planning that considers at a minimum the following: The License shall submit a Restoration Research Plan that includes, but may not be limited to, the following;	Appendices 5.1-4 and 5.1-5
# 1 p) (i)	# 3 a)	an update of reclamation research to date and how the results may affect reclamation planning,	Appendices 5.1-4 and 5.1-5
	# 3 b)	a timetable of future requirements	Chapter 8.0, Appendices 5.1-4 and 5.1-5.
# 1 p) (ii)		details of further reclamation research the License will undertake to resolve the needs identified in Part J, Item 1 (k)	Appendices 5.1-4 and 5.1-5
# 1 p) (iii)	# 3 c)	a description of a process to ensure that the reclamation procedures that might result from the research are ecologically appropriate, viable and achievable	Appendices 5.1-4 and 5.1-5
# 1 p) (iv)	# 3 d)	a description of how the research will incorporate objectives relating to the reclamation or creation of viable wildlife (terrestrial and aquatic) habitat	Appendices 5.1-4 and 5.1-5
# 1 p) (v)	# 3 e)	a description of how metal uptake in revegetated plant communities will be monitored	Appendices 5.1-4 and 5.1-5
# 1 p) (vi)	# 3 f)	a schedule of anticipated reclamation research expenditures on an annual basis,	Appendices 5.1-4 and 5.1-5
# 1 p) (vii)	# 3 g)	a description of QA/QC protocols for conducting research, how research progress will be monitored, and how results may affect the operational reclamation program,	Appendix 5.1-6

(continued)

Table 1.1-4a. Table of Conformance Between EKATI ICRP and Water Licenses (completed)

MV2003L2-0013	MV2001L2-0008	ICRP Requirement	ICRP Conformity
# 2		Within six (6) months of the approval of the Terms of Reference referred to in part J, item 1, the License shall submit to the Board for approval an Interim Closure and Reclamation Plan. This Plan shall address all parts of the Terms of Reference and shall be in accordance with NWT Water Board's "Guidelines for Abandonment and Reclamation Planning for Mines in the Northwest Territories, September 1990" or any subsequent editions.	Complete
# 3		The Licensee shall review the approved Interim Closure and Reclamation Plan annually, and shall revise the Plan as necessary to reflect changes in operations, technology, and results from reclamation research and other studies. All proposed amendments to the plan shall be submitted to the Board for approval.	In Progress
	# 4	The Licensee shall initiate the reclamation research not later than six (6) months after the submission of the Abandonment and Reclamation Plan, or as soon as practicable thereafter.	In Progress
	# 5	The Licensee shall revise the Plan(s) referred to in this section as required by the Board in its review of the Plan(s). Revisions to the Plan(s) shall be submitted to the Board for its approval within six (6) months of receiving notification of the Board's requirement for revision.	In Progress
# 4	# 6	The Licensee shall implement the Interim Closure and Reclamation Plan as approved by the Board in accordance with the schedules and procedures specified in the plan(s) and endeavor to carry out progressive reclamation of areas as soon as is reasonably practicable,	In Progress
# 5		A minimum of twenty four (24) months prior to mine closure, the Licensee shall submit to the Board for approval a Final Closure and Reclamation Plan.	Not applicable to the 2011 ICRP
# 6		The Licensee shall revise the Terms of Reference or the Interim or Final Closure and Reclamation Plans as required by the Board. Revisions to the plan(s) shall be submitted to the Board for its approval within three (3) months of receiving notification of the Board's requirement for revision, or as otherwise directed.	Complete
	# 7	The Licensee shall review the Abandonment and Reclamation Plan annually, and shall modify the Plan as necessary to reflect changes in operations, technology, and results from reclamation research and other studies. All proposed modifications to the Plan shall be submitted to the Board for approval.	In Progress
	# 8	Compliance with the Abandonment and Reclamation Plan specified in this Licence does not limit the legal liability of the Licensee, other than liability arising from provisions of the Act and it Regulations.	
	# 9	The Licensee shall submit to the Board for approval by March 31, 2004 a Reclamation Monitoring Program to evaluate the effectiveness of all progressive reclamation and to identify any modifications required to facilitate landscape reclamation.	Complete

Table 1.1-4b. Table of Conformance Between EKATI ICRP and Environmental Agreement

Environmental Agreement	ICRP Requirement	ICRP Conformity
Article VIII, 8.1 (a)	The Reclamation Plan shall be prepared in Consultation and in co-operation with the Minister, the GNWT and the Monitoring Agency and shall include, without limitation:	In Progress
(a) (i) & Section 8.3.	specific and comprehensive plans to deal with the reclamation of the Project site as contemplated in Section 8.3; Section 8.3 <u>Natural Recovery.</u> Closure and reclamation shall be undertaken in such a manner as to enhance the natural recovery of the areas affected by the Project by: ensuring that mine facilities and infrastructure are abandoned in such a manner that: the Project site is physically stable and any requirement for long-term maintenance and monitoring is minimized; any threat to public safety is eliminated; and all buildings and such man-made structures are removed as required by the approved Reclamation Plan; preventing continuing impacts from contaminants and wastes on the environment including those associated with acid rock drainage; and returning affected areas to a state where negative effects on the use of the surround lands compatible with original undisturbed conditions are minimized to the fullest extent reasonably possible giving due consideration to factors such as aesthetics, economics, future ecosystem productivity and future users.	Appendix 5.1-1.
(a) (ii)	ongoing reclamation during the term of the Surface Leases;	
(a) (iii)	plans to address the following:	
(a) (iii) (A)	buildings and structures	Section 5.7.
(a) (iii) (B)	roads and airstrip	Section 5.7.
(a) (iii) (C)	petroleum and chemical storage areas and facilities	Section 5.7.
(a) (iii) (D)	site drainage systems	Chapter 5.0.
(a) (iii) (E)	tailings disposal facilities	Section 5.5.
(a) (iii) (F)	pipelines and electrical transmission installations	Section 5.7.
(a) (iii) (G)	water supply facilities	Section 5.6.
(a) (iii) (H)	waste rock disposal areas	Section 5.4.
(a) (iii) (I)	garbage, sewage and waste storage or disposal sites and facilities	Section 5.7.
(a) (iii) (J)	site drainage systems, granular material deposits and open pit areas	Chapter 5.0, Section 5.7, and Section 5.2.
(a) (iii) (K)	Other facilities or sites utilized during the operation of the Project (*Sumps, settling and collection ponds, and sedimentation ponds*) (*underground workings*)	Chapter 5.0.

(continued)

Table 1.1-4b. Table of Conformance Between EKATI ICRP and Environmental Agreement (completed)

Environmental Agreement	ICRP Requirement	ICRP Conformity
(a) (iii) (L)	The Project site generally; and	
(a) (iii) (M)	Other areas which may be affected by the Project in a material way	
Section 8.4	Progressive Reclamation. Reclamation of the Project site shall be undertaken progressively during the life of the Project, to the extent feasible, given the mining methods employed.	Chapter 8.0.
Article V, 5.2 (a)	BHP shall prepare and submit to the Minister, the GNWT, the Monitoring Agency and the Aboriginal Peoples a comprehensive report (the "Environmental Impact Report") on April 30, 2000 and on each third April 30 thereafter until full and final reclamation of the Project site has been completed in accordance with the requirements of all Regulatory Instruments and the terms of this Agreement.	Section 8.3.

Table 1.1-4c. Table of General Conformity for EKATI ICRP

Regulation	ICRP Requirement	ICRP Conformity
Land Leases 76 D/9-3-2; 76 D/10-2-2; 76 D/15-4-2; 76 D/10-7-2		
76 D/9-3-2 (# 13) 76 D/10-2-2 (#13) 76 D/15-4-2 (#13) 76 D/10-7-2 (#13)	Upon the termination or expiration of this lease, the lessee shall deliver up possession of the land in a condition as set out and agreed to in accordance with the Environmental Agreement	Refer to Environmental Agreement Conformity Table
Land Leases 76 D/9-4-2; 76 D/10-5-2; 76 D/10-3-2; 76 D/10-4-2		
76 D/9-4-2 (# 13) 76 D/10-5-2 (#13) 76 D/10-3-2 (#13) 76 D/10-4-2 (#13)	Upon the termination or expiration of this lease, the lessee shall deliver up possession of the land in a condition satisfactory to the Minister, which shall include fulfillment of all the lessee's obligations under the Environmental Agreement	Refer to Environmental Agreement Conformity Table
Land Use Permit MV2002C0040 (Class A); EKATI Claim Block		
26(1)(o) (78)	The Permittee shall apply grass seed and fertilizer to areas as authorized in writing by the Inspector	Chapter 5.0.
(79)	The Permittee shall complete all clean-up and restoration of the lands used prior to the expiry date of the Permit	Chapter 5.0.
Land Use Permit MV2001F0032 (Class A); Sable Road		
Part C (10)	When the pits are no longer in operation the road is to be used for reclamation and then decommissioned, unless prior approval is obtained by the Board,	Section 5.7.
26(1)(o) (43)	The Permittee shall dispose of all overburden as directed in the approved A&R Plan by the Land Use Inspector.	Section 5.4.
Land Use Permit MV2001X0071 (Class A); Sable Pipe, and Land Use Permit MV2001X0072 (Class A); Pigeon Pipe		
Part C (10)	When the pits are no longer in operation the road is to be used for reclamation and then decommissioned, unless prior approval is obtained by the Board	Section 5.7.
Part C (18)	The Permittee shall slope the sides of waste material piles to a gradient specified as approved in the Waste Rock Management Plan or otherwise authorized by an Inspector,	Section 5.4, Appendix 5.1-1.
Land Use Permit MV2001X0071 (Class A); Sable Pipe, and Land Use Permit MV2001X0072 (Class A); Pigeon Pipe		
(63)	The Permittee shall complete all cleanup, removal of buildings and restoration of the lands within the Sable Lease Area / Pigeon Lease Area as per the approved A&R Plan,	Chapter 5.0.
Authorization for the Harmful Alteration, Disruption or Destruction of Fish Habitat SCA96021; Panda, Koala, Fox 1, Alexis, Leslie, Airstrip, Long , Brandy, Willy, Nancy, and West Panda Lakes, as well as interconnecting and commonly ephemeral head water streams associated with the above named lakes.		
No fish habitat reclamation of pits required under this Authorization.		

(continued)

Table 1.1-4c. Table of General Conformity for EKATI ICRP (completed)

Regulation	ICRP Requirement	ICRP Conformity
Authorization for the Harmful Alteration, Disruption or Destruction of Fish Habitat SC00028; King Pond and the associated King-Cujo streams		
6.2	To rehabilitate and enhance fish habitats in King Pond and the King-Cujo streams, upon completion of mining activity of Misery Pit, BHP shall conduct the following as indicated in the Project Plan:	Section 5.6.
6.2.1	Remove sediments accumulated within King Pond that degrade the quality of or interfere with the enhancement of fish habitat.	Section 5.6.
6.2.2	Enhance bathymetry within the King Pond to promote over-wintering habitat,	Section 5.6.
6.2.3	Increase habitat diversity within the King Pond,	Section 5.6.
6.2.4	Re-establish King Pond outflow,	Section 5.6.
6.2.5	Enhance the drainage and migration corridor between King Pond and Cujo Lake	Section 5.6.
Authorization for the Harmful Alteration, Disruption or Destruction of Fish Habitat SC99037; Sable Lake, Two-Rock Lake and it's outflow stream-lake transitional area, Pigeon Pond, and reach 3 and 4 of Pigeon Stream, Big Reynolds Pond, Beartooth Lake, and 1,500 m^2 area of Bearclaw Lake.		
5.	Because BHPB no longer intends to proceed with the dewatering and the resulting HADD of Leslie Lake under the 1997 Authorization, pursuant to clause 7 of the 1996 Fish Habitat Compensation Agreement between DFO and BHPB, BHPB's previously accepted compensation for the HADD of lake fish habitat set out above in section 1. (S*ee above list*).	N/A
No fish habitat reclamation of pits required under this Authorization.		
Authorization for the Harmful Alteration, Disruption or Destruction of Fish Habitat SC01111; Desperation and Carrie Ponds		
5.1.2	BHP Billiton shall compensate for the loss of lake and stream fish habitat by providing HU (Habitat Unit) gains through the implementation of compensation project(s) approved by DFO. Compensation project(s) shall be such that HU gains will offset losses at a ration of at least 2:1, unless reduced ratios are otherwise approved by DFO.	
Authorization for the Harmful Alteration, Disruption or Destruction of Fish Habitat SC01168; Nema-Nero Stream		
Compensation work for the Nema-Nero stream is currently underway. BHP Billiton expects this work to be completed within the period of mining operations. Therefore the compensation work for this has not been included in this conformity table.		
Navigable Waters Protection Act 8200-T-12313.1; Leslie Lake, Fox Lake, Koala Lake, Panda Lake and Long Lake		
3.	Beds & banks of the waterway with respect to all works constructed such as pipe line discharges are to be restored to their original contour and the banks are to be protected from erosion as necessary	Section 5.2, Section 5.7.
Navigable Waters Protection Act (NWPA) 8200-97-6112; Sable Lake, Pigeon Pond, Two Rock Lake, Big Reynolds Lake, Falcon Lake, Beartooth Lake and Bearclaw Lake		
2.	The beds & banks of the waterway with respect to the works constructed (i.e., pipeline discharges, jetty etc) are to be restored to their original contour & the banks are to be protected from erosion as necessary.	Section 5.7.
3.	All temporary piles, false works, debris, etc are to be completely removed from the waterway upon completion.	Section 5.7.

Appendix 1.1-5
Plain Language Summary

bhpbilliton

resourcing the future

EKATI Diamond Mine

Interim Closure and Reclamation Plan

Plain Language Summary

August 2011

BHP Billiton Canada Inc.
EKATI Diamond Mine

This report is designed to give information about the ongoing work at the mine to readers who are not familiar with technical language. If you require more detailed information, contact BHP Billiton for a version of the technical report, available on CD-Rom.

Prepared by Rescan Environmental Services Ltd.

Table of Contents

Introduction

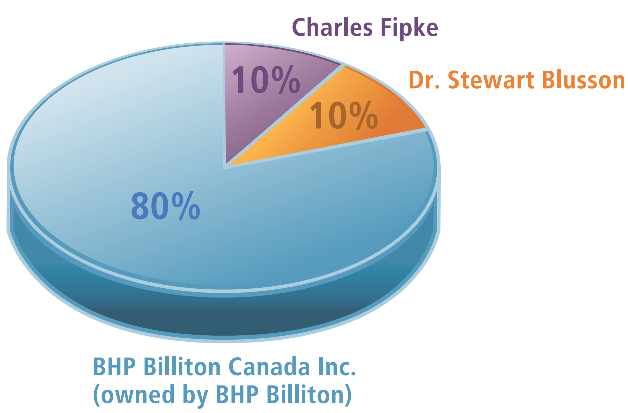
Planning for the closure of a mine is as important as the planning of mine construction and operation. Even though the EKATI Diamond Mine is not expected to close until 2020, BHP Billiton has a plan in place for closing the mine. This plan is called the Interim Closure and Reclamation Plan, or ICRP. The ICRP will be changed as new scientific studies and research are carried out, and as the mine plan evolves. The final closure plan will be submitted at least two years before the mine closes.

This report is a Plain English Summary of BHP Billiton's plan for the closure of EKATI. For more information and technical details, please see the *2011 Interim Closure and Reclamation Plan*, which is available on CD-ROM from BHP Billiton.

Story of EKATI

The EKATI Diamond Mine is located on the Canadian barrenlands in the Northwest Territories. The region consists of boulder fields, heath tundra, wetlands, lakes and eskers. There are over 8,000 lakes on the EKATI mineral claim block. The mine is located at the headwaters of the Coppermine River, which flows from Ursula Lake on the claim block into Lac du Sauvage and through Lac de Gras before turning north and flowing 400 kilometres to the Inuit hamlet of Kugluktuk on the Arctic Ocean. The mine is about 300 kilometres north of Yellowknife and 200 kilometres south of the Arctic Ocean.

Joint ownership of the EKATI Diamond Mine.



The story of EKATI began in 1989, when geologists Charles Fipke and Stewart Blusson made an exciting discovery. While prospecting near Lac de Gras on the frozen tundra, the two men found kimberlite, a rock that often hosts diamonds. Their work set off a flurry of exploration as geologists searched for more kimberlite, which drew the interest of BHP Billiton. Two years later, diamonds were found at what was to be Canada's first diamond mine, EKATI. After environmental assessment and construction, EKATI officially opened on October 14, 1998.

The name "e'kati" was given to the area around Lac de Gras by the Tlicho peoples. It means "fat lake," referring to white layers of quartz veins in the rock that look like marbled caribou fat.

BHP Billiton's Sustainable Development Policy

POL.004
SUSTAINABLE DEVELOPMENT POLICY

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resourcing the future

We stand for Zero Harm to people, our host communities and the environment and work to achieve leading industry practice. Sound principles to govern safety, business conduct, social, environmental and economic activities are integral to the way we do business.

Wherever we operate we will develop, implement and maintain management systems for sustainable development that drive continual improvement and ensure we:

- do not compromise our safety values, and seek ways to improve the health of our workforce and the community;
- identify, assess and manage risks to employees, contractors, the environment and our host communities;
- uphold ethical business practices and meet or, where less stringent than our standards, exceed applicable legal and other requirements;
- respect and promote fundamental human rights within our sphere of influence, respecting the rights of Indigenous peoples and valuing cultural heritage;
- encourage a diverse workforce and provide a work environment in which everyone is treated fairly, with respect and can realise their full potential;
- take action within our own businesses and work with governments, industry and other stakeholders to address the challenge of climate change;
- set and achieve targets, including energy efficiency and greenhouse gas intensity, that promote efficient use of resources and include reducing and preventing pollution;
- enhance biodiversity protection by assessing and considering ecological values and land-use aspects in investment, operational and closure activities;
- engage regularly, openly and honestly with our host governments and people affected by our operations, and take their views and concerns into account in our decision-making;
- develop partnerships that foster the sustainable development of our host communities, enhance economic benefits from our operations and contribute to poverty alleviation;
- work with those involved through the lifecycles of our products and by-products to enhance environmental and social performance along the supply chain and promote their responsible use and management;
- regularly review our performance and publicly report our progress.

In implementing this Policy, we will engage with and support our employees, contractors, suppliers, customers, business partners and host communities in sharing responsibility for meeting our requirements.

We will be successful when we achieve our targets towards Zero Harm, are valued by our host communities, and provide lasting social, environmental and economic benefits to society.

Engaging with Communities

The EKATI Diamond Mine is built on the traditional lands of Aboriginal people. Aboriginal communities used the land of the EKATI claim block long before the mine existed, and will continue to use the land long after the mine is closed. BHP Billiton wants the input of these communities to be a part of mine closure and reclamation.

In 2005 and 2006, BHP Billiton invited representatives from the communities of Kugluktuk, Lutsel K'e Dene First Nation, Yellowknives Dene First Nation, North Slave Métis Alliance, and the Tlicho Government to a series of presentations, mine site tour, and workshop, where the company listened to concerns and suggestions from the participating communities. Some of the main concerns the company heard were about protecting the wildlife around EKATI and making sure the water is safe for people and wildlife. BHP Billiton, the communities and regulators discussed different closure options for the mine in June and July of 2006. The understanding gained at these meetings, as well as from elders' site tours and projects like the Nanaiyaotit Traditional Knowledge Project and the Caribou and Roads Traditional Knowledge Project, helped BHP Billiton to bring community ideas and concerns into EKATI's closure plan.

BHP Billiton has already started to use the information gathered at the community meetings to refine the closure plan. For example, the communities have said they wanted the water and the wildlife to be safe. After listening to the concerns of Aboriginal communities, BHP Billiton proposed to pump flood the pits with water, rather than allow them to fill naturally over many years. Faster filling will shorten the time the pits remain open and will improve the water quality in the pit lakes. The company will continue to engage with communities and modify the plan during the life of the mine.

Social and Economic Benefits

EKATI provides a number of social and economic benefits to local and regional communities. BHP Billiton signed agreements with the Government of the Northwest Territories and with local Aboriginal groups to create opportunities for Aboriginal and non-Aboriginal residents through direct employment, cash payments, scholarships, training, apprenticeships, and other programs.

BHP Billiton will continue to contribute to the improvement of social and economic conditions in northern communities after EKATI closes by:

- consulting with communities in mine closure-related decision-making;
- altering existing training programs to help mine employees find new jobs post-closure; and
- working with communities to find new opportunities for mine employees and local industries.

EKATI Diamond Mine

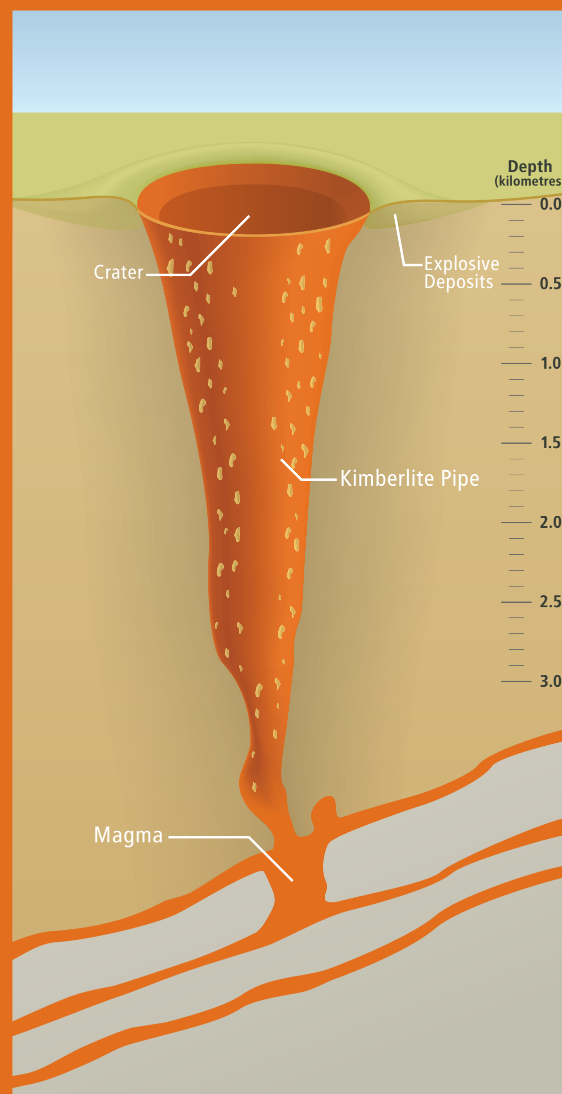
Mining

Two different kinds of mining are carried out at EKATI: open pit mining and underground mining. In open pit mining, explosives and digging equipment are used to remove surface earth and rock to expose valuable ore, which contains diamonds. The ore is cut away in wide steps, called benches, and taken away by haul trucks for processing. In underground mining, spiral-shaped tunnels are built to allow digging equipment to cut ore from kimberlite pipes. The ore is brought to the surface using trucks or a conveyor system.

The ore from the open pit and underground mines is brought to the Process Plant in the Main Camp, where it goes through a series of crushing machines. These machines reduce the size of the ore pieces, allowing diamonds to be removed. The remaining coarse-sized ore is trucked to the Panda/Koala Waste Rock Storage Area, while the fine-grained waste material is piped to the Long Lake Containment Facility.

What is Kimberlite?

Kimberlite is a dark-coloured rock that sometimes contains diamonds. It forms deep within the earth's crust and reaches the earth's surface in an explosion resembling a volcano. The explosion produces a rock that is carrot-shaped and is referred to as a kimberlite pipe. Each pipe is given a unique name or number to distinguish it from other pipes. BHP Billiton has eight kimberlite pipes in the Life of Mine Plan.

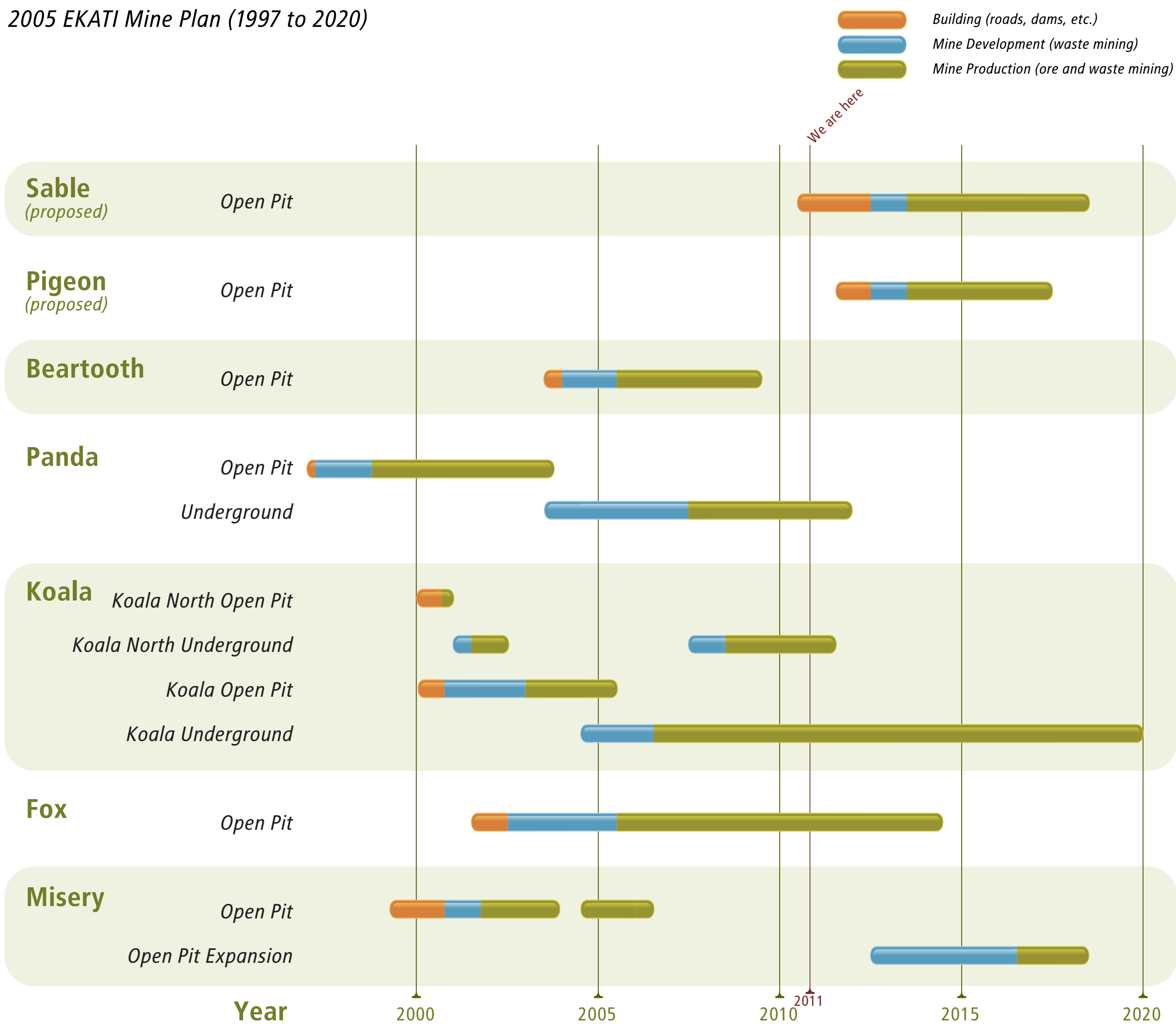


The EKATI Diamond Mine

Mine Plan

The EKATI Mine Plan is BHP Billiton's plan and schedule for extracting ore from the mine. This plan changes over time. For example, in 1996, the Mine Plan included the development of only five open pits. Today, one of those pits is no longer part of the Mine Plan, while three others have been added. As the Mine Plan continues to evolve, BHP Billiton will make appropriate changes to the ICRP. As a result, the dates referenced in the ICRP may change.

2005 EKATI Mine Plan (1997 to 2020)



Closure

Overview

Closure is a stage in every mine's life. When BHP Billiton stops all commercial processing at EKATI, or is finished with an area of the mine with no plan to continue mining there in the future, closure will begin. BHP Billiton's ICRP for EKATI includes separate plans for each mine component, from the open pits, to diversion channels, to the Main Camp. This allows BHP Billiton to complete progressive reclamation on some mine components while still operating at others. Closure objectives and criteria within the plan provide standards by which the mine will be closed. The plan also complies with both government regulations and BHP Billiton's policies and commitments, including the following:

- NWT Mine Health and Safety Act;
- ICRP Terms of Reference;
- Environmental Agreement;
- Water Licences;
- Land Use Permits;
- Land Leases;
- Fisheries Compensation Agreements;
- Dam Safety Guidelines;
- BHP Billiton's Sustainable Development Policy; and
- ISO 14001 Standards.

The following sections summarize the closure plan for each of the components of the EKATI Diamond Mine.

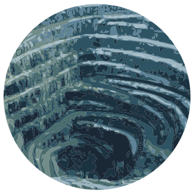
Reclamation Goal

Return the EKATI Minesite to viable, and wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment, human activities, and the surrounding environment.

The following are the six major mine components areas that the Interim Closure and Reclamation Plan is based upon:

- open pits;
- underground mines;
- Waste Rock Storage Areas;
- processed kimberlite containment areas;
- dams, dikes, and channels; and
- buildings and infrastructure.

Open Pits

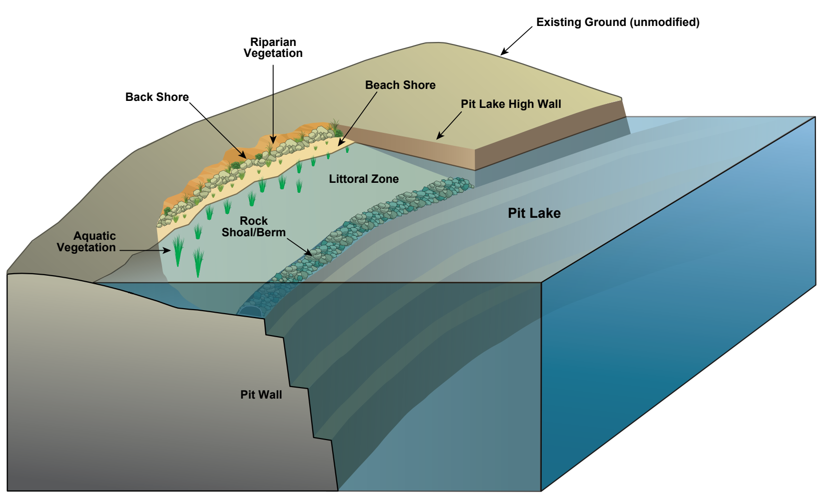


BHP Billiton's 2005 Mine Plan (upon which this ICRP is based) is to mine eight kimberlite pipes in the mineral claim block. These pipes are known as the Sable, Pigeon, Beartooth, Panda, Koala, Koala North, Fox and Misery pipes. Each pipe, except Pigeon, is located beneath a lake that must be dewatered (or drained) before mining can begin.

The Beartooth, Panda, Koala, Fox and Misery lakes were dewatered between 1997 and 2003. The Beartooth, Panda and Koala open pits, as well as the Panda underground mine, have been completed, and Koala is now in underground operations. Mining of the Fox open pit is underway. The Misery Open Pit has been suspended and an expansion is proposed for the future. Sable Lake and Pigeon Pond have not yet been disturbed.

Each open pit will be closed by filling it with water. BHP Billiton will build barriers, called access berms around the rims of the pits that will keep wildlife safe during flooding. Pipelines will be built to pump water into the open pits from nearby lakes. These pipelines and the pumping equipment will be removed after each pit is filled. In addition, BHP Billiton will clean up and safely dispose of any equipment, garbage, or debris from the open pits.

Following pit flooding and when the water quality meets the water licence criteria, fish access will be allowed into the pit lakes. As part of the closure planning, a design report will be developed that outlines how BHP Billiton will facilitate the establishment of a self-sustaining ecosystem in the pit lakes. A conceptual design of pit lake littoral zones is shown in the figure below.



Conceptual Design of Pit Lake Littoral Zones

Panda, Koala and Beartooth Open Pits

Prior to mining starting at EKATI, water in this area flowed from Beartooth Lake to Panda Lake to Koala Lake and then on to Kodiak Lake. This water flow was changed so that mining could start. The water now flows through the Panda Diversion Channel and into Kodiak Lake. This is a permanent channel that will continue to divert water around Panda and Koala pit lakes to Kodiak Lake at closure.

The Beartooth open pit was completed in 2009, and is currently being used for mine water storage.

Open pit mining has finished at Panda, Koala North and Koala pits, and underground mining has finished below the Panda Pit. There will be a number of years of underground mining beneath the Koala North and Koala open pits. The Panda and Koala underground mining must be finished before these pits can be filled with water. Currently, Koala is expected to close in 2020 and begin pump filling. The water to fill these pits and the underground mines will come from Lac de Gras.

When the flooding of these pits has been completed (around 2050), they will be reconnected so that water will flow to Kodiak Lake. The water quality in the pit lakes will be monitored to ensure the water flowing into Lac de Gras is safe.

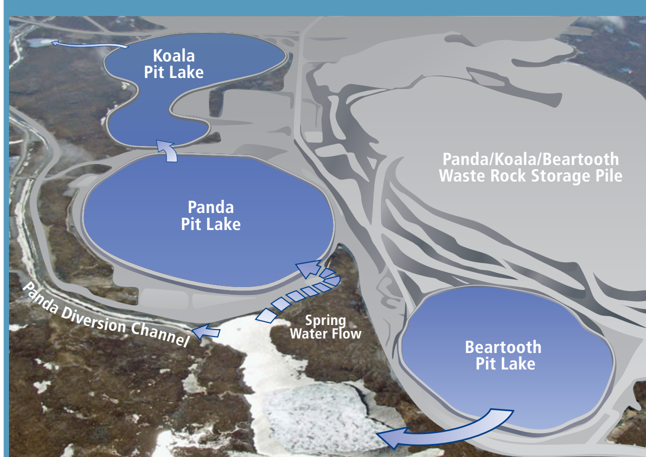
BHP Billiton is still looking at other options for the Panda and Beartooth pits for the next update of the ICRP. In the future, as we learn more, BHP Billiton may suggest an alternative use of Long Lake Containment Facility water to help fill the pits. In addition, BHP Billiton may suggest putting processed kimberlite into Panda or Beartooth and then filling the rest of the pit with water.

Panda, Koala and Beartooth Open Pits...

...Before EKATI

...Today

... After Closure (schematic)



Misery Open Pit

Mining operations at the Misery Open Pit are temporarily suspended with a proposal to expand the pit in the future. BHP Billiton expects to begin the closure of the Misery Open Pit in 2018. The pit will be filled with water pumped from Lac de Gras. Since there is no existing roadway between the lake and the pit, a road will have to be built for the pipeline. BHP Billiton will reopen the channel between Misery Pit Lake and Lac de Gras for excess water flow. The Misery Open Pit is expected to finish flooding in 2024.

Misery Open Pit...

Fox Open Pit

Closure of the Fox Open Pit is expected to begin when mining is completed and no additional ore reserves are found. BHP Billiton will build a pathway for excess water leading from the rim of the Fox Pit Lake to 1 Hump Lake. Water will be pumped from Lac de Gras to the Fox Open Pit, and the pit flooding is expected to finish in 2031.

Fox Open Pit...

Sable Open Pit

The 2005 Life of Mine Plan has Sable Pit commencing in 2012. BHP Billiton's current closure plan is to build a pipeline to carry water along a roadway from Ursula Lake to flood the Sable Open Pit. A pathway for excess water leading from the Sable Open Pit to Two Rock Pond will be constructed. Sable Pit flooding is expected to be finished in 2033.

Sable Open Pit (not built)...

Pigeon Open Pit (not built)...

Pigeon Open Pit

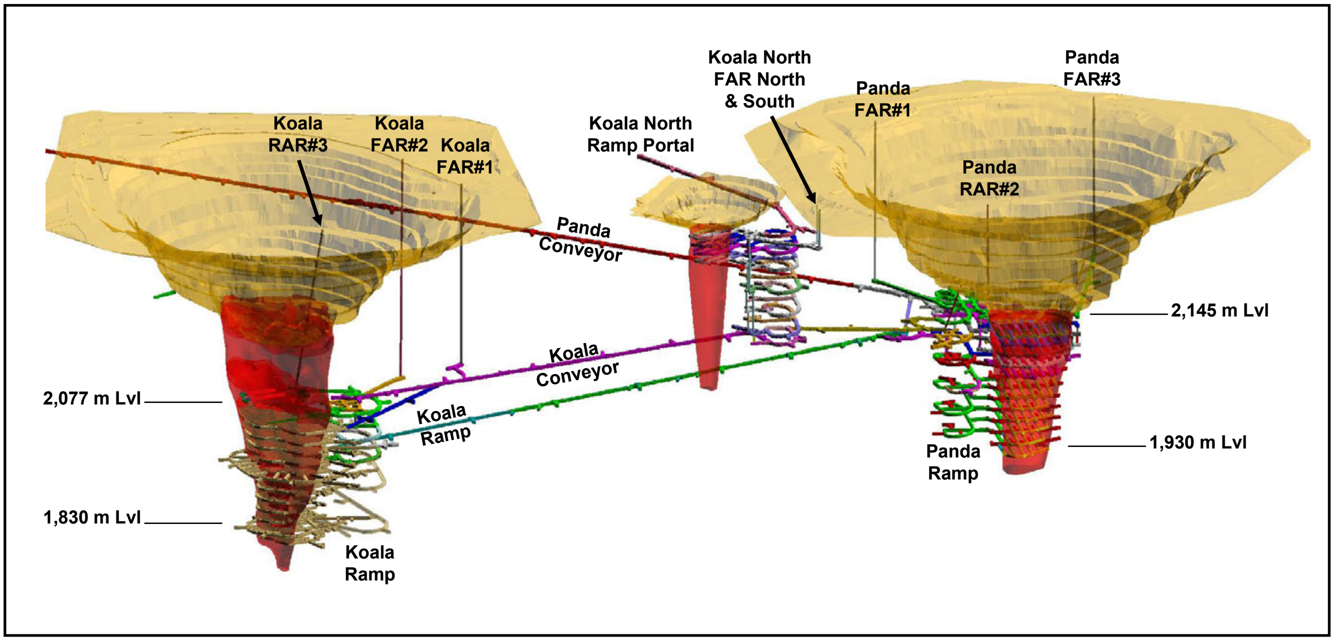
The open pit at Pigeon Pond will not be built until approximately 2014. For closure, BHP Billiton will build a roadway and pipeline from Upper Exeter Lake to the Pigeon Open Pit, and water will be pumped through the pipeline to flood the pit. When the pit lake is full and the water meets water quality criteria a channel will be opened to re-establish Pigeon Pit Lake flow into Pigeon Stream. Pigeon Pit flooding is expected to be finished in 2019.

Underground Mines

There are three underground mines at EKATI. The Panda Underground Mine is complete. The Koala and Koala North Underground mines are currently in operation.

BHP Billiton began progressive reclamation of the Panda Underground Mine in 2010. Koala and Koala North Underground mines will begin reclamation in 2020. All salvageable equipment will be removed from the mines; all fluids (such as fuel and oil) and dangerous materials will be removed from any remaining equipment, and the Panda, Koala North and Koala underground mines will be flooded with water. The portals and ventilation shafts leading to the mines will be sealed with rock or cement, and the Panda Underground Mine will be filled with water.

BHP Billiton will monitor the locations where the mines have surface infrastructure to make sure that the portals and vents are sealed and that the ground above the underground mines is stable.



Computer design for the Panda and Koala and Koala North underground mines and open pits.

Aerial view showing above-ground support facilities and portal to underground mining operations.

Waste Rock Storage Areas

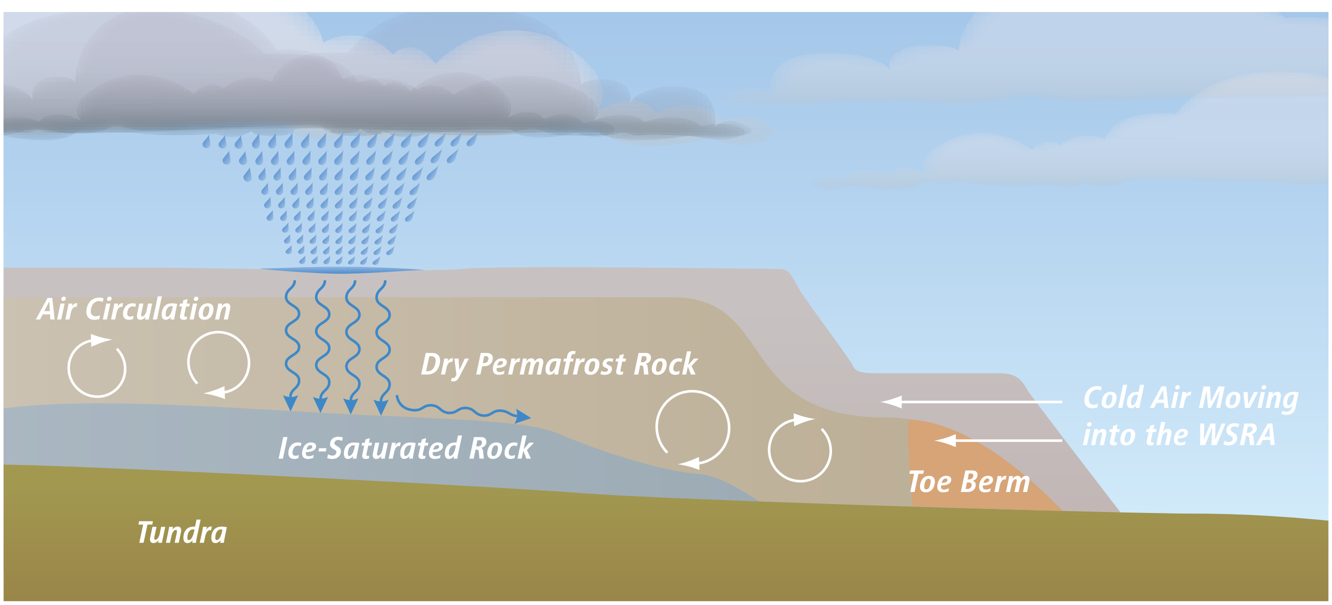
BHP Billiton keeps the waste rock that is removed from the open pits in rock piles called Waste Rock Storage Areas, or WRSAs. The Beartooth, Panda and Koala pits share a common WRSA, while the Sable, Pigeon, Fox and Misery sites have individual WRSAs. The Panda/Koala/Beartooth and Fox WRSAs are currently active, the Misery WRSA is temporarily closed, and the Sable and Pigeon WRSAs have not yet been built.

BHP Billiton designed the WRSAs with EKATI's eventual closure and reclamation in mind. For example, the ground underneath the WRSAs is permanently frozen, and scientists and engineers have shown that permafrost will keep water frozen within the piles and prevent it from seeping out. To encourage permafrost to form, BHP Billiton places a blanket of coarse waste rock on the tundra as the first layer of each WRSA. Water collects in the spaces between these rocks and freezes. Permafrost grows quickly in the centre of the WRSAs, but the edges are slower to freeze. Toe berms at the base of WRSAs also help to keep water within the piles. The WRSAs are also built so that coarse rock at the base of piles allows cold air to flow into the pile and maintain permafrost within the storage area.

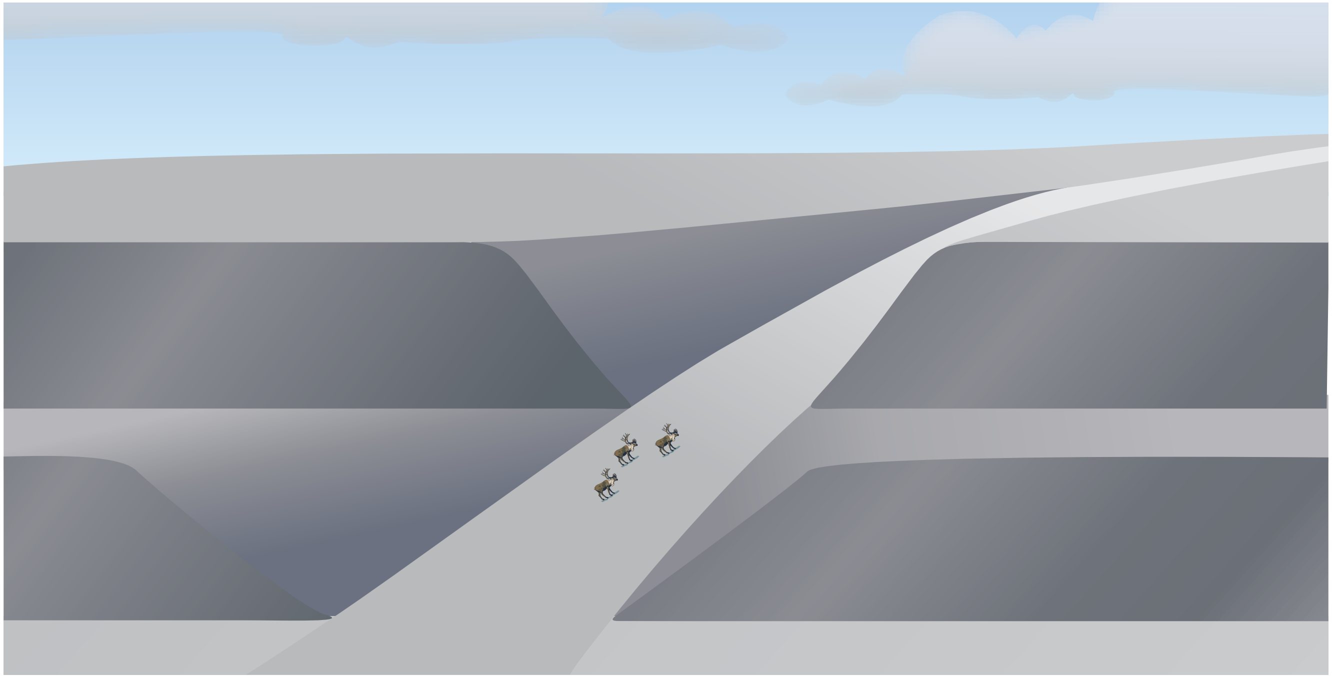
Typical waste rock pile at EKATI.

The sides of the WRSAs have an average slope of 25°, and the highest point of the piles will be no higher than 50 metres above the highest point of ground that they are laid on.

Closure of the WRSAs is expected to begin in 2018. The tops of the piles will be smoothed to encourage the snow to blow clear during the winter months. This will allow the permafrost to grow in the pile. The coarse kimberlite

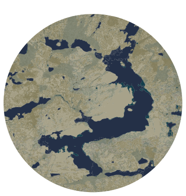


WRSAs are constructed to allow rain and melted snow to flow into the piles and freeze.



Wildlife access ramps will allow animals to travel over the WRSAs.

rejects at the Panda/Koala/Beartooth WRSA, as well as all landfill sites, will be capped with granite waste rock. BHP Billiton will clean up all garbage and other debris and make sure that any contaminated soils in the area are properly remediated. To help wildlife travel over the WRSAs, access ramps will be built. The locations of these ramps will be determined after consultation with local communities to benefit from their understanding of caribou migration patterns and observations around the EKATI site. BHP Billiton will continue to monitor the WRSAs for a period after mine closure.



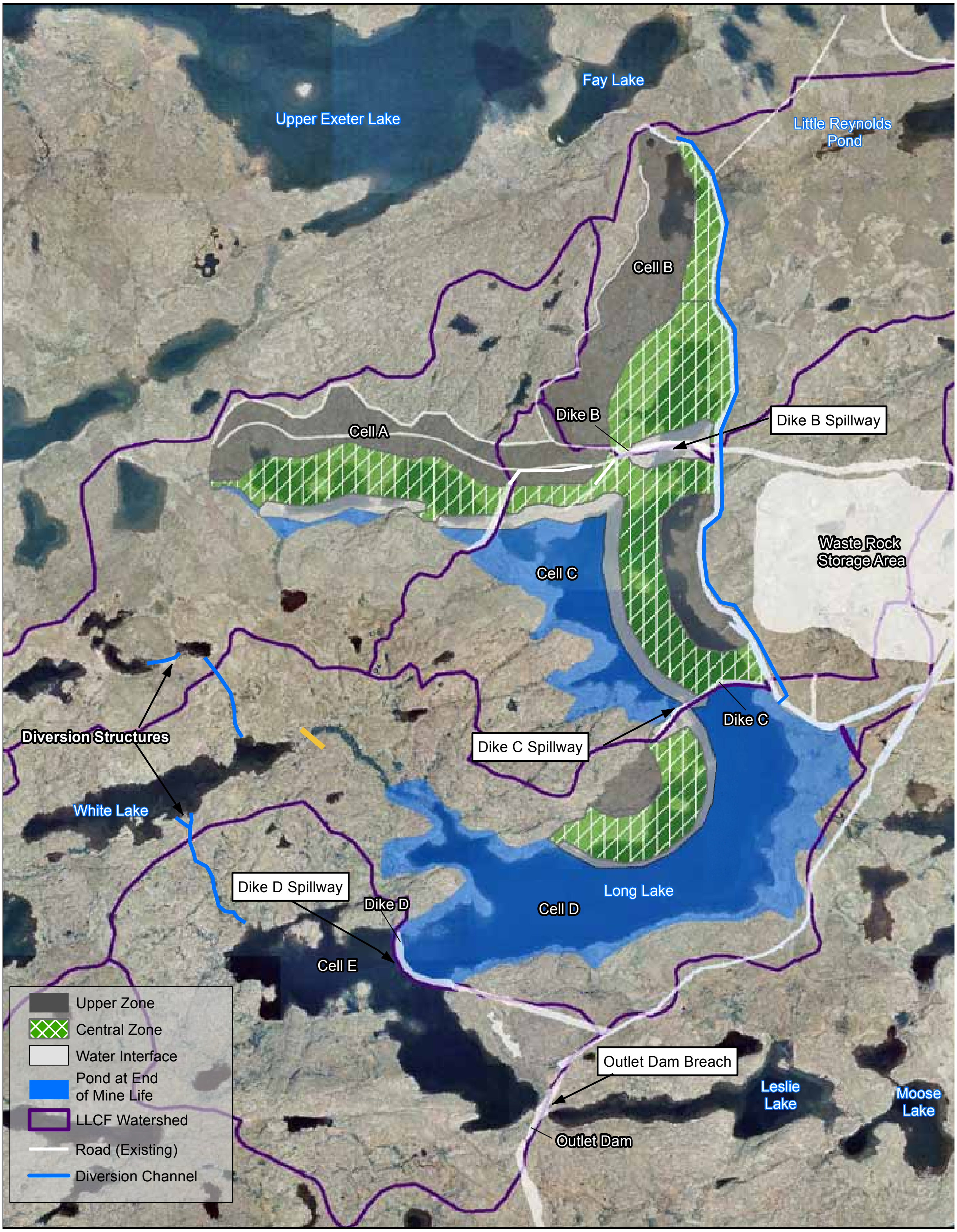
Long Lake Containment Facility

The Long Lake Containment Facility, or LLCF, is designed to hold processed kimberlite. The LLCF was built within the Long Lake Drainage Basin. There are five cells in the LLCF, and a frozen core Outlet Dam at the southern end of the facility. Water must meet water quality criteria before it is released from the facility and into the downstream watershed.

Cells A, B and C of the LLCF are currently used to store fine processed kimberlite, and Cell D may be used for that purpose in the future. No processed kimberlite will be stored in Cell E, which acts as a polishing pond for water before it is released back into the environment.

To close the LLCF, BHP Billiton plans to cover the surface of the kimberlite with a combination of rock and vegetation. At closure, the LLCF will be mostly flat, with each cell sloping downhill away from the kimberlite discharge point.

Closest to the discharge points, the surface of the LLCF will be dry and may not be able to support a vegetation cover. An erosion-resistant cover of coarse rock will be used to cover this Upper Zone. Mid-way down the slope of each cell (the Central Zone), the waste rock will be laid out in a grid pattern and vegetation will grow between the rock spaces, while the lower slope (Water Interface Zone) will be covered with rock to ensure there is no erosion on the pond edge. Some plants will also grow between the rock spaces and in the moist areas around the pond edges. The Central and Water Interface zones will be planted with a mixture of native grasses. Fertilizers will be added to encourage plants to grow.



Long Lake Containment Facility after closure.

Dams, Dikes and Channels

BHP Billiton has built several dams, dikes and channels at EKATI to control the flow of water to and from various facilities, such as the open pits and underground mines, and to assist with sedimentation.

Dams and Dikes

Dams at EKATI are built during the winter months. The Panda Diversion Dam, Long Lake Outlet Dam and Bearclaw Diversion Dam are frozen core dams, with ice-saturated frozen sand and gravel cores that act as a barrier to seepage. The King Pond Dam and Waste Rock Dam are built with liners that serve the same purpose.

The King Pond Dam, East and West Coffer Dams, and Waste Rock Dam are all found in the Misery mine area. The King Pond Dam holds mine water in the King Pond Settling Facility that has come from the Misery site. Once the water meets water quality criteria, it is discharged into Cujo Lake. The Waste Rock Dam and the East and West Coffer Dams contain runoff from the Misery WRSA. All the dams in the Misery area will be breached when the Misery Open Pit closes and monitoring shows that the water is safe for discharge.

The Bearclaw Diversion Dam and Panda Diversion Dam are located near the Beartooth and Panda open pits. The Bearclaw Dam holds water within the Bearclaw Lake. A pipeline around Beartooth pit takes water from Bearclaw Lake to Upper Panda Lake. BHP Billiton will remove the Bearclaw Dam when the water in the Beartooth Pit Lake can be discharged to Upper Panda Lake. The Panda Diversion Dam keeps water from Upper Panda Lake out of the Panda open pit and the underground mines, and diverts it into the Panda Diversion Channel. The Panda Dam is a permanent structure.

The Two Rock Dam below the proposed Sable Pit has not been built yet, but will be constructed at the outlet of Two Rock Lake to contain the Two Rock Settling Facility.

All dams and dikes except the permanent Panda Diversion Dam will be breached at mine closure, and their slopes stabilized. If the ground is suitable, some areas will be fertilized and planted with grasses, while others will be naturally colonized by lichens and mosses.

Outlet Dam.

Dike C.

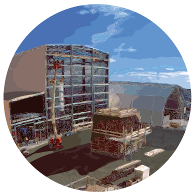
Channels

The Panda Diversion Channel, or PDC, was finished in 1997. The PDC was designed to carry water from Upper Panda Lake around the Panda and Koala open pits and underground mines to Kodiak Lake, and also to provide habitat for fish. Today, fish are using the PDC as they would any other stream in the EKATI area: for spawning, rearing and foraging. Like the other streams at EKATI, the flow of water in the PDC slows as winter approaches, and freezes in early January. The PDC will not be removed after EKATI closes. However, before closure, BHP Billiton plans to make a number of changes to the channel to ensure that it will continue to provide safe fish habitat. A section of steep slope along the PDC, known as Canyon Reach, will be reshaped to make it more stable. Selected areas of the channel will be reinforced with riprap to guard against erosion, and all the culverts will be removed. BHP Billiton will continue to monitor the condition of the PDC for a period after mine closure.

At the closure workshops held in 2006, some communities suggested that the Panda Diversion Channel remain open for fish. The communities also asked for BHP Billiton to protect fish and fish habitat. BHP Billiton has listened to the communities and included these suggestions in this plan.

BHP Billiton will use the knowledge gained from the construction of the PDC to improve the design of the Pigeon Diversion Stream, which has not yet been built. When completed, the Pigeon Diversion Stream will divert water from Pigeon Stream around the Pigeon Open Pit to Fay Lake and Upper Exeter Lake. Like the PDC, the Pigeon Diversion Stream will be designed to provide good habitat for fish. The Pigeon Diversion Stream will remain as fish habitat after the Pigeon Pit Lake is filled and the mine is closed.

Panda Diversion Channel.



Buildings and Infrastructure

The buildings and infrastructure that support EKATI have been designed and built for the extreme cold and remote location, and with a compact footprint to reduce tundra disturbance. Steel and compacted gravel have been used to minimize the need for concrete fill-in foundations. BHP Billiton designed the pipes for water, processed kimberlite and fuel to be above ground to reduce the need for excavation, minimize permafrost damage, and make disassembly easier.

When EKATI is closed, all the permanent buildings and other structures will be dismantled, except the ones that will be used for reclamation or on-going monitoring. Dangerous materials will be removed and inert materials that are not salvageable will be disposed of in an on-site landfill.

Main Camp

The major facilities that support mining operations at EKATI are located at the Main Camp. These facilities include a camp building with bedrooms and kitchen, dining and recreation areas. There are also sewage treatment facilities, offices, warehouses, and maintenance shops. Other important mine site facilities include the power plant and ammonium nitrate Storage building.

At closure, all permanent structures at Main Camp will be removed, and the pipes for water, kimberlite, sewage and fuel will be dismantled. Some areas of the camp pads, such as those with exposed bedrock, will be left as is, since they are not expected to support vegetation. Selective areas will be covered with topsoil that was salvaged during mining operations, and seeded with native plants to encourage revegetation.

Main Camp.

Satellite Facilities

Several satellite facilities have been constructed away from the Main Camp. At the Fox Open Pit, for example, there is a truck lineup area and a temporary trailer complex including washrooms, offices and lunchroom facilities. BHP Billiton has plans for similar buildings at the proposed Sable Open pit. Additional accommodations and offices as well as other facilities have been built to support the Misery Open Pit.

When EKATI closes, structures at the satellite facilities that are not needed for closure or reclamation will be removed, and any items with salvage value will be sold. Remaining fuel will be drained from the fuel tanks and the tanks will be removed. BHP Billiton will conduct a site assessment to determine the extent of any contaminated soils, and will perform the appropriate remediation.

Sites such as Old Camp, Norm's Camp and Boxcar Camp were constructed for exploration and construction purposes. BHP Billiton has already removed the buildings from the Old Camp and Boxcar Camp and has transferred ownership of Norm's Camp.

All salvageable structures will be re-used at the EKATI Main Camp, and hazardous materials will be shipped off site. BHP Billiton will investigate the area for soil contamination, and will revegetate those areas that need protection from erosion.

Hauling Misery ore to the Process Plant.

Roads and Airstrip

There are two kinds of roads at EKATI: access roads and haul roads. The narrower access roads are used by light-duty trucks, while the wide haul roads support haul trucks and large mining equipment. Both kinds of road were built using waste rock excavated from the pits.

At closure, some roads that are not required for maintenance and monitoring will have their surfaces reworked. Vegetation is expected to naturally colonize on the longer haul roads, such as the Sable, Fox and Misery roads. These roads will be used during reclamation and monitoring. When the roads are closed, the shoulder berms which line the edges of the roads will be knocked down, except in areas where this is considered to be hazardous to wildlife. The roads will serve as travel corridors and areas where caribou can find relief from insects.

A 1,950 metre long airstrip has been built using granite waste rock and esker sand. The airstrip is equipped with runway lighting and an approach system, and is used by aircraft such as Hercules C130s and Boeing 737 jets.

During mine reclamation and monitoring, the airstrip will remain operational and will continue to be used as an emergency landing strip for aircraft. When monitoring at EKATI is concluded, the airstrip will be closed. The buildings, airstrip lights and culvert will be contoured and seeded with native cultivar grasses.

Water truck on Misery haul road.

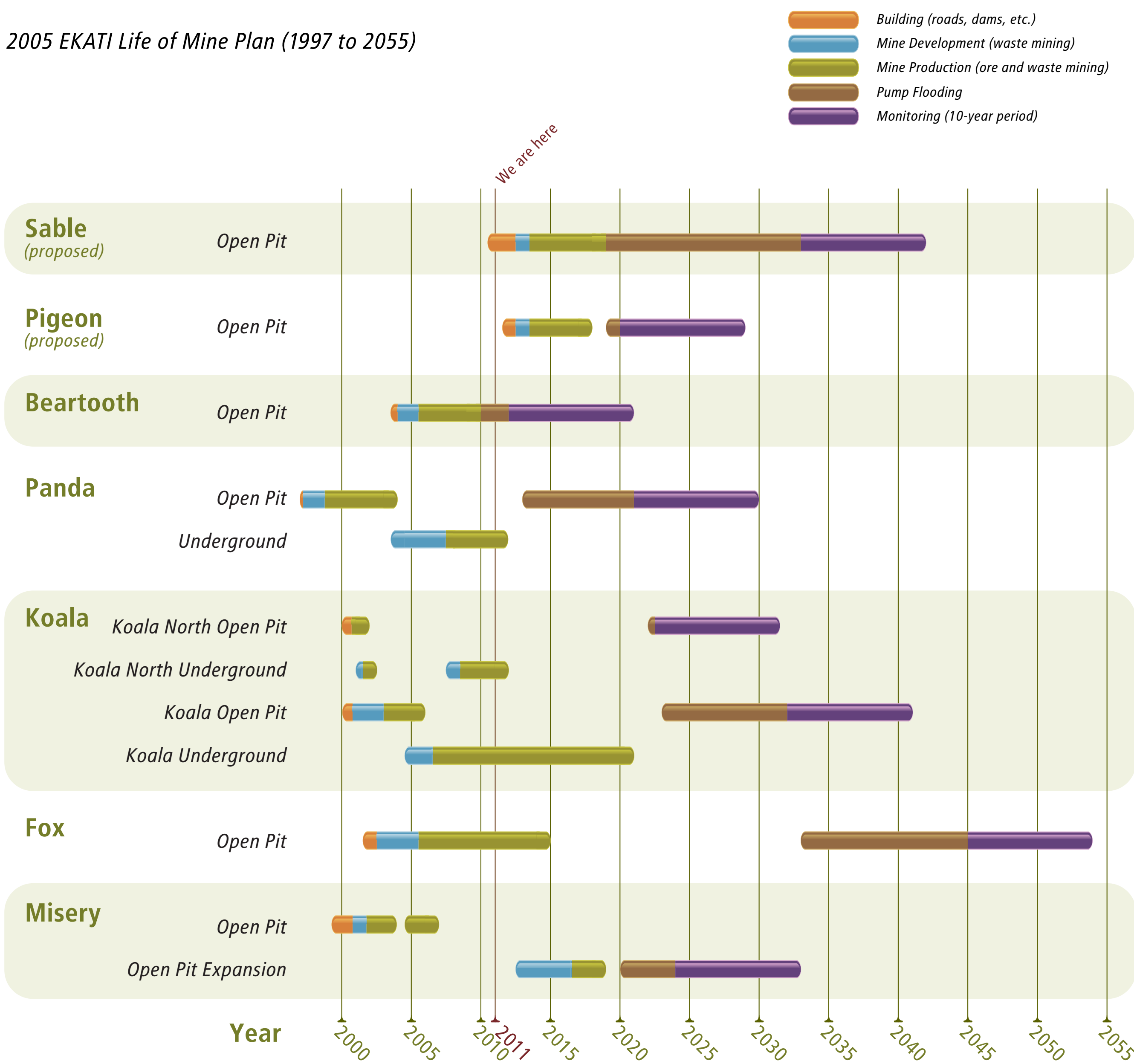
Progressive Reclamation

Closure activities planned for EKATI concern the reclamation of land used for exploration camps, storage areas, roads and buildings. Reclamation has already begun in some areas at EKATI. For example, the perimeter of the airstrip was contoured, fertilized and seeded between 1996 and 1998, and the road to Fox Portal was closed and allowed to naturally vegetate.

Between 2000 and 2005, vegetation research was conducted at Cell B of the LLCF. The research shows that vegetation can grow and sustain itself on processed kimberlite.

Reclamation will continue throughout the life of the mine. BHP Billiton will begin reclamation as early as possible, beginning with areas that are no longer needed for mining operations. The proposed timeline for all stages of closure and reclamation activities at EKATI is presented below.

2005 EKATI Life of Mine Plan (1997 to 2055)



Conclusions

EKATI is presently expected to finish mining in 2020. BHP Billiton and the communities have been talking together early in the planning stages of the closure plan to find ways to close the mine so that the land is left safe for wildlife and people to use.

Community meetings, mine site tours and workshops over 2005 and 2006 have been beneficial for BHP Billiton and communities. The company has listened to community concerns related to reclamation and the communities have listened to the company discuss how a mine operates, how mine plans are developed, and why they change.

The Interim Closure and Reclamation Plan contains closure objectives and closure criteria. The objectives set the goals for closing the mine and each of the mine components, such as protection of public and wildlife health and safety. Closure criteria set the standard at which these objectives will be met. For example, water that flows from pit lakes into the Koala Watershed will meet water quality criteria.

The Interim Closure and Reclamation Plan is based on the current information and research available to BHP Billiton, and will continue to be refined as EKATI nears closure in 2020. Progressive reclamation of the mine site continues as different parts of the mine are no longer used for mining activities. Early reclamation helps to stabilize and recover disturbed sites early, and reduces the work which will remain when the mine operations end. The Interim Closure and Reclamation Plan will be updated as required, and finalized at least two years before final closure.

Visitors inspecting the growth of grasses on processed kimberlite (June 2005).

Appendix 2.1-1

Community Consultation Summary

Rescan™
Engineers and Scientists

Appendix 2.1-1. Community Consultation Summary

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1. COMMUNITY CONSULTATION IN THE ICRP

The involvement of various stakeholders was considered an important part of the process of the compilation of the 2011 ICRP. The BHP Billiton Closure Standard objectives confirm the importance of stakeholder input to any closure plan designed by BHP Billiton. The Closure Standard states that one of its objectives is to "ensure that stakeholders' needs, concerns and aspirations are taken into account when considering closure". Consultation requires that the key stakeholders, particularly Aboriginal groups, be provided with information on the options, have time to consider that information, and be given an opportunity to respond. Consultation carried out to date has included presentations in the communities, mine site visits, a workshop, written communications and requests for participation in the consultation process.

BHP Billiton appreciates and thanks the communities and regulatory agencies for their participation and valuable input into the development of the ICRP. A summary highlighting all of the community and regulatory presentations and workshops between June 2005 and January 2007 is presented in the ICRP. A record of the concerns, suggestions and comments heard by BHP Billiton is also included as a summary of the various closure options that were evaluated with the communities and regulatory agencies during a week-long closure options evaluation workshop in July of 2006.

While the ultimate responsibility for the ICRP remains with BHP Billiton, it is recognized that involvement of the wider community will result in a better plan.

A series of meetings and presentations were held in 2005 through 2007 with the aim of gaining input from communities on the ICRP. The following stakeholders (in alphabetical order) were invited to contribute:

- Community of Kugluktuk (KIA);
- Community of Lutsel K'e;
- Corporate - BHP Billiton;
- Fisheries and Oceans Canada (DFO);
- Indian and Northern Affairs Canada (INAC);
- Environment Canada (EC);
- Government of the Northwest Territories (GNWT);
- Independent Environmental Monitoring Agency (IEMA);
- Management - EKATI Diamond Mine;
- North Slave Métis Alliance (NSMA);
- Tlicho Government;
- Wek'èezhìi Land and Water Board (WLWB); and
- Yellowknives Dene.

2. COMMUNITY CONSULTATION SUMMARY TIMELINE

Table 2.1-1a summarizes the meetings, presentations and invitations for consultation throughout the development of the ICRP.

Table 2.1-1a. Community Consultation Summary

DATE	COMMUNITY/AGENCY
Closure Feedback during 2005 Community Mine Site Tours	
Opportunity taken to discuss concerns and expectations of closure and reclamation with visiting community groups	
June 6, 2005	Community of Wekweti
June 7, 2005	Community of Rae Edzo
June 13, 2005	Community of Kugluktuk
June 14, 2005	Community of Lutsel K'e
Presentation of Closure Plan Development, and Request for Closure Concerns and Suggestions	
Presentation of approved Closure Plan, request for concerns and aspirations for closure at EKATI	
	BHP Billiton sent invitations to the communities of Kugluktuk (KIA), Lutsel K'e, Yellowknives Dene, NSMA and the Tlicho Government, and the following regulatory agencies: WLWB, INAC, GNWT, EC, DFO and IEMA.
October 28 ,2005	Independent Environmental Monitoring Agency (IEMA)
November 8, 2005	Community of Kugluktuk
November 15, 2005	Community of Lutsel K'e
January 30, 2006	NSMA
February 23, 2006	NSMA sent written ICRP comments
March 31, 2006	IEMA sent written ICRP comments
No responses were received from the Yellowknives Dene or the Tlicho Government	
Closure Options Discussions - 1. Presentation, 2. Mine Site Tour and 3. Workshop	
Presentation of options under consideration for closing the large mine components, mine site tour to provide information and a chance to see the mine site, workshop to review the options and provide further input to assist BHP Billiton in selecting the methods for closure	
June 30, 2006	BHP Billiton sent invitations to the communities of Kugluktuk (KIA), Lutsel K'e, Yellowknives Dene, NSMA and the Tlicho Government, and the following regulatory agencies: WLWB, INAC, GNWT, EC, DFO and IEMA.
1. Closure Options Presentations	
Presentation of options for Open Pits, Waste Rock Storage Areas, Long Lake Containment Facilities and the Panda Diversion Channel. This was an information session and included a request to nominate four representatives from each community and one from each regulator for more detailed involvement.	
June 9, 2006	Inter-Agency Coordinating Team (IACT)
June 12, 2006	IEMA
June 25, 2006	NSMA
July 4, 2006	Kugluktuk Community, including the Community Beneficiary Committee (CBC) and the Kitikmeot Inuit Association (KIA).
June 30, 2006	Community of Lutsel K'e unable to set up presentation due to other commitments in the community. Therefore, BHP Billiton sent a written presentation of Closure Options.
No responses were received from the Yellowknives Dene or the Tlicho Government	
2. Mine Site Tour	
Selected representatives given the opportunity to tour the mine site to view the components and discuss the closure options in more detail	
July 7-9, 2006	Lutsel K'e, NSMA, and Kugluktuk, INAC, GNWT, EC, DFO and IEMA

(continued)

Table 2.1-1a. Community Consultation Summary (completed)

DATE	COMMUNITY/AGENCY
3. Closure Options Workshop	
Review the closure options for the Open Pits, Waste Rock Storage Areas, Long Lake Containment Facilities and the Panda Diversion Channel. Provide input (both as a group and individually) to assist BHP Billiton in their selection of the closure option for the ICRP.	
July 18-21, 2006	Lutsel K'e, Kugluktuk, NSMA, INAC, GNWT, EC, DFO and IEMA
June 19, 2006	The Tlicho Government declined participation due to unavailability
No responses was received from the Yellowknives Dene	
Closure Objectives Review	
Written request for input on the Global Closure Objectives for the EKATI site	
October 13, 2006	BHP Billiton sent outline of proposed closure objectives to the communities of Kugluktuk (KIA), Lutsel K'e, Yellowknives Dene, NSMA and the Tlicho Government, and the following regulatory agencies: WLWB, INAC, GNWT, EC, DFO and IEMA.
October 16, 2006	KIA responded
October 31, 2006	IEMA and NSMA responded
November 6, 2006	DIAND responded
Presentation of Interim Closure and Reclamation Plan	
November 17, 2006	BHP Billiton sent an invitation to a presentation of the ICRP to the communities of Kugluktuk (KIA), Lutsel K'e, Yellowknives Dene, NSMA and the Tlicho Government, and the following regulatory agencies: WLWB, INAC, GNWT, EC, DFO and IEMA.

3. STAKEHOLDER CONCERNS AND SUGGESTIONS

During the discussions and feedback on the closure planning process and closure options, notes were taken on the statements made and concerns raised. Table 2.1-1b summarizes these notes. Additional written comments were received after the community and regulatory closure presentations were made and these written comments are summarized in Table 2.1-1c.

4. STAKEHOLDER COMMENTS ON CLOSURE OBJECTIVES

In October 2006, BHP Billiton sent a request via letter to all communities and regulators involved in the ICRP consultations for input on the closure objectives that were to be presented in the ICRP. Tables 2.1-1d and 2.1-1e show the responses to the request and the finalized objectives, respectively.

Where possible and practical, a number of the issues and concerns addressed during the consultation process were incorporated into the ICRP. Throughout the consultation process, BHP Billiton has reminded all parties that it is not possible to incorporate all input and suggestions into the ICRP. BHP Billiton has carefully considered all comments, concerns and suggestions from regulatory stakeholders and the communities. These issues and concerns, that naturally vary from community to community and across regulatory agencies, were balanced in their incorporation into the closure options for the major mine components, closure objectives, closure activities, reclamation research and closure monitoring. BHP Billiton prepared an ICRP that can reasonably satisfy the stakeholder aspirations and follows sound engineering and environmental practices.

Table 2.1-1b. Community Closure Presentations Summary of Suggestions and Concerns

IEMA, October 28, 2005 **OPEN PITS** **Comments on Objectives:**	**Other Discussion Points:**
• Productive (biologically) usage. • Establish clean water habitat. • Traditional usage (is this a Goal?). • Receptacle for waste rock (option? or objective for waste rock?). • Cost effective. • Reasonable closure period. • Walkaway (goal). • Self-sustaining (goal). • Keep all biological out. • Keep all water and contaminant in pit - isolate from ecosystem, if can't protect. • Restore to way it was. **Suggestions:** • Fence/berm open pit. • Sloping. • Meromictic. • Contain contaminants.	• Clarify terminology. • Look at objectives? Then options? • Site visit next summer (review options again, initiate MAA). • (This is a) First step (in the process). • Before, during (now) photos. • Possible schematics of options at closure (pre/now/?). • Clarification about progressive reclamation. • Suggest say "We want the input of the communities" • Explain process required to develop a closure plan - high level for better community understanding. Include logical parts of consultation decision points, etc. • Need to consider input/addition to objectives (INAC guidelines may not be complete). • Objectives come before options. • Clarify definitions (objectives, options and criteria). • Consult on options. • Important to show to communities that some components will be at execution phase while others are at conceptual Phase 1 • Add to reasons ICRP plan changes because of input from communities. • Avoid saying "people must understand
WASTE ROCK STORAGE AREAS **Comments on Objectives:**	**Other Discussion Points:**
• Biologically productive surface. • Ecologically productive habitat. • Safe for wildlife. • Restore to pre-existing environment. **Suggestions:** • Doming and shaping to maintain permafrost. • Capping source for LLCF.	• Insert objectives before open pit, waste rock and LLCF. • Safe and stable (physical, chemical and biological). • Define terminologies.
LLCF **Comments on Objectives:**	
• Ecologically productive. • Maintain downstream water quality in perpetuity (Leslie and onwards). • Maintain (or establish) fish habitat. • Physical stability (frozen or dry, erosion).	

(continued)

Table 2.1-1b. Community Closure Presentations Summary of Suggestions and Concerns (continued)

Suggestions/Ideas:	Concerns:
Kugluktuk, November 8, 2005	
OPEN PITS	
Suggestions/Ideas:	**Concerns:**
• Should be filled with gravel. • Fill with waste rock. • Fill with gravel. • Build barrier around pit to make sure no animals get in. • Continue monitoring of berm. • Electric fence around pit. • Snow fence around pit, fence has to be checked once in a while. • Put orange snow fence up when animals are coming.	• Make sure water in pit is safe. • Concern that animals will go over the berm. • Concern that if berm is 5 foot high, then migrating animals will go over it. • Concern with all of those open (mine pits).
WASTE ROCK STORAGE AREAS	
Suggestions/Ideas:	**Concerns:**
• Put the waste rock back in the pits. • Contour for water runoff. • Flat and contoured with the land, barriers. • Crush rock before it is put in the pit, make it smaller. • The waste rock can be made into a hill or mountain.	• Is there any sign of anything bad coming from the waste rock? • Will all go back (in to the pits) or will there be extra on the side?
LLCF	
Suggestions/Ideas:	**Concerns:**
• Continue to monitor after the reclamation work, after the mine closes. • Leave diamonds behind. • Plant vegetation. • Put back into original state, as close as possible. • Monitor the water that comes to Kugluktuk – our drinking water.	• How is the processed kimberlite going to be contained? • What is meant by stable? • Is there a concern with contaminants? • Water quality and metals is a concern. • Will fish still have a habitat in these lakes? • Concern with water quality that leaves the facility and travels down through Lac de Gras to Kugluktuk. • Try not to let the water come to Lac de Gras too – try to take it the other way.

(continued)

Table 2.1-1b. Community Closure Presentations Summary of Suggestions and Concerns (continued)

IACT, November 14, 2005 OPEN PITS Suggestions/Ideas:	Concerns:
• Natural infill. • Pumped/flooding. • With fish habitat - depends on water quality. • Transit for fish - depends on water quality. • Restored to as close to previous. • Don't want to see a big hole. • Adjust operations to enable backfill of pits. • Functioning biological habitat. • Emergency Egress – ramp. • Encourage meromictic conditions. • Shore vegetation to promote waterfowl. • Interim barriers during infill process.	• Stability of pit walls. • Potential for ARD (Misery schist and Pigeon). • Metal leaching (wall rock, waste rock runoff). • Water quality over time. • Integrate Waste Rock and Pits to deal with • ARD issues: special handling of materials, wastes and waters into one or two areas (pit) to minimize potential for water treatment. • Adjust operations so backfilling of pit is possible. • Wildlife and public safety. • Pilot test (large scale) of pit lake. • Permafrost stability - potential for thawback. • Groundwater - would pit water be contained? Particularly if water quality is poor in pit.
WASTE ROCK STORAGE AREAS **Suggestions/Ideas:**	**Concerns:**
• Isolate PAG. • Contain PAG-generating within (few) watersheds. • Ditches/pipelines to collect seepage to collect in on place. • Wildlife ramps - not to encourage use but to allow them to get off. • Different criteria for North Slope and South Slope. • Inukshuk or fences to prevent wildlife. • Allow wildlife access. • Contour so that it functions/looks like eskers or kames. • Water cover for fluffy processed kimberlite. • Erosion resistant cap. • Tailings backfill to pits.	• Thermistors - performance to date. Potential for climate change. • Wildlife safety and access. • Designed for slope failure and slumping. Saturating effects due to seepage. • BHP Billiton to incorporate issues raised during previous review of 2003/2004 A&R Plans. • Hydrocarbon contaminated materials - how are they encapsulated? • Water quality of seepage. • Use of heathers (woody plants) or other plants to encourage drainage, reduce erosion. • Stability of rock on PK - deficiency of knowledge. • Erosion control (wind, water). • Vegetation uptake of metals. Comparison with non-impacted areas (i.e., eskers). • Need to build knowledge base before decisions are made. • Water quality. • Seepage from waste rock. • Cover. • List of studies ongoing / outstanding. • Stability of beaches - subsidence, ice lenses, etc. • Stability of "fluffy" slurries. • Drainage diversions.

(continued)

Table 2.1-1b. Community Closure Presentations Summary of Suggestions and Concerns (completed)

Lutsel K'e, November 15, 2005	
OPEN PITS	
Suggestions/Ideas:	**Concerns:**
• Put rocks back in pits - at least half. • Put mud (processed kimberlite and overburden) back in pits. • Perhaps about 100 feet of water. • Have about 10 degree slope on edge so it is shallow and safe for fish and caribou. • Put back in layers. • Have water depth same as before. • Berms to protect wildlife. • Fill faster to protect wildlife. • Rocks put back into pit and underground and waste rock piles moved on top of where it came from. • Returning to natural state. • Fill open pit with sand (processed kimberlite) from tailings so the animals don't eat it.	• Make sure roads are properly closed - perhaps lay them flat. • Fish habitat. • Geese and other birds use water. • Will animals drown in water? or die if they fall into pit? • Should be filled up as soon as finished. • Monitoring after done to make sure it is okay and done right. • Will the fish be healthy if they go into pits? • Will communities have opportunity to be involved in doing closure? • Don't see many birds any more near my camp.
WASTE ROCK STORAGE AREAS	
Suggestions/Ideas:	**Concerns:**
• Move waste rock piles on top of holes that it came out of. • Make more caribou passageways.	• Make sure oil does not flow out of waste rock piles into lake. • We see injured caribou from big rocks.
LLCF	
Suggestions/Ideas:	**Concerns:**
• Can we open one or more dikes and have more water in LLCF? • Vegetation and grass. • Don't put vegetation on things (sand) that have bad things that animals (caribou) would eat.	• Cover tailings (processed kimberlite) with rock as soon as mine closes. • Take elders there to show/explain how muddy water (PK discharge) turns to clean water. • Geese and birds use water and habitat. • Caribou laying on processed kimberlite mud and eating it. • Caribou drinking water if it is salty - it dries then, makes them thirsty. • We eat caribou and we are concerned about what they eat. Vegetation on rocks and processed kimberlite. • Dirt, soil and berries (birds and caribou eat these) near Yellowknife are contaminated - don't want this to happen at EKATI. • Smoke from burning goes into the ground / plants at EKATI.

Table 2.1-1c. Summary of Written Comments

North Slave Metis Alliance, February 13, 2006 GENERAL ISSUES Suggestions/Ideas:	 Concerns:
	• We have not agreed to reclamation instead of restoration. Why is it a reclamation plan when the Waters Act requires a restoration plan? Are we getting compensation for the difference? • What about all the exploration drill holes all over the place, are animals getting hurt in them? • How will the dust be controlled from the site? • Where will the power lines go, and all the poles? • Salvage rights for buildings, equipment, fuels, and materials will be equitably distributed among the Aboriginal groups. • Consideration will be given to leaving some benign, stable infrastructure on site for use in renewed harvesting activities. • More detail desired on reclamation work available to communities, and what training should be started now? • What will be done with the wind generators after the mine is done?
OPEN PITS **Suggestions/Ideas:**	 **Concerns:**
• Steep sides to pits can be a danger to people, wildlife, but a benefit to raptors. • Did anyone think about using the pits to bury nuclear waste or other hazardous waste from south?	• Are Misery and Koala North being progressively reclaimed? • Leaking underground between pits may keep some pits partially empty. • Snow may pile up in pit and make mini-glacier that is too deep to get enough sun to melt. • Caribou may be chased into pits by wolves, and kept there or injured. • Round whitefish and other fish that were in the lakes - will they come back as healthy as before? How long will it take? • If the lakes are deeper, will they be colder or warmer? • If the lakes are flooded quickly, where will the water come from? and will there be enough available? • What will the water be like in the pits? Will the fish be good to eat? Will there be the same fish as there was before? • Will the rocks fit in the pit again after they are all broken up? • Won't the pits fill up faster if you put rocks back in?

(continued)

Table 2.1-1c. Summary of Written Comments (continued)

<table>
<tr><td colspan="2">North Slave Metis Alliance, February 13, 2006
WASTE ROCK STORAGE AREAS</td></tr>
<tr><td>Suggestions/Ideas:</td><td>Concerns</td></tr>
<tr><td></td><td>• How much will it cost to put the waste rock back in the pits? Is there enough security on deposit to cover that?
• How much security is there? Can it pay for putting the rocks back in the pit?
• What kind of vegetation will grow on the rock piles - waste rock and processed kimberlite?
• Will it be safe for birds and animals to eat? What about people? What about the water that leaks off?
• What happens to a caribou if it licks or eats the broken up rocks?
• Will bears and wolves and other animals build dens in the rock piles? and will that make a difference to the water leaking through? Is it safe for the animals?
• How much erosion will there be from the rock piles?</td></tr>
<tr><td colspan="2">LLCF</td></tr>
<tr><td>Suggestion/Ideas:</td><td>Concerns:</td></tr>
<tr><td></td><td>• What will be in Long Lake?
• How dangerous is it?
• How will it be kept safe?
• Will the ice freeze the same? or will there be hidden thin spots - dangerous for travelling and caribou?</td></tr>
<tr><td colspan="2">IEMA March 31, 2006
OPEN PITS</td></tr>
<tr><td>Comments on Objectives:</td><td>Options:</td></tr>
<tr><td>• Safety for humans and wildlife (during refilling and afterwards, if necessary).
• Water quality must meet discharge criteria to protect downstream aquatic life.
• Create biological productive lake.
• Create productive shore habitat.
• Minimize effects on water balance for outside water bodies.
• Safe passage for fish.</td><td>• Create littoral zones at pit edges (to prevent worker safety issues during work).
• Accelerate re-flooding with pumping but minimize effects on outside water bodies.
• Tie Panda and Koala pits into Panda Diversion Channel and remove Upper Panda Dam.
• Berming pit(s).
• Fill with waste rock or tailings during operations.
• Fill with extra fine processed kimberlite during operations or at closure (see note below).
• Create shallow lake vs. deep lake.</td></tr>
</table>

(continued)

Table 2.1-1c. Summary of Written Comments (continued)

North Slave Metis Alliance, February 13, 2006 WASTE ROCK STORAGE AREAS Suggestions/Ideas:	Concerns
	• How much will it cost to put the waste rock back in the pits? Is there enough security on deposit to cover that? • How much security is there? Can it pay for putting the rocks back in the pit? • What kind of vegetation will grow on the rock piles - waste rock and processed kimberlite? • Will it be safe for birds and animals to eat? What about people? What about the water that leaks off? • What happens to a caribou if it licks or eats the broken up rocks? • Will bears and wolves and other animals build dens in the rock piles? and will that make a difference to the water leaking through? Is it safe for the animals? • How much erosion will there be from the rock piles?
LLCF **Suggestion/Ideas:**	**Concerns:**
	• What will be in Long Lake? • How dangerous is it? • How will it be kept safe? • Will the ice freeze the same? or will there be hidden thin spots - dangerous for travelling and caribou?
IEMA March 31, 2006 **OPEN PITS** **Comments on Objectives:**	**Options:**
• Safety for humans and wildlife (during refilling and afterwards, if necessary). • Water quality must meet discharge criteria to protect downstream aquatic life. • Create biological productive lake. • Create productive shore habitat. • Minimize effects on water balance for outside water bodies. • Safe passage for fish.	• Create littoral zones at pit edges (to prevent worker safety issues during work). • Accelerate re-flooding with pumping but minimize effects on outside water bodies. • Tie Panda and Koala pits into Panda Diversion Channel and remove Upper Panda Dam. • Berming pit(s). • Fill with waste rock or tailings during operations. • Fill with extra fine processed kimberlite during operations or at closure (see note below). • Create shallow lake vs. deep lake.

(continued)

Table 2.1-1c. Summary of Written Comments (completed)

Comments on Objectives:	Options:
WASTE ROCK STORAGE AREAS	
Comments on Objectives:	**Options:**
• Human safety. • Safe use for caribou (predator escape and insect relief access). • Prevention of ARD and metal leaching. • Revegetation?	• Sloping of edges with smaller granular materials (mixture of slopes). • Allow some revegetation on top of edges. • Impervious rock cap. • Wildlife access and egress ramps (15-20% of edges as ramps of at least 100 m). • Collect and treat drainage (as a contingency only). • Pit disposal of "problem rock".
LLCF	
Comments on Objectives:	**Options:**
• Protecting downstream water quality during closure. • Protection of surrounding terrestrial ecosystems. • Avoid wind erosion on tailings. • Wildlife protection and safety. • Avoid leaving dams in place that require monitoring and maintenance. • Stability of tailings within the LLCF. • Tailings should be in a stable state (un-erodable) after closure.	• Pump unconsolidated material into a pit. • Divert water from upstream sources into Cell C. • LLCF cover and/or revegetation. • Pump extra fine processed kimberlite into pit during operations or a closure (see note below). • No revegetation directly on tailings, need to cover (rock or water?). • Pump tailings backwards from the dike to have solids rather than water against the dikes. • A "neutral" landscape rather than a "green" one. A neutral landscape is neither an attractant nor a deterrent to wildlife species.
ROADS	
Comments on Objectives:	**Options:**
• Enhance natural recovery. • Safe access for caribou. • Restore water flow. • Preserve key access roads for closure and post-closure monitoring (above objectives may not apply to these key roads) and emergencies. • Inventory and classify roads for reclamation purposes and caribou crossing.	• Edge sloping 1:3 ratio. • Small substrate. • Berm removal. • Scarifying. • Accelerated revegetation. • Remove culverts and bridges when roads no longer needed.

Table 2.1-1d. Summary of Written Comments on Closure Objectives

North Slave Metis Alliance, October 31, 2006
• The objectives presented do not meet NSMA’s expectations and requirements of the June 2006 TOR or Part L of MV2001L2-0008 or Part J of MV2003L2-0013. • The objectives are not sufficiently detailed to be of much use. • NSAM expects the objectives to include all closure objectives committed to during the environmental assessment, environmental agreement, socioeconomic agreement, regulatory approvals and criteria yet to be negotiated with NSMA. • All relevant physical, chemical biological and social objectives need to be specified in enough detail to guide the development of and evaluation of the specific performance criteria.

(continued)

Table 2.1-1d. Summary of Written Comments on Closure Objectives (continued)

• Closure criteria must provide enough detail information to ascertain whether the closure objectives have been met. • The performance criteria must be suitable for use in the future to determine whether compensation is owed or whether a refund of security out to be made.
Kitikmeot Inuit Association, October 16, 2006 • KIA's guiding principles for any closure plan are protect the environment, safe for future use by people and wildlife, restore for future use by people and wildlife and no perpetual care. • The current set of objectives has a lot of overlap with KIA interests, however wildlife considerations do not have enough priority or clarity. • Objectives for wildlife should be more explicitly stated. • Recommend making addition to Objective #2 to state: Protect public and wildlife health and safety.
Independent Environmental Monitoring Agency. October 31, 2006 • The objectives need to be developed for each mine area component and not as overall objectives. • Need for a greater level of specificity with regard to objectives. • "Ensure that reputation of BHP Billiton as a responsible corporate citizen is maintained and enhanced" is not appropriate as an objective for closure and reclamation of the mine site. • Recommend BHP Billiton develop clear definition and hierarchical relationships amongst overall mine closure and reclamation goals, objectives for specific components, and corresponding to the objectives, measurable criteria for each mine area component. • The objectives set out have the potential to conflict with one another and some sense of priority would be better set for each mine area component.
INAC November 6, 2006 • Present reclamation objectives submitted have sufficient detail for a high-level approach to reclamation, however they should be expanded to address each of the major mine area components in sufficient detail to guide the evaluation and selection of appropriate activities. • Closure criteria should describe a precise measure of when the objective has been satisfied. • Requesting a greater level of detail than is presented. • The level of detail is not consistent with recommendations presented in the 2006 Mine Site Reclamation Guidelines for NWT.

Table 2.1-1e. 2007 ICRP Closure Objectives

No.	Objective
1	Comply with legal and regulatory obligations, BHP Billiton corporate and other requirements.
2	Protect public and wildlife health and safety.
3	Mitigate significant adverse environmental effects to identified Valued Ecosystem Components (VECs) using a risk based approach.
4	Consider the relevant expectations of stakeholders for post closure land use, including biodiversity, sustainable development and respect of traditional values.
5	Minimize negative socio-economic impacts in the area.
6	Achieve closure criteria completion and return of securities as soon as practicable.
7	Design the plan such that long-term care and maintenance is not required.
8	Ensure that the reputation of BHP Billiton as a responsible corporate citizen is maintained.

To illustrate how community and regulatory feedback was incorporated into the ICRP, an example of the relative proportion of community and regulatory feedback is shown in Figure 2.1-1a. The sizes of the bubbles illustrate the relative number of comments on issues recorded during the community visits and presentations. The larger the bubble, the more concern raised during the community presentations. In this example, the closure methods chosen for the open pits is linked to, and addresses, the relatively important issue of water quality and wildlife safety. BHP Billiton noted the water quality and wildlife as two key uncertainties in Section 1.4 of the main document. The concern for water quality and wildlife safety have been addressed throughout the ICRP, but with particular attention to the closure method for open pits (discussed in Section 5.2), and the reclamation research plans which focus on the uncertainties related to water and wildlife safety.

5. MINESITE TOUR - QUESTIONS AND ANSWERS

A closure planning tour was held at the EKATI mine site on July 7 to 9, 2006. During the tour, a number of questions were asked. BHP Billiton prepared answers to all of the questions and later distributed the answers to the tour participants. Table 2.1-1f summarizes the questions and BHP Billiton's responses.

6. CLOSURE OPTIONS EVALUATED

A closure options workshop was held in Yellowknife on July 18 to 21, 2006. Tables 2.1-1g to 2.1-1j summarize the closure options evaluated at the workshop and include the selected options included in the ICRP.

7. CLOSURE OPTIONS EVALUATION WORKSHOP – EVALUATION QUESTIONS AND FEEDBACK

The Closure Options Evaluation Workshop was attended by community (Kugluktuk, Lutsel K'e, and NSMA) regulatory agencies (INAC, GNWT, EC and DFO), IEMA representatives and technical consultants. WLWB attended as an observer. The workshop objectives were:

- To review closure options for the open pits, PDC, WRSA and the LLCF.
- Evaluate closure options using a simplified selection process previously used at similar closure planning workshops in Northern Canada (e.g., Colomac, Red Dog and Brewery Creek).
- Evaluate closure options through listing of pros and cons, group discussions of options, technical discussions, group and individual ranking of options, and identification of option variations.
- Provide the opportunity for community and regulatory feedback on closure options to assist BHP Billiton in the development of closure methods for the major mine components.

The workshop was conducted over four days in July 2006. Workshop participants were divided into common groups (tables) to facilitate feedback and to ensure that discussion and opinions came directly from each of the community, regulatory, consultant and BHP Billiton groups, and not filtered through the general group or from more vocal participants. The groups were the Technical Consultants, Regulators 1, Regulators 2, Community 1, Community 2 and BHP Billiton (EKATI).

The decision on group makeup was well considered and all tables were encouraged to ask questions and talk to each other throughout the workshop. Observations and experiences during community and regulator consultations both at EKATI and other mine sites has shown that communities are more vocal in their opinions when not directly influenced or outnumbered. BHP Billiton was keen to ensure the community's opinions were given as much weight as the opinions of regulators and IEMA and that they had an equal opportunity to contribute. A good range of opinions were heard and recorded during the workshop which helped BHP Billiton develop the Closure Options to be adopted.

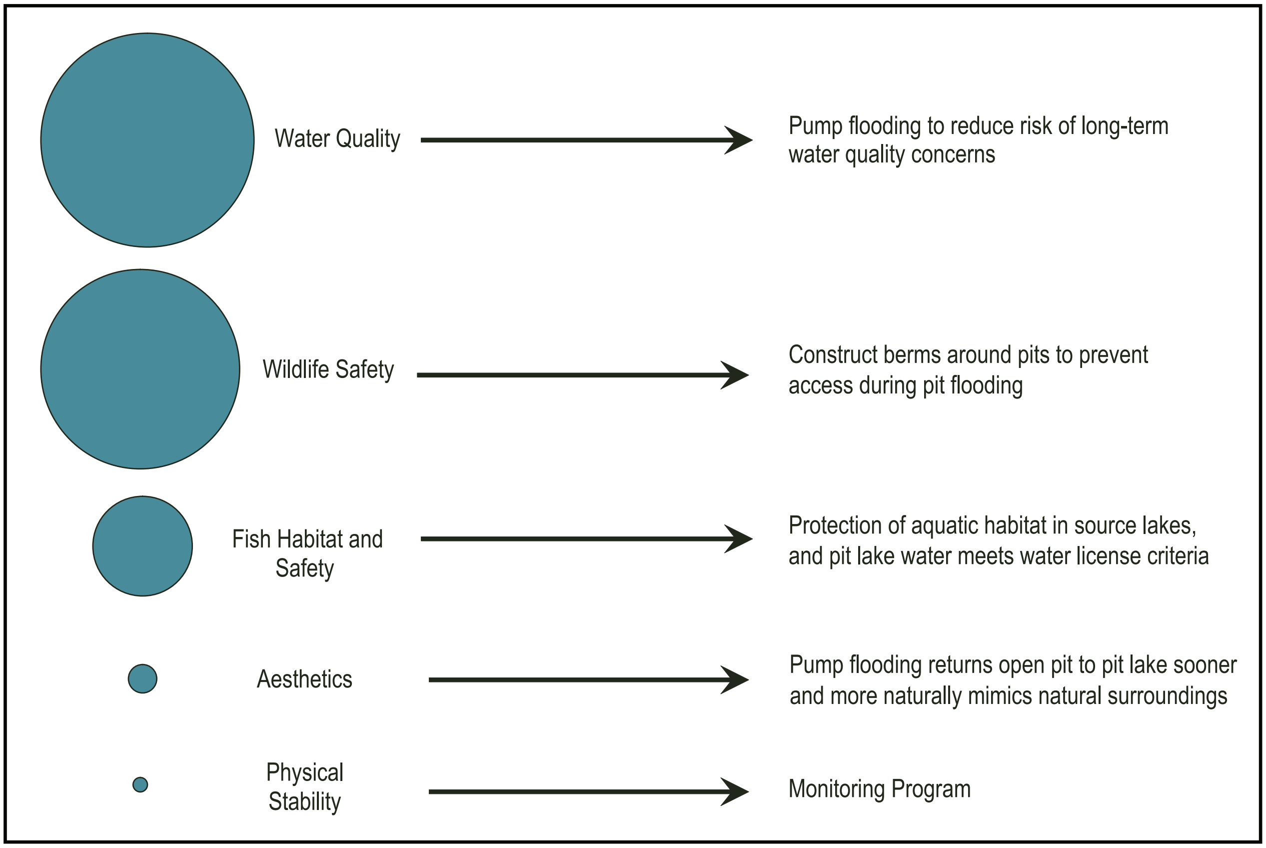

Figure 2.1-1a

Incorporation of Consultation Feedback into the ICRP

Table 2.1-1f. July 2006 Mine Site Closure Planning Tour Questions and Answers

Tour Questions	BHP Billiton Answers
• How long will it take to fill the pits with water that have been backfilled with waste rock first?	Based on a 30% void space, the estimated fill time would be 30% of the natural fill time.
• What will you do with the berms around the pit once they are filled with water?	The berms would remain in place as wildlife deterrents.
• Explain the difference between recontouring and wildlife access ramps?	Recontouring involves resloping the outer perimeter of the WRSA to make a smooth rock pile, as a final closure option. Wildlife access ramps would involve constructing a limited number of ramps for wildlife to travel safely across the WRSA.
• What will happen with the PDC while the pits are naturally filling?	If abandoned before pit flooding, compensation habitat for the PDC would be required, and BHP Billiton and DFO would need to agree a suitable area for compensation. In the alternative, the PDC will have to be stabilized for the long-term (during pit flooding).
• Has someone looked at the closure and reclamation at Pine Point?	Not in detail.
• Check the calculation of the PK fill option vs pump fill alone option, the time estimate should not be the same.	Updated numbers are included in the presentation.
• Has there been any thought on how to construct wildlife access ramps, is there any criteria?	Consistent with NWT Mines Act, 30 m wide, 10 to 12% grade.
• Are there any contaminants in the kimberlite in the LLCF?	The LLCF water is increasing in salinity; there are traces of molybdenum from Misery ore processing, traces of coagulants and flocculants that are bound into the sediments, trace amounts of hydrocarbons bound to the sediment.
• Who will decide what closure options are selected, the government, the company?	The decision as to the closure options and their environmental and financial consequences presented in the ICRP are the ultimate responsibility of BHPB. Regulatory authorization of the Closure Plan is the responsibility of the Minister.
• What is the survival rate of eggs in the PDC?	It varies from approximately 0.2 to 1.0%, typical of for grayling found in the PDC and in other natural streams.
• What types of fish are found in the PDC?	Whitefish, lake trout, grayling, burbot and slimy sculpin.
• Where is the original flow channel for the Panda Lake?	The original flow channel is from Upper Panda Lake through Panda Lake (area of open pit) and into Kodiak Lake (picture shown in presentations).
• Where does firefighting water come from?	Grizzly Lake.
• Are the thermosyphons in the PDC frozen core dam finned?	The are finned above ground, not below ground.
• Where are the hydrocarbon spills on the exploration pads (frozen lakes) taken to?	Any snow or ice containing hydrocarbons is taken to the contaminated snow and ice containment facility (CSCF) on top of the Panda WRSA.
• What is an exploration sump?	An exploration sump is a small hole or basin constructed to contain the cuttings and material from the exploration drill holes.
• What is done with the exploration sump after you are done?	The exploration sumps are cleaned of any material and reclaimed.

(continued)

Table 2.1-1f. July 2006 Mine Site Closure Planning Tour Questions and Answers (continued)

Tour Questions	BHP Billiton Answers
• Is there a difference in price per carat of diamonds?	Yes, from pipe to pipe and within a pipe, the price (value) differs.
• Will people be laid off with more underground mining?	To date, the normal resignations from the open pit workforce has allowed for a gradual decline of workforce so far.
• Is the level of mine planning at EKATI unique and more than at other mining operations?	The mine planning at EKATI is very complex and challenging due to a number of influences including multiple open pits, underground mines, regulatory restraints, and community expectations and commitments.
• Would it be possible to have a timeline of closure activities shown next to the LOM Plan?	Yes this will be provided at the workshop.
• How do you transfer material from underground to the surface?	Primarily by conveyor but can also be brought to the surface up the decline ramp using underground haul trucks.
• Would it be less expensive with respect to reclamation if all of the deposits were mined underground instead of open pit?	It is not economic or feasible to mine all of the kimberlite from underground. Underground mining is far more expensive than surface mining.
• What happens to all of the buildings and equipment at closure?	The buildings will be dismantled and buried in the landfill or underground. Equipment that has remaining value will be transported back down the winter road or if not salvageable will be buried at site either in the landfill or underground.
• Will the small diamond recovery plant change the mine plan?	If the plant works as we expected. The size of the change of mine plan may take a few years to determine.
• What is a granite cap?	A granite cap is a cover of granite waste rock placed over other material.
• What types of rock are buried in the WRSA so they are not exposed?	Details are given in presentation.
• Is there a difference in temperature between dry waste rock and ice rich waste rock?	Only while it freezes, otherwise there is no difference.
• Are coarse rejects kimberlite?	Yes, coarse rejects are the coarser size fraction of kimberlite removed prior to the fines being pumped to the LLCF.
• Is there any water that seeps out of the toe of the WRSA?	Yes, there are some small seeps in some areas around the perimeter of the WRSA that are monitored on a routine basis.
• Is there any poison or bad rock in the WRSA that may be harmful to people or animals?	No.
• Will we be able to see any recontoured slopes on the WRSA?	There are no recontoured slopes on the waste rock storage areas at this time.
• Are the angles on the WRSA for truck traffic the same angle that would be used for wildlife access ramps?	The wildlife access ramps would likely be similar in grade to the ramps required for truck traffic.
• Can we see any seepage points on the tour?	Access to the seepage points is very difficult and will not be possible
• How many tonnes of coarse rejects are stored on the WRSA?	Approximately 29 Mt at end of mine life.
• Is there any painted wood buried in the landfill?	Very small amounts. Non-toxic paint has been used at EKATI.

(continued)

Table 2.1-1f. July 2006 Mine Site Closure Planning Tour Questions and Answers (continued)

Tour Questions	BHP Billiton Answers
• Do you do any burning in the landfill?	We have in the past and will be doing so in the future, similar to communities across the NT. We are considering burning timbers to reduce the size required for a landfill.
• Do you empty the water out of the contaminated snow and ice facility?	Yes, it is applied to the surface of the WRSA, in the area referred to as the Racetrack.
• Why don't you take the material in your landfill back down the winter road and put it in the Yellowknife landfill?	It would not be cost effective to haul the landfill material to Yellowknife. As well there are liability issues to consider and the city of YK would likely not accept the landfill material from EKATI.
• Why is the contaminated snow and ice facility so high up in the WRSA?	The location of the CSIF is in a location that will provide long term access as the WRSA is constructed.
• Why isn't there any recycling program at the mine?	There are recycling programs for waste oil and filters, waste glycol, batteries and other materials.
• Could you join forces with Diavik and DeBeers to help on backhauling recycled materials?	We have not discussed this with them.
• Is it possible to compost your food waste and make soil for reclamation?	Food waste cannot be composted at this time because it would become an animal attractant.
• Where is the sewage sludge going?	EKATI has primary and secondary sewage treatment. (This is a better standard than the Yellowknife Treatment Plant). The treated liquid goes to the LLCF and the solids are placed on the WRSP.
• Can you explain what happens at the outlet dam and pumping water?	Pumping is done only when requirements of the Water Licence are met. The pumping system is designed to nearly mimic the natural hydrograph (freshet, low summer flows). Pumping is now typically done in June and September.
• Why are you putting kimberlite in the lake rather than on land?	The original licence required that the processed kimberlite (40% solids, 60% liquid) be stored in Long Lake.
• There are lots of water licence requirements. Who/how many people do that?	There are 13 full time employees in the EKATI Environment Department(the largest in the company) and about 30 consultants that track compliance with these requirements. The Department is supported by several consultants. The staff increases to 23 over the summer (consultants and summer students)
• Why isn't more water recycled?	All of the requirements for water used in the process plant come from the LLCF. Water taken from Grizzly Lake is for potable use only.
• Is it safe for caribou to travel over the LLCF?	See recent photographs of caribou crossing the LLCF. Since EKATI commenced operation there have been no caribou harmed by site operations.
• Do you use dynamite?	Dynamite is not used. An emulsion is used in the open pits and ANFO is used in the underground.
• Will the pits be backfilled with waste?	This is one of the options being presented at the workshop, but it is one of the least practical solutions.
• Are the flocculants used in the process plant safe for the environment and animals?	Works done to date indicates that the flocculants are non-toxic when they reach the environment. These substances are commonly used in drinking water treatment in Canada and the United States.

(continued)

Table 2.1-1f. July 2006 Mine Site Closure Planning Tour Questions and Answers (completed)

Tour Questions	BHP Billiton Answers
• What are the chemicals in the flocculants?	Long chain polymers. Exact formulas are proprietary information of the manufacturer.
• Are there any chemicals or contaminants in the rock brought up from underground?	It is the same type of rock that is mined in the open pits, only the mining methods are different.
• Would the landfill be frozen before it is buried?	The same freezing processes that are occurring in the WRSA are occurring in the landfill. The active landfill is constantly being buried. Ultimately the landfill will become permafrost.
• Have the closure options been costed out?	Yes, high level costs will be presented at the workshop.
• Is BHBP prepared to implement any of these closure options?	BHPB will evaluate the closure options and select the most viable option with approval from the Minister. BHPB will not implement a closure plan that has no net environmental benefit and jeopardizes the economic viability of the mine.
• Can you quantify the amount and type of hydrocarbons, how they breakdown and will the LLCF become a hazardous site after closure.	The LLCF is monitored for hydrocarbons at cell E and concentrations in water samples are below analytical detection limits, and therefore are not an issue both current or in the future. Longterm water quality modeling supports the conclusion. Low levels of dissolved hydrocarbons can enter the LLCF from the mine sump water and from the underground. Any hydrocarbons present in the discharge into the LLCF will break down through natural attenuation and through water amalgamation. The estimated total extractable hydrocarbon concentrations in the settled processed kimberlite in the LLCF are more than 100 times lower than the most protective Canada wide standard for hydrocarbons in soil.
• Are there any natural chemicals in the underground rock that are different or not in the open pit rock.	The underground rock is the same as the open pit rock, the only difference is the mining method.
• Can you bring an example of kimberlite to the workshop.	Yes.
• Can you classify last week's rainstorm as a 50 or 100 year event?	It was approximately a 100 year 24 hour event.
• Has this type of precipitation event been factored into closure planning?	Yes.
• Is there any effect on caribou migration patterns from the height of the WRSA?	Our monitoring indicates there is no regional influence or effect. The local migration pattern has changed so that caribou tend to ravel around the minesite.
Have you looked at the cumulative effects on Lac de Gras of pump flooding Misery at the same time Diavik will be flooding their open pits with Lac de Gras?	Regulatory authorization would be required to pump any water from Lac de Gras for pit flooding. The effects on any source lakes would have to be investigated to ensure there is no adverse effect on Lac de Gras or the Coppermine River.
Is there a reference lake to Long Lake?	No, it is a storage pond for processed kimberlite. Our reference lakes for the AEMP are Polar Vulture, Counts and Nanuq Lakes.

Table 2.1-1g. Panda/Koala/Beartooth Closure Options Evaluated

Option	Waste Rock Storage Area	Panda/Koala Pits	Panda Diversion Channel	Beartooth Pit
A (approved 2000 Abandonment and Reclamation Plan)	Recontour	Natural Flooding	Abandon Channel and Re-establish stream flow	Natural Flooding and Reconnect
B	Backfill into Pits	Waste Rock Backfill	Leave Channel Open	Waste Rock Backfill
C	Wildlife Ramps and Vegetation Islands	PK Disposal in Panda, followed with Pump Flooding Pump Flood Koala	Leave Channel Open	PK Disposal Followed with Pump Flooding
D	No Vegetation and No Access	Pump Flooding	Leave Channel Open	Pump Flooding
Selected Option for Closure Plan	No Vegetation and Wildlife Ramps	Pump Flooding	Leave Channel Open	Pump Flooding

Table 2.1-1h. LLCF Closure Options Evaluated

Option	LLCF Closure Options
A	Waste Rock Cover with Ponds
B	Direct Vegetation with Ponds
C	Combination Waste Rock and Vegetation with Ponds
Selected Option for Closure Plan	Combination Waste Rock and Vegetation with Ponds

Table 2.1-1i. Fox Closure Options Evaluated

Option	Waste Rock Storage Area	Open Pit
A (approved 2000 A&R Plan)	Recontour, Vegetation Islands	Natural Flooding
B	Backfill into Pit	Waste Rock Backfill
C	No Recontour, Wildlife Ramps, Vegetation Islands	Pump Flooding
D	No Vegetation, No Access	Pump Flooding
Selected Option for Closure Plan	No Recontour, No Vegetation, Wildlife Ramps	Pump Flooding

Option B (Rock fill) and Option C (Pump Flooding and no recontouring for WRSA) were not considered by popular demand.

Table 2.1-1j. Misery Closure Options Evaluated

Option	Waste Rock Storge Area	Open Pit
A (approved 2000 A&R Plan)	Recontour, Vegetation Islands	Natural Flooding
B	Backfill into Pit	Waste Rock Backfill
C	No Recontour, Wildlife Ramps, Vegetation Islands	Pump Flooding
D	No Vegetation, No Access	Pump Flooding
Selected Option for Closure Plan	No Recontour, No Vegetation, Wildlife Ramps	Pump Flooding

Seven evaluation questions were used during the July 2006 workshop to help in assessing the various closure options:

- Does this option protect water quality and fish?
- Does this option ensure physical and chemical stability?
- Does this option ensure technical certainty?
- Does this option protect the health and safety of the regional people?
- Does this option protect traditional uses?
- Does this option protect future economic and community benefits?
- Does this option control future liabilities?

Each group was given two or three of these questions to answer. Tables 2.1-1k to 2.1-1n summarize the questions and feedback received from the workshop groups.

8. CLOSURE OPTIONS EVALUATION WORKSHOP – OPTIONS PROS AND CONS

During the evaluation of each option, a series of Pros and Cons were developed by the workshop participants on open forum. Tables 2.1-1o to 2.1-1r summarize the pros and cons for each of the closure options.

Table 2.1-1k. Panda/Koala/Beartooth Evaluation Questions and Feedback

Questions	Technical Consultants	Regulatory 1	Regulatory 2	Community 1	Community 2	EKATI
Option A (recontour wrsa/natural flood pits/abandon pdc and re-establish stream flow between pit lakes)						
1. Does this option protect water quality and fish?	Long fill time, freeze/ thaw of pit wells Long term ground water input Pit lake would act as nutrient sinks for downstream inputs Unknown quality of compensated PDC habitat	Strongly disagree with loss of PDC without assurance of alternative stream flow and water quality alternative	Long term water quality uncertain New stream drainage, geothermal uncertainty in stability Seepage (TSS) are unknown Known habitat being replaced with new stream habitat Drinking water - WAY downstream OK	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.
2. Does this option ensure physical and chemical stability?	Long flood time will lead to more freeze/ thaw Connate water will contribute to pit flooding High maintenance cost for PDC that will eventually be abandoned, and maintenance of new habitat that will be the compensation for PDC	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.

(continued)

Table 2.1-1k. Panda/Koala/Beartooth Evaluation Questions and Feedback (continued)

Questions	Technical Consultants	Regulatory 1	Regulatory 2	Community 1	Community 2	EKATI
3. Does this option ensure technical certainty?	Slow flooding not a proven designed closure method Cost of PDC compensation unknown Uncertainty of performance of PDC compensation habitat	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Strongly agree that the pits are technically certain Agree the WRSA is tech. possible but may lead to issues with permafrost Strongly disagree with closure of the PDC which is working and with modifications can be set up for long term
4. Does this option protect the health and safety of the regional people?	This group did not cover this question.	Unattended open pit poses hazard	Open pit left open for a prolonged period, travel hazard unknown Dusting of caribou forage, metal uptake due to eating veg with dust Traditional hunting requires travel (visibility in winter)	Monitoring of water - must happen all the years Travel hazards (open pits) Impacts to hunting and fishing by mine footprint and downstream (Coppermine, Lac de Gras)	Unknown quality of water Could affect caribou and fish Deep level of water may not allow ice to thaw - affects fish	This group did not cover this question.
5. Does this option protect traditional uses?	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Would eat fish at end of Long Lake	Open exposure to wildlife and people People will avoid the area because of the mine, they won't hunt/ fish there Recontouring will affect plants - affects whole food chain	This group did not cover this question.
6. Does this option protect future economic and community benefits?	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	It all depends on the employment! Over such a long time communities can decide how they want the area to be used	Benefits BHP's interests	With reservation on PDC closure (due to potential costs after closure to re-establish alternative stream habitat)

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Table 2.1-1k. Panda/Koala/Beartooth Evaluation Questions and Feedback (continued)

Questions	Technical Consultants	Regulatory 1	Regulatory 2	Community 1	Community 2	EKATI
7. Does this option control future liabilities?	This group did not cover this question.	Water quality uncertainty and fish habitat uncertainty	The long term strategies breeds uncertainty in who will deal with the issues	This group did not cover this question.	This group did not cover this question.	Major reservation re: PDC closure
Option B (backfill into pits/waste rock backfill open pits/leave pdc open)						
1. Does this option protect water quality and fish?	Dust generation from rehandling waste rock More nitrates onto Kodiak Beartooth overflow into Panda and PDC	Undesirable: various materials within WR pile, contents in the WR pile - therefore water quality would be unknown. Desirable: Maintains the PDC	Potential contaminants placement in pits Saline water from UG mine (at depth) could negatively affect water Geothermal disruption = stability issues possibly Potential contaminants entering water stream Also nitrates from re-blasting the waste rock pile	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.
2. Does this option ensure physical and chemical stability?	Physically stable - more potential PF degradation	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.
3. Does this option ensure technical certainty?	No precedent	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	PDC remains but water quality in open pit major issue

(continued)

Table 2.1-1k. Panda/Koala/Beartooth Evaluation Questions and Feedback (continued)

Questions	Technical Consultants	Regulatory 1	Regulatory 2	Community 1	Community 2	EKATI
4. Does this option protect the health and safety of the regional people?	This group did not cover this question.	Travel becomes more safe	Uncertainty in caribou forage/water quality Travel hazards (open pits) have been removed	Nothing will grow on the footprint - all small sediments etc will be blown off Black dirt should be added Contaminants from WR exposed, more explosives used (acid, landfill, hydrocarbons)	Pit filling eliminates from safety/travel hazards, but still potential for Connate water contamination (seeping into void spaces) altering WRP reduces height but more dust, exposure of contaminants, erosion, permafrost degradation, etc. Stream PDC habitat maintained, but unknown water quality and potential for fish to go into pits	This group did not cover this question.
5. Does this option protect traditional uses?	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Rain cleans everything - goes through the rock Can still hunt and fish in the area Contaminants exposed from WR More expenses	Safety/travel hazards less by filling pits, but… Huge area disturbed and will never return to original state, major habitat loss People reluctant to hunt/fish here No vegetation, natural stream flows not restored (although some fish habitat maintained in PDC) Natural plant recolonization - success? Vegetation islands - success?	This group did not cover this question.

(continued)

Table 2.1-1k. Panda/Koala/Beartooth Evaluation Questions and Feedback (continued)

Questions	Technical Consultants	Regulatory 1	Regulatory 2	Community 1	Community 2	EKATI
6. Does this option protect future economic and community benefits?	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Jobs after mine closes	Major costs, irreversible process, not clear if it achieves objectives (won't know - water quality issues etc until rock in pit and creates additional issues eg dust, permafrost degradation, contaminants, etc. Only positive is potential for local employment due to amount of work required	Additional costs impact life of mine planning and future exploration. There would be an impact on long term viability of the mine
7. Does this option control future liabilities?	This group did not cover this question.	Some unknowns (irreversible) Liability would go to government	Segregation of waste materials could allow for successful placement of material we know to be clean. (i.e. granite and negligible biotite schist (PAG) . How about partial infilling?	This group did not cover this question.	Too many unknowns	This group did not cover this question.

(continued)

Table 2.1-1k. Panda/Koala/Beartooth Evaluation Questions and Feedback (continued)

Questions	Technical Consultants	Regulatory 1	Regulatory 2	Community 1	Community 2	EKATI
Option C (wildlife ramps and vegetation islands on wrsa/pk disposal in panda and beartooth, pump flood koala/leave pdc open)						
1. Does this option protect water quality and fish?	Pumping could be done in such a way to minimize impact on source lakes Upside is LLCF to minimize upsets or failure Ability to fill pits with water of known quality Main flow of water until PDC – nutrients Note: Fox tailings, chemistry - stratification	Water quality should be = LLCF but uncertain, difficult More unknowns Effects of Fox More sites of contamination Tailings to cell A may not be ideal Faster filling, shallower lakes could be positive	If PK releases contaminants in the long term, then all PK should be contained in one place Given the unknowns (we acknowledge pit lake studies, special effect studies coming) we can't speak to whether or not water quality will be acceptable Seven "variables" contaminants were identified in the 2006 EIR that have significantly increased compared to baseline (unanticipated) indicate that there are unknowns with respect to long term water quality	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.
2. Does this option ensure physical and chemical stability?	Release of contaminants - regulates more waste – tailings Rest revision of closure pan Veg??	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.
3. Does this option ensure technical certainty?	Concept good - uncertainty on fox tails Technical certainty - acknowledge that unknowns with fox tailings	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Vegetation on top of WRSA is unproven and unpredictable Long lake water flows to date are below our water licence discharge criteria

(continued)

Table 2.1-1k. Panda/Koala/Beartooth Evaluation Questions and Feedback (continued)

Questions	Technical Consultants	Regulatory 1	Regulatory 2	Community 1	Community 2	EKATI
4. Does this option protect the health and safety of the regional people?	This group did not cover this question.	Agree	The hazard of a long term open pit (Option A) is not an issue here (positive) Can't comment on long term water quality (caribou/animal drinking water) and forage (metal uptake in lichen, dusting issues, etc.)	Agree	Don't open the water flow for 15-20 yrs, until water quality is good Add more vegetation	This group did not cover this question.
5. Does this option protect traditional uses?	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Agree - no fish in the pits	We're OK with the ramps Long term monitoring for fish and water, sampling on the PDC and Koala pit	This group did not cover this question.
6. Does this option protect future economic and community benefits?	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Agree - Mine will run longer	Neutral	Agree
7. Does this option control future liabilities?	This group did not cover this question.	Containment of tailings in LLCF would be easier to deal with Saline water could be isolated at the bottom of the pit but could also require treatment	Liabilities will be defined early on ie whether or not a water treatment plant	This group did not cover this question.	This group did not cover this question.	With reservation re: vegetation islands and their ability to survive

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Table 2.1-1k. Panda/Koala/Beartooth Evaluation Questions and Feedback (continued)

Questions	Technical Consultants	Regulatory 1	Regulatory 2	Community 1	Community 2	EKATI
Option D (No vegetation islands or access/pump flood open pits/leave pdc open)						
1. Does this option protect water quality and fish?	Puts PK back into Cell D	Need access ramps Less timing issues with when things can be done - pits fill faster PDC remains open Pump flooding protects water quality and fish Leaves Cell D at risk - serves as a contingency in the event water quality drops in Long Lake	No PK this time, so best case scenario for downstream water quality	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.
2. Does this option ensure physical and chemical stability?	More monitoring/ maintenance in LLCF due to PK into Cell D	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.
3. Does this option ensure technical certainty?	Lot of flooded pits Easy to monitor performance	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Strongly agree
4. Does this option protect the health and safety of the regional people?	This group did not cover this question.	Pits fill quickly Water quality maintained	Waste rock piles (as they are) likely to be a travel hazard	Water must be monitored (still nitrate around edges of pit) Question regarding safety and lack of vegetation	Faster fill = less hazards w/ open pits but still uncertainties about pit water quality, effects on source lakes, pit wall stability, dust impacts on food sources, etc.	This group did not cover this question.
5. Does this option protect traditional uses?	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Questions re: safety, lack of vegetation	Some positives (e.g., maintain PDC fish habitat, faster filling of open pits), but many potential negatives as well (wildlife safety, water quality downstream, dust issues, effects on sources lakes, etc.)	This group did not cover this question.

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Table 2.1-1k. Panda/Koala/Beartooth Evaluation Questions and Feedback (completed)

Questions	Technical Consultants	Regulatory 1	Regulatory 2	Community 1	Community 2	EKATI
6. Does this option protect future economic and community benefits?	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Jobs over long term Not agreed to in the beginning There was some understanding that the pits would be backfilled…(approved plan not understood) now changing plans Some translation problems	Not huge cost but lots of unknowns, potential for problems in future (pit water quality, source lakes, dust, wildlife mortalities, etc)	Does not allow pits to be used for PK, no requirement to fill pits to protect possible poor water quality, use of water to fill pit rather than flowing downstream
7. Does this option control future liabilities?	This group did not cover this question.	Water quality maintained Pits fill quickly	Liabilities can be defined early on and dealt with	This group did not cover this question.	This group did not cover this question.	Provides certainty on liabilities - still issue of not being able to use as PK storage location

Table 2.1-1l. LLCF Evaluation Questions and Feedback

Questions	Technical Consultants	Regulatory 1	Regulatory 2	Community 1	Community 2	EKATI
Option A (recontour/natural flooding/abandon channel and re-establish stream flow)						
1. Does this option protect water quality and fish?	Cell E rock weir will prevent fish passage WQ is good now and will improve after end of operation Dust generation minimized or eliminated, protecting pond water quality	Rock cover has best chance to protect tailings from erosion and protecting downstream water quality Uncertainties because doesn't deal with cell water and EFPK and their effects to downstream	Long term view - after achieve steady state Well engineered and monitored	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.
2. Does this option ensure physical and chemical stability?	Global warming will thaw at same rate as surroundings Rock causes more material to freeze	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.
3. Does this option ensure technical certainty?	Covers elsewhere Monitoring of PK freeze now being done	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Agree
4. Does this option protect the health and safety of the regional people?	This group did not cover this question.	Agree	Agree	All depends on the size of rocks Size of rocks will affect caribou Packing caribou over rock (not safe) Can be dangerous during a winter storm or summer for traveling	Concern of the quality of water Vegetation may still grow. May contain unknown pollutants which may affect the food chain. People may not want to hunt/fish from that area because of the mine	This group did not cover this question.
5. Does this option protect traditional uses?	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	No more fish (Cell A-D) Can be dangerous travelling in the summer and winter	Even though caribou can not directly eat from the tailings plants may still grow - unknown quality of plants People may not want to travel there because of the rough terrain	This group did not cover this question.

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Table 2.1-1l. LLCF Evaluation Questions and Feedback (continued)

Questions	Technical Consultants	Regulatory 1	Regulatory 2	Community 1	Community 2	EKATI
6. Does this option protect future economic and community benefits?	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Agree	Neutral	Agree
7. Does this option control future liabilities?	This group did not cover this question.	Assume properly constructed and no subsequent degradation of cover Contingency extra rock might be required if substantial settling	Strongly agree	This group did not cover this question.	This group did not cover this question.	Strongly Agree
Long Lake Containment Facility (LLCF) **Option B (Backfill into pits/waste rock backfill open pits/leave pdc open)**						
1. Does this option protect water quality and fish?	More potential erosion on beach More potential erosion at water's edge than with rock Long time to establish Stability of channel	Physical stability concern Uncertain if veg would stop erosion - could it be established? How much time required before this option would be successful (for veg to be established) … with greater certainty of success would have been agree	Concern for stability/erosion potential	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.
2. Does this option ensure physical and chemical stability?	Chemical stability OK, physical unsure	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.
3. Does this option ensure technical certainty?	Disagree	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Revegetation of tailings is common throughout Canada. Experience at Ekati has shown that vegetation will grow on kimberlite. The greatest uncertainty is in the area to be covered.

(continued)

Table 2.1-1l. LLCF Evaluation Questions and Feedback (continued)

Questions	Technical Consultants	Regulatory 1	Regulatory 2	Community 1	Community 2	EKATI
4. Does this option protect the health and safety of the regional people?	This group did not cover this question.	Metal uptake concern (slight risk)	Note: hazards for travel in summer - low probability	Is the vegetation safe for caribou Agreement is assuming the mine has to prove vegetation is safe	If vegetation successful, major concerns about caribou eating vegetation (metal uptake from PK) - even if planting non-caribou friendly veg, are still other animals in area (small mammals etc.) that could eat it… If vegetation unsuccessful, will have problems with erosion, dust etc. Still uncertainties about downstream water quality	This group did not cover this question.
5. Does this option protect traditional uses?	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Assuming vegetation does not contaminate caribou	See comments on #4	This group did not cover this question.
6. Does this option protect future economic and community benefits?	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Progressive reclamation (vs. irreversible rock cover) Amount of work should be about the same but different?	Cheapest option but doesn't achieve objectives for closure, major long term consequences are possible (water quality, erosion, etc.) Still very unsure about success rate for re-establishing vegetation	Again greatest concern is the sustainability of the vegetation over such a large area
7. Does this option control future liabilities?		Uncertainty of veg being successful contingency of rock pile could be costly and difficult	disagree			Questions re: long term veg sustainability

(continued)

Table 2.1-1l. LLCF Evaluation Questions and Feedback (continued)

Questions	Technical Consultants	Regulatory 1	Regulatory 2	Community 1	Community 2	EKATI
Long Lake Containment Facility (LLCF)						
Option C (wildlife ramps and vegetation islands on WRSA/PK Disposal in Panda and Beartooth, Pump flood koala/leave pdc open)						
1. Does this option protect water quality and fish?	Not different than rock cover Helps the re-suspension issue that exists along water's edge	Grave concerns about differential settling between rock cap might increase water quality issues	Concerns with erosion at pocket margins Piping through rock, what would contingency be?	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.
2. Does this option ensure physical and chemical stability?	Slightly more maintenance Looks much more like natural Encourages more natural colonization than revegetation only Chemical stability not an issue	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.
3. Does this option ensure technical certainty?	More maintenance likely required Need pilot trial at realistic scale	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Builds in an insurance factor i.e.: if there is exposed kimberlite due to rock cover failure then there would be plants closer by for natural colonization
4. Does this option protect the health and safety of the regional people?	This group did not cover this question.	Agree	Would this become an "oasis" which attracts caribou - surrounded by rock hazards?	Assuming no contamination to caribou Seems more natural Travel safety questionable	Concern of caribou grazing Concern of water quality	This group did not cover this question.
5. Does this option protect traditional uses?	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Same comments as #4	Concern of caribou and other wildlife getting/ eating contaminants Concern of boulders	This group did not cover this question.

(continued)

Table 2.1-1l. LLCF Evaluation Questions and Feedback (completed)

Questions	Technical Consultants	Regulatory 1	Regulatory 2	Community 1	Community 2	EKATI
6. Does this option protect future economic and community benefits?	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Progressive reclamation Local participation Can use TK	Puts money in locals pockets (i.e. longer mine life)	Agree
7. Does this option control future liabilities?	This group did not cover this question.	Because of uncertainties of differential settling	How do you know when a problem? Time is a factor	This group did not cover this question.	This group did not cover this question.	Vegetation sustainability over the long term and potential additional rock cover requirements

Table 2.1-1m. Fox Evaluation Questions and Feedback

Questions	Technical Consultants	Regulatory 1	Regulatory 2	Community 1	Community 2	EKATI
Option A (recontour/natural flooding/abandon channel and re-establish stream flow)						
1. Does this option protect water quality and fish?	Resloping possibly expose kimberlite in the active layer Assumes that release of water in 500 yrs will be monitored and mitigated if needed Eliminates any potential for source lake impacts Fox pit lake would have low flow as a headwater lake	More water quality uncertainty over the longer term Recontouring may jeopardize the stability of the WRP	Water quality uncertainties Hard to estimate failure risks with long time frame	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.
2. Does this option ensure physical and chemical stability?	Kimberlite in pit walls may fail over the long pit flooding time	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.
3. Does this option ensure technical certainty?	Long fill time - uncertainty in final costs Sampling problematic, would have to be new methods	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Long term potential water quality issues
4. Does this option protect the health and safety of the regional people?	This group did not cover this question.	Longer time with an open pit Likelihood is low Overall low risk	Disagree	If you find dead caribou in the pit every year who will pay for that?	Quality of water is uncertain Open pit is hazardous for wildlife Time frame is too long to naturally fill	This group did not cover this question.

(continued)

Table 2.1-1m. Fox Evaluation Questions and Feedback (continued)

Questions	Technical Consultants	Regulatory 1	Regulatory 2	Community 1	Community 2	EKATI
5. Does this option protect traditional uses?	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Safety issues	Doesn't protect the caribou or fish downstream Not safe to travel around the area No one would want to travel and hunt around that area	This group did not cover this question.
6. Does this option protect future economic and community benefits?	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Liability for communities for >500 years	Most economic plan but many things can go wrong Not a lot of work for people in the communities	This is the approved plan as which the pit economics are based
7. Does this option control future liabilities?	This group did not cover this question.	Too long for conclusions to be made	Time frame presents uncertainties	This group did not cover this question.	This group did not cover this question.	Such a long time frame before water quality assurance
Option D (No vegetation islands or access/pump flood open pit/leave pdc open)						
1. Does this option protect water quality and fish?	Volume of pit is large. Concurrent pumping of all the pits may require a much longer fill time for Fox. This may reduce any flooding benefits in terms of water quality, pit wall stability	Given source lake is Lac de Gras - yes	Treatment plant contingency	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.
2. Does this option ensure physical and chemical stability?	Pit wall stability improved, but fill time may not be fast enough to eliminate inter-bench failures at kimberlite and kimberlite in pit lake	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.

(continued)

Table 2.1-1m. Fox Evaluation Questions and Feedback (completed)

Questions	Technical Consultants	Regulatory 1	Regulatory 2	Community 1	Community 2	EKATI
3. Does this option ensure technical certainty?	Pump flooding done elsewhere as a designed closure method Source lakes and rivers have been used Monitoring still a challenge but over shorter period	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Creates defined closure option closer to walk away
4. Does this option protect the health and safety of the regional people?	This group did not cover this question.	Agree	Neutral	Pumping effects to Coppermine Safety traveling over 15 yrs Not against pumping - just worried about time taken, effects to water Most prefer rock option B only 5 years saves our water	Due to potential impact to Coppermine River watershed	This group did not cover this question.
5. Does this option protect traditional uses?	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Comments: if you fish in there - you get no brain	Uncertainty on water quality and quantity downstream Fish habitat would be impacted	This group did not cover this question.
6. Does this option protect future economic and community benefits?	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Less money for communities Affects Coppermine river	Costs are lower than others Water quality still a concern	Cost OK. This closer option not in approved plan. Will impact decision to extend mine life.
7. Does this option control future liabilities?	This group did not cover this question.	Agree	Question of water quality with clay	This group did not cover this question.	This group did not cover this question.	Define closure option, clear accountabilities from both government and company

Option B (Rock fill) and Option C (Pump Flooding and no recontouring for WRSA) were not considered by popular demand.

Table 2.1-1n. Misery Evaluation Questions and Feedback

Questions	Technical Consultants	Regulatory 1	Regulatory 2	Community 1	Community 2	EKATI
Option A (recontour WRS/natural flood pits/abandon PDC and re-establish stream flow between pit lakes)						
1. Does this option protect water quality and fish?	Exposed biotite schist for > 100 years The long term water quality is unknown and will take a long time before it can be characterized	Is freeze back going to occur in the schists? What will the long term drainage flow path and quality be? Increasing trends in constituents in seepage	Movement of water and its chemistry Biotite schist exposure and potential contribution to ARD Long term leads to uncertainty	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.
2. Does this option ensure physical and chemical stability?	Possible geochemical instability from resloping	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.
3. Does this option ensure technical certainty?	Long term nature of pit flooding leads to uncertainties Long term costs are uncertain for 180 year flooding period No pits have been successfully flooded over 180 years as a closure method	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Everything in scope can or has been done here or elsewhere Biggest issue is cutting back into WRSA potentially exposing biotite schist
4. Does this option protect the health and safety of the regional people?	This group did not cover this question.	Caribou routes Pit water not used for fishing/drinking	Coppermine drainage in vicinity of human habitation Coppermine drainage would be minimally affected Hazardous to winter travel esp. while pit is partially filled	Main concern is water quality	Climate change will affect permafrost Affects containment/can't rely on things being kept frozen Long term to naturally fill Unsure of quality of water Hazardous for wildlife and travelers Natural food sources will take a long time to re grow Lost hunting and gathering grounds	This group did not cover this question.

(continued)

Table 2.1-1n. Misery Evaluation Questions and Feedback (continued)

Questions	Technical Consultants	Regulatory 1	Regulatory 2	Community 1	Community 2	EKATI
5. Does this option protect traditional uses?	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Joseph used to hunt right through the Ekati area (trap line)	Does not protect hunting and fishing. Area is vastly disturbed and will never be the way it was. When recontouring dust affects edible plants Disturbed area affecting migrating herds Natural food re growth will take a long time	This group did not cover this question.
6. Does this option protect future economic and community benefits?	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Not enough time to answer	This option is economically good for BHP but not for the caribou, land and wildlife. Timeframe is too long for monitoring. It's hard to determine how it will be in the future.	This is approved plan on which all mine economics have been based.
7. Does this option control future liabilities?	This group did not cover this question.	Greater uncertainty due to time it takes to fill, but more time to monitor/react	Too much uncertainty Could be a good thing that there is so much time to mitigate any problems.	This group did not cover this question.	This group did not cover this question.	There is no current sign off mechanism to identify end of closure period and end of liability Long term water quality effects are expected to be negative due to benign nature of host rocks, low water flows and size of Lac de Gras

(continued)

Table 2.1-1n. Misery Evaluation Questions and Feedback (continued)

Questions	Technical Consultants	Regulatory 1	Regulatory 2	Community 1	Community 2	EKATI
Option B (backfill into pits/wasterock backfill open pits/leave pdc open)						
1. Does this option protect water quality and fish?	Affects active layer melt on WRSA Water quality of drinking water for animals Water from pit voids and drainage off WRSA will have same level of contamination that may require treatment. Thermocasting issues would cause upset to permafrost	With modifications this might work	Where does the neutral material come from? Concern about seepage from waste rock pile which is now thinner Value objective of filling in pits and suggest sequential mine reclamation options Meddling with engineering structure Actual habitat not altered	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.
2. Does this option ensure physical and chemical stability?	No physical stability issues w/ 5m thick WRSA remnant, but possible geochemical instability (schist) Uncertainty of smell factor, so if remnant pile ends up at 20m this defeats the purpose Global warming risks have potential consequences	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.
3. Does this option ensure technical certainty?	Backfill of frozen waste dump has never been done and is irreversible Monitoring within backfilled pit may be difficult over the long term water filling of the voids Operational risks will be challenging	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This has not been demonstrated to work in the north Levels of maintenance are unknown and may be extensive

(continued)

Table 2.1-1n. Misery Evaluation Questions and Feedback (continued)

Questions	Technical Consultants	Regulatory 1	Regulatory 2	Community 1	Community 2	EKATI
4. Does this option protect the health and safety of the regional people?	This group did not cover this question.	Long term effects	Uncertainty re: contamination from disturbed waste rock pile Contamination of Coppermine river drainage would be negligible due to dilution	Should be no chemicals Natural filtration Blasting chemicals ammonium nitrate, acid generation Travel - difficult to walk on	Potential for water contamination, acid rock drainage, ammonia problems, runoff/seepage from waste rock, water seeping into void spaces Remaining 5m WRP - climate change and PF degradation Dust generation, settles on lichens, food chain effects Barren area - no vegetation, won't attract wildlife No lake, no fishing	This group did not cover this question.
5. Does this option protect traditional uses?	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	No vegetation for caribou, disturbed habitat, no lake for fish but no danger to wildlife/ humans once pit refilled Reduction of high waste rock pile is good, but other problems No revegetation, dust issues Food chain contamination concerns: dust-lichens-caribou-people	This group did not cover this question.
6. Does this option protect future economic and community benefits?	This group did not cover this question.	This group did not cover this question.	This group did not cover this question.	Agree - money/ employment More $$ in the north, 5 more years of jobs	Major change to mine plan Impossible to reverse if something goes wrong Major costs (economic and environmental) Doesn't really achieve objectives Maybe some local jobs, but short term and doesn't outweigh costs	Costs almost double mining cost, this will limit future mining potential within the current mine plan and future exploration targets. This will reduce the mine life and result in curtailing investment in the North.

(continued)

Table 2.1-1n. Misery Evaluation Questions and Feedback (completed)

Questions	Technical Consultants	Regulatory 1	Regulatory 2	Community 1	Community 2	EKATI
7. Does this option control future liabilities?	This group did not cover this question.	Can't change or modify once completed Heat sink in pit could impact water quality Water quality issues	Economic liability to NWT and Canada based on BHP response to question Once waste rock pile is destroyed, don't know what might happen Is BHP able to put up the 195.5 mil as security How will the water behave in the pit? Irreversible process	This group did not cover this question.	This group did not cover this question.	Future liabilities would be unknown.

Table 2.1-1o. Panda/Koala/Beartooth and PDC Closure Options Pros and Cons

Pros:	Cons:
Option A – Natural Flooding for pit & Closure of the PDC	
Pros:	**Cons:**
• Wildlife access to WRSA. • No effect on source lakes. • Re-establishes original flow patterns. • PDC is eventually closed.	• Long timeframe. • Wildlife exposed to open pit. • Water quality due to slow fill rates. • Extended monitoring periods. • Dust from re-contouring. • Human safety. • Loss of established stream habitat when PDC closed. • Have to find replacement stream. • Re-shaping of WRSA pushes active layer deeper. • Long term stability of PDC. • Wildlife access to WRSA - uneven and broken surface. • Used by carnivores as "trap".
Option B – WRSA backfill into pits & leave PDC open	
Pros:	**Cons:**
• Reduces height of waste rock pile. • No pit lake concerns. • Local employment in short term. • Maintains existing stream habitat in PDC. • Prevents land/stream disturbance for PDC replacement.	• Waste rock footprint remains. • Re-mobilization of contaminants in WRSA. • Dust. • Environmental impact from emissions and re-blasting of WRSA. • Degradation of permafrost. • Irreversible process - no option to fix. • Water quality - pore water in pits, remaining WRSA. • Cost - potential to impact life of mine and future exploration. • Competition for clean granite. • Expose landfill/zones.
Option C – PK into Panda, pump flooding of pits & leave PDC open	
Pros:	**Cons:**
• Access for wildlife to WRSA. • Waste rock remains in designed frozen state. • Rapid filling – closure completed earlier. • Less processed kimberlite into LLCF. • Maintain PDC – fish passage assured, stream habitat maintained. • More control on water quality than any other option. • Allows progressive reclamation in Long Lake. • No processed kimberlite in Cell D.	• Success of vegetation on top of WRSA uncertain. • Source lake effects and location. • Reduced safety exposure for wildlife. • Potentially facilitating wildlife use which we don't understand. • Additional snow catchment resulting in extra infiltration. • No downstream polishing from PK (ie Cell D/E). •

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Table 2.1-1o. Panda/Koala/Beartooth and PDC Closure Options Pros and Cons (completed)

Option D – Pump Flooding of pits & leave PDC open	
Pros:	**Cons:**
• No access to wildlife. • Waste rock remains in frozen state. • Rapid filling – shorter timeframe. • Maintain PDC – habitat, passage. • More control on water quality. • Shorter fill time.	• Source lake effects and location. • No access to wildlife. • PK into Cell D. • Underground Safety – plugging of UG connections between Panda and Koala. • Ground water contribution to water quality. • Groundwater movement between PK and increased due to hydraulic gradient.

Table 2.1-1p. LLCF Closure Options Pros and Cons

Option A – Rock Cover	
Pros:	**Cons:**
• No exposed kimberlite. • Stable erosion protection. • Standard construction techniques. • Long term reduction of dust. • Rocky surface may improve access if finer surface used. • Looks more like surrounding area. • Would not be wildlife attractant.	• Settlement risk of cover. • Dust during construction. • Rocky surface – wildlife safety.
Option B – Vegetation Cover	
Pros:	**Cons:**
• Large area of revegetation. • Returns disturbed area to productive land use. • Selective use of plants to deter caribou.	• Vegetation establishment uncertainty – wind, water erosion issues. • Metals uptake concerns. • Settlement of rock drainage channels. • Vegetation is animal attractant. • Long term containment uncertainty. • Vegetation could slow down caribou moving into hunting areas.
Option C – Combination (Rock and Vegetation) Cover	
Pros:	**Cons:**
• Provides areas of re-vegetation. • Natural colonization will be easier. • More closely mimics tundra. • More biodiversity. • More variability in topography to encourage biodiversity. • Lowers risk regarding re-blasting etc of waste rock. • More options for cover types. • Rocks provide protection for plants.	• Vegetation establishment uncertainty - wind, water erosion. • Dust during construction. • Settlement risk of rock cover. • Metals uptake concerns.

Table 2.1-1q. Fox Closure Options Pros and Cons

Option A – Natural Filling for pit, recontour WRSA & use Vegetation Islands	
Pros:	**Cons:**
• Preserves WRSA design and freezing configuration (except for recontouring on edges). • Wildlife berm protects caribou from entering pit lakes. • No water source lake issues. • Could be modified for wildlife ramps.	• Large pit - very long time to fill naturally. • Water quality in pit. • Overflow water quality. • No wildlife ramps. • Animals can fall in pit with long fill time (berm degrades). • Kimberlite exposed in pit walls.
Option D – Pump Flooding & No Vegetation or Access for WRSA	
Pros:	**Cons:**
• Dome on WRSA improves water quality runoff. • Access ramps. • Preserves WRSA design (freezing). • Faster fill time (pumping).	• Very large pit - source lake issues. • Water quality into/downstream lakes. • Impact of additional costs on marginality of Fox ore source and resulting potential loss of benefits. • Water level in Coppermine River. • Impacts on fishing/drinking water.

Option B (Rock fill) and Option C (Pump Flooding and no recontouring for WRSA) were not considered by popular demand.

Table 2.1-1r. Misery Closure Options Pros and Cons

Option A – Natural Filling for pit, Recontour & Vegetation Islands for WRSA	
Pros:	**Cons:**
• WRSA currently in design that encourages freezing. • No wildlife ramps.	• Reshaping of WRSA pushing active layer deeper into pile. • Animals can fall into open pit. • Too slow to fill pit. • Water quality in pit at end of filling. • Overflow water quality downstream in Coppermine River.
Option B – Backfill of Pit with WRSA	
Pros:	**Cons:**
• Local employment. • Put it to the way it was before (land, vegetation).	• Higher cost = reduction in mining. • Environmental: • - Water in contact with broken schist = very poor water. • - Unplanned base remaining on WRSA site = exposure of poor rock types. • Environmental impact from emissions and blasting (nitrates in re-blasted WRSA). • Irreversible process - no option to fix. • Permafrost exposure = thermokarst erosion.

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Table 2.1-1r. Misery Closure Options Pros and Cons (completed)

Option C – Pump Flooding of pit, No recontour of WRSA with Wildlife Ramps and Vegetation Islands	
Pros:	**Cons:**
• Waste rock remains in designed frozen state. • Pump filling may reduce uncertainty on water quality. • Does not potentially expose schist. • No re-handling = no additional dust.	• Potential to affect Lac de Gras water level. • Caribou will not use the ramps but will go around. • Potentially facilitating wildlife use which we don't understand. • Human safety with access to WRSA.
Option D - Pump Flooding of pit, No Access or Vegetation Islands	
Pros:	**Cons:**
• Slight "dome" will improve water quality.	• Water quality into Lac de Gras. • Would like to see access for wildlife. • Would like to see plants.

Appendix 5.1-1

Closure Objectives and Criteria

Appendix 5.1-1. Closure Objectives and Criteria

List of Tables

TABLE **PAGE**

Table 5.1-1a. Closure Objectives and Criteria – Open Pits

Open Pit Closure Objectives	Closure Criteria	Actions/ Measurements	Research Reference	Monitoring Reference
AIR				
1. Fugitive dust levels meet Canadian Ambient Air Quality Objectives.	Mean TSP concentrations do not exceed 60 μg/m^3 annual objective, and the 24 hr maximum acceptable concentration does not exceed 120 μg/m^3 for the Canada Ambient Air Quality Objectives (NAAQO), and the NWT Ambient Air Quality Standards.	Routine AQMP monitoring and sampling	N/A	Appendix 5.1-6: Table 5.1-6a, AIR 1; Table 5.1-6m
LAND				
1. Pit wall slopes are stabilized.	No significant slumping or erosion occurring. (*Engineering research in place to address appropriate measurable closure criteria*)	Physical inspection by qualified engineer	Appendix 5.1-5: Section RES # 1.	Appendix 5.1-6: Table 5.1-6a, LAND 1; Table 5.1-6b
2. Removal/remediation of hydrocarbon contamination.	Meet the agricultural standard for hydrocarbon remediation.	Environmental Site Assessment	N/A	N/A
3. Native vegetation used for rehabilitation work.	Record of species types used for revegetation work.	Sampling and Inspection	Appendix 5.1-4: RRP # 4.	Appendix 5.1-6: Table 5.1-6b.
4. Sites rehabilitated with plant cover have sufficient plant cover to stabilize land surfaces.	Vegetation cover (%) (*Reclamation research in place to address appropriate measurable closure criteria*)	Routine monitoring and sampling	Appendix 5.1-4: RRP # 5.	Appendix 5.1-6: Table 5.1-6a, LAND 2; Table 5.1-6b.
5. Remaining operational, engineered structures meet appropriate design levels.	Remaining operational structures are signed off by a professional engineer, and constructed to standards as applied to the Canadian Dam Association Guidelines and/or as determined by risk assessment.	As-built design plan.	N/A	Appendix 5.1-6: Table 5.1-6b
WATER				
1. No significant impacts to source lake aquatic habitats.	a) Source lakes and connecting outlet streams water levels remain within natural fluctuations.	Routine AEMP monitoring and sampling	Appendix 5.1-4: RRP # 2.	Appendix 5.1-6: Table 5.1-6a, WATER 1; Table 5.1-6b.
	b) Water quality and fish habitat in source lakes is maintained.	Routine AEMP monitoring and sampling	Appendix 5.1-4: RRP # 2.	Appendix 5.1-6: Table 5.1-6a, WATER 1; Table 5.1-6b.

N/A = Not Applicable; RRP = Reclamation Research Plan; RES = Reclamation Engineering Study.

(continued)

Table 5.1-1a. Closure Objectives and Criteria – Open Pits (continued)

Open Pit Closure Objectives	Closure Criteria	Actions/ Measurements	Research Reference	Monitoring Reference
2. Surface drainage patterns at pit lakes are established to ensure runoff is channelled through the watershed.	Stream flow occurring from pit lakes through outlet streams to downstream watershed.	Physical inspection.	Appendix 5.1-5: RES # 2.	Appendix 5.1-6: Table 5.1-6a, WATER 2; Table 5.1-6b.
3. Any permanent lake stratification caused by meromixis remains stable.	Water licence criteria are met.	Routine monitoring and sampling.	Appendix 5.1-4: RRP # 3.	Appendix 5.1-6: Table 5.1-6a, WATER 3; Table 5.1-6b.
4. Pit lake water meets water licence criteria.	Water licence criteria are met.	Routine monitoring and sampling.	Appendix 5.1-4: RRP # 3.	Appendix 5.1-6: Table 5.1-6a, WATER 3; Table 5.1-6b.
5. Facilitate the establishment of a self-sustaining aquatic ecosystem in the pit lakes.	Pit perimeters and any other features necessary to promote the objective are 'built as designed'.	Compliance with Design Report.	Appendix 5.1-5: RES # 2.	N/A
6. Pit Lakes are safe for fish passage.	The WLWB, through consultation with regulators and communities agrees that conditions are safe for fish before fish passage is allowed.	Compliance with water licence criteria.	Appendix 5.1-4: RRP # 3.	N/A
WILDLIFE				
1. Allow emergency access and egress from flooded pits.	Pit ramp left in place, and perimeter berms breached.	Physical inspection and survey control.	Appendix 5.1-4: RRP # 1.	Appendix 5.1-6: Table 5.1-6a, WILDLIFE 1 and HEALTH and SAFETY 1; Table 5.1-6b.
2. Wildlife are using the EKATI Claim Block.	Wildlife observed using the EKATI Claim Block.	Routine monitoring through WEMP.	Appendix 5.1-4: RRP # 27.	Appendix 5.1-6: Table 5.1-6a , WILDLIFE 1; Table 5.1-6m.

N/A = Not Applicable; RRP = Reclamation Research Plan; RES = Reclamation Engineering Study.

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Table 5.1-1a. Closure Objectives and Criteria – Open Pits (continued)

Open Pit Closure Objectives	Closure Criteria	Actions/ Measurements	Research Reference	Monitoring Reference
HEALTH and SAFETY				
1. Minimize access to open pit to protect humans.	Berm in place around open pit	Physical inspection and survey control.	Appendix 5.1-4: RRP # 1; Appendix 5.1-5: RES # 1.	Appendix 5.1-6: Table 5.1-6a, LAND 1 and HEALTH and SAFETY 1; Table 5.1-6b.
2. Appropriate safety control measures in place for reclamation activities associated with reclaiming open pits.	OH&S, HSEC Risk Registry, ISO 14001 compliance, Daily safety meetings, JSO's, SOP's, JHA's completed where necessary. *Mine Health and Safety Act* and Regulations are met.	Inspections, audits and reporting	N/A	Appendix 5.1-6: Table 5.1-6a, HEALTH and SAFETY 1; Table 5.1-6b.
3. Open pit mine component is left in a healthy state that supports continuation of human land use activities.	a) Human land use of the pit lake mine component at post closure does not compromise people's health through the use of air, land, water and wildlife.	Routine monitoring, physical inspection and survey control	Appendix 5.1-4: RRP # 1.	Appendix 5.1-6: Table 5.1-6a, AIR 1, LAND 1, and WATER 3; Table 5.1-6b.
	b) Maximum ice thickness on pit lakes does not negatively deviate from ice thicknesses in local natural lakes.	Physical inspection and survey control.	N/A	Table 5.1-6b.
COMMUNITY				
1. Community land use expectations and TK have been considered in the closure planning.	Community engagement when designing and constructing fish barriers for pit lakes.	Compliance with BHPB Billiton Sustainable Development Policy	Appendix 5.1-4: RRP # 26.	Appendix 5.1-6: Table 5.1-6a, COMMUNITY 1; Table 5.1-6b.
2. Archaeological sites are protected.	Negligible residual effects on archaeological sites.	Physical inspection and survey control	N/A	Appendix 5.1-6: Table 5.1-6a, COMMUNITY 2; Table 5.1-6b.
3. Transition Plan in place.	Transition planning aligns with BHP Billiton Sustainable Development Policy and Closure Standard.	Corporate reporting	N/A	N/A

N/A = Not Applicable; RRP = Reclamation Research Plan; RES = Reclamation Engineering Study.

(continued)

Table 5.1-1a. Closure Objectives and Criteria – Open Pits (completed)

Open Pit Closure Objectives	Closure Criteria	Actions/ Measurements	Research Reference	Monitoring Reference
OPERATIONS				
1. Compliance with legal, regulatory, and corporate obligations.	Compliance with Annual reporting requirements for regulatory, Compliance with Mines Inspection and reporting (*Mines Health and Safety Act*), Compliance with BHP Billiton Group Level Documents.	Compliance with BHP Billiton Sustainable Development Policy	N/A	N/A
2. Appropriate documentation is in place for open pits closure operations.	As-built plans for Panda Dam, Panda Spillway, Survey data for pit lake and outflow stream elevations.	Records management	N/A	N/A
3. Business procedures and policies in place for reclamation project development.	Application of BHP Billiton Investment Policy and Standards are applied through reclamation planning to operations stages (Identification, Selection and Definition, Execution and Operation)	Use of systems and protocols	N/A	N/A

N/A = Not Applicable; RRP = Reclamation Research Plan; RES = Reclamation Engineering Study.

Table 5.1-1b. Closure Objectives and Criteria – Underground Mines

Underground Mines Closure Objectives	Closure Criteria	Actions/ Measurements	Research Reference	Monitoring Reference
AIR				
N/A	N/A	N/A	N/A	N/A
LAND				
1. Hazardous materials are removed from the underground mine and sent to appropriate facilities.	Fuel, oils, glycol, batteries, explosives, electrical transformers have been removed.	Physical inspection	N/A	N/A
WATER				
1. Groundwater contribution from underground does not significantly impact water quality of pit lakes.	Water licence criteria are met in pit lakes.	Routine monitoring and sampling.	Appendix 5.1-4: RRP # 3.	Appendix 5.1-6: Table 5.1-6a, WATER 3; Table 5.1-6b.
WILDLIFE				
1. Eliminate access to underground workings.	Vent raises have been capped and portals have been sealed as per *Mine Health and Safety Act*.	Physical inspection and survey control.	N/A	Appendix 5.1-6: Table 5.1-6c, LAND 1. Table 5.1-6d.
HEALTH and SAFETY				
1. Eliminate access to underground workings.	Vent raises have been capped and portals have been sealed.	Physical inspection and survey control.	N/A	Appendix 5.1-6: Table 5.1-6c, LAND 1; Table 5.1-6d.
2. Appropriate safety control measures in place for reclamation activities associated with reclaiming underground mines.	OH&S, HSEC Risk Registry, ISO 14001 compliance, Daily safety meetings, JSO's, SOP's, JHA's completed where necessary. Compliance with *Mine Health and Safety Act* and Regulations.	Inspections, audits and reporting	N/A	Appendix 5.1-6: Table 5.1-6c, HEALTH and SAFETY 1; Table 5.1-6d.

N/A = Not Applicable; RRP = Reclamation Research Plan; RES = Reclamation Engineering Study.

(continued)

Table 5.1-1b. Closure Objectives and Criteria – Underground Mines (completed)

Underground Mines Closure Objectives	Closure Criteria	Actions/ Measurements	Research Reference	Monitoring Reference
COMMUNITY				
As per Open Pits.				
OPERATIONS				
1. Compliance with legal, regulatory, and corporate obligations.	Compliance with Annual reporting requirements for regulatory, Compliance with Mines Inspection and reporting (*Mines Health and Safety Act*), Compliance with BHP Billiton Group Level Documents.	Compliance with BHPB Billiton Sustainable Development Policy	N/A	Appendix 5.1-6: Table 5.1-6c, OPERATIONS 1; Table 5.1-6d.
2. Appropriate documentation is in place for underground closure operations.	Surveyed plans for underground infrastructure (tunnels, portals, vent raises).	Records management	N/A	N/A
3. Identification of equipment and materials to be removed from the underground mine.	All mobile equipment and salvageable material has been removed from the underground mine.	Physical inspection	N/A	N/A

N/A = Not Applicable; RRP = Reclamation Research Plan; RES = Reclamation Engineering Study.

Table 5.1-1c. Closure Objectives and Criteria – Waste Rock Storage Areas (WRSA)

WRSA Closure Objectives	Closure Criteria	Actions/ Measurements	Research Reference	Monitoring Reference
AIR				
1. Fugitive dust levels meet Canadian Ambient Air Quality Objectives.	Mean TSP concentrations do not exceed 60 µg/m^3 annual objective, and the 24 hr maximum acceptable concentration does not exceed 120 µg/m^3 for the Canada Ambient Air Quality Objectives (NAAQO), and the NWT Ambient Air Quality Standards.	Routine AQM monitoring and sampling	N/A	Appendix 5.1-6: Table 5.1-6e, AIR 1; Table 5.1-6m.
LAND				
1. Materials defined in the /waste Rock and Ore Storage Management Plan as potentially acid generating, are encapsulated.	Minimum 5 m granite cap.	Physical inspection and survey control	N/A	N/A
2. Remove (or cut to surface) surface infrastructure (i.e., buildings, pipelines, tanks, electrical).	Surface infrastructure is removed or cut to surface.	Physical inspection	N/A	N/A
3. Waste rock side slopes are stable.	Slope angles of WRSA is maximum of 35° angle of repose.	Physical inspection	N/A	Appendix 5.1-6: Table 5.1-6e, LAND 1; Table 5.1-6f.
4. Dump height designed to appropriate elevation.	Dump height above highest intersecting topographic point as outlined in the WROSMP*.	Physical inspection	N/A	N/A
5. WRSA is appropriate distance from adjacent natural lakes.	WRSA is no less than 100 m from high water mark of adjacent natural lakes.	Physical inspection	N/A	N/A
6. Permafrost is maintained or growing in the WRSA.	Permafrost temperatures at measurement points in the WRSA are at or below freezing point.	Routine monitoring	Appendix 5.1-4: RRP # 7.	Appendix 5.1-6: Table 5.1-6e, LAND 1; Table 5.1-6f.
7. Landfill encapsulated in the WRSA.	Minimum 5 m granite cap over Landfill.	Physical inspection and survey control	N/A	N/A
8. Landfarm decommissioned and encapsulated in WRSA	Minimum 5 m granite cap over Landfarm.	Physical inspection and survey control	N/A	N/A

** WROSMP – Waste Rock and Ore Storage Management Plan.*
N/A = Not Applicable; RRP = Reclamation Research Plan; RES = Reclamation Engineering Study.

(continued)

Table 5.1-1c. Closure Objectives and Criteria – Waste Rock Storage Areas (WRSA) (continued)

WRSA Closure Objectives	Closure Criteria	Actions/ Measurements	Research Reference	Monitoring Reference
9. Contaminated Snow Containment Facility is decommissioned.	Water pumped out to LLCF and facility capped with 5 m granite cap.	Physical inspection and survey control	N/A	N/A
10. Coarse Rejects are stabilized.	Minimum 5 m granite cap on Coarse Rejects.	Physical inspection and survey control	N/A	N/A
11. Waste kimberlite areas are stabilized to prevent seepage and erosion.	Minimum 5 m granite cap on waste kimberlite, or disposed of in open pit.	Physical inspection and survey control	N/A	N/A
12. Topsoil storage sites are stabilized.	Vegetation cover (% cover) and/or rock cover in place on remaining topsoil storage areas. (*Reclamation research in place to address appropriate measurable closure criteria*)	Physical inspection and survey control Routine monitoring and sampling	Appendix 5.1-4: RRP # 11.	Appendix 5.1-6: Table 5.1-6e, LAND 2; Table 5.1-6f.
13. Lake sediments/glacial till storage sites are stabilized.	Vegetation cover (% cover) and/or rock cover in place on remaining lake sediments/glacial till storage areas. (*Reclamation research in place to address appropriate measurable closure criteria*)	Physical inspection and survey control Routine monitoring and sampling	Appendix 5.1-4: RRP # 11.	Appendix 5.1-6: Table 5.1-6e, LAND 2; Table 5.1-6f.
14. Native vegetation used for rehabilitation work on topsoil and lake sediment/glacial till storage site.	Record of species types in place for revegetation work.	Sampling and Inspection	Appendix 5.1-4: RRP # 10.	N/A
15. Quarry sites within WRSA are stabilized to prevent permafrost degradation.	No significant thermokarst erosion or subsidence within WRSA. (*Engineering research in place to address appropriate measurable closure criteria*)	Physical inspection	Appendix 5.1-4: RRP # 7. Appendix 5.1-5: RES # 7.	Appendix 5.1-6: Table 5.1-6e LAND 3; Table 5.1-6f.
16. Removal/remediation of hydrocarbon contamination in hydrocarbon-contaminated materials management areas of the Panda/Koala/Beartooth WRSA.	Meet the agricultural standard for hydrocarbon remediation.	Selective assessment of impacted materials.	N/A	N/A

** WROSMP – Waste Rock and Ore Storage Management Plan.*
N/A = Not Applicable; RRP = Reclamation Research Plan; RES = Reclamation Engineering Study.

(continued)

Table 5.1-1c. Closure Objectives and Criteria – Waste Rock Storage Areas (WRSA) (continued)

WRSA Closure Objectives	Closure Criteria	Actions/ Measurements	Research Reference	Monitoring Reference
WATER				
1. Seepage discharge at the receiving environment meets water licence criteria.	Water Licence criteria are met.	Routine monitoring and sampling	Appendix 5.1-4: RRP # 9.	Appendix 5.1-6: Table 5.1-6e, WATER 1; Table 5.1-6.f
WILDLIFE				
1. Access and egress available for wildlife on WRSA.	Access ramps available for use by wildlife.	Routine monitoring	Appendix 5.1-4: RRP # 8.	Appendix 5.1-6: Table 5.1-6, WILDLIFE 1; Table 5.1-6f.
2. Wildlife are using the EKATI Claim Block.	Wildlife observed using the EKATI Claim Block.	Routine monitoring through WEMP.	Appendix 5.1-4: RRP # 27	Appendix 5.1-6: Table 5.1-6m.
HEALTH and SAFETY				
1. Appropriate safety control measures in place for reclamation activities associated with reclaiming WRSA.	OH&S, HSEC Risk Registry, ISO 14001 compliance, Daily safety meetings, JSO's, SOP's, JHA's completed where necessary. *Mine Health and Safety Act* and Regulations are met.	Inspections, audits and reporting	N/A	Appendix 5.1-6: Table 5.1-6e, HEALTH and SAFETY 1; Table 5.1-6f.
2. WRSA mine component is left in a healthy state that supports continuation of human land use activities.	Human land use of the WRSA mine component at post closure does not compromise people's health through the use of air, land, water and wildlife.	Routine monitoring, physical inspection and survey control	Appendix 5.1-4, RRP # 8.	Appendix 5.1-6: Table 5.1-6f.
COMMUNITY				
1. Community land use expectations and TK have been considered in the closure planning.	Community engagement when designing and constructing wildlife access ramps on WRSA.	Compliance with BHPB Billiton Sustainable Development Policy	Appendix 5.1-4: RRP # 26.	Appendix 5.1-6: Table 5.1-6e , COMMUNITY 1; Table 5.1-6f.
2. Transition Plan in place.	Transition planning aligns with BHP Billiton Sustainable Development Policy and Closure Standard.	Corporate reporting	N/A	N/A

** WROSMP – Waste Rock and Ore Storage Management Plan.*

N/A = Not Applicable; RRP = Reclamation Research Plan; RES = Reclamation Engineering Study.

(continued)

Table 5.1-1c. Closure Objectives and Criteria – Waste Rock Storage Areas (WRSA) (completed)

WRSA Closure Objectives	Closure Criteria	Actions/ Measurements	Research Reference	Monitoring Reference
OPERATIONS				
1. Compliance with legal, regulatory, and corporate obligations.	Compliance with Annual reporting requirements for regulatory, Compliance with Mines Inspection and reporting (*Mines Health and Safety Act*), Compliance with BHP Billiton Group Level Documents.	Compliance with BHPB Billiton Sustainable Development Policy	N/A	Appendix 5.1-6: Table 5.1-6e, OPERATIONS 1; Tables 5.1-6f.
2. Appropriate documentation is maintained for closure operations of WRSA.	Surveyed location of landfill and landfarm sites.	Records management	N/A	N/A
3. Business procedures and policies in place for reclamation project development.	Application of BHP Billiton Investment Policy and Standards are applied through reclamation planning and execution (Identification, Selection and Definition, Execution and Operation).	Use of systems and protocols.	N/A	N/A

** WROSMP – Waste Rock and Ore Storage Management Plan.*
N/A = Not Applicable; RRP = Reclamation Research Plan; RES = Reclamation Engineering Study.

Table 5.1-1d. Closure Objectives and Criteria – Processed Kimberlite Containment Areas (PKCA) (Phase 1 – Old Camp and Long Lake Containment Facility)

PKCA Closure Objectives	Closure Criteria	Actions/ Measurements	Research Reference	Monitoring Reference
AIR				
1. Fugitive dust levels meet Canadian Ambient Air Quality Objectives.	Mean TSP concentrations do not exceed 60 μg/m^3 annual objective, and the 24 hr maximum acceptable concentration does not exceed 120 μg/m^3 for the Canada Ambient Air Quality Objectives (NAAQO), and the NWT Ambient Air Quality Standards.	Routine AQM monitoring and sampling	N/A	Appendix 5.1-6: Table 5.1-6g, AIR 1; Table 5.1-6m.
LAND				
1. Processed kimberlite surfaces are stabilized.	No significant slumping or water erosion occurring on the facility surface or within channels. (*Reclamation research in place to address appropriate measurable closure criteria*)	Physical inspection by qualified engineer	Appendix 5.1-4: RRP # 17.	Appendix 5.1-6: Table 5.1-6g, LAND 1; Table 5.1-6h.
2. Remove (or cut to surface) surface infrastructure (i.e., buildings, pipelines, tanks, electrical).	Surface infrastructure is removed or cut to surface.	Physical inspection	N/A	N/A
3. Channel banks (including internal and external channels, and breach locations) are stabilized.	No significant slumping, subsidence or erosion. (*Engineering research in place to address appropriate measurable closure criteria*)	Physical inspection by qualified engineer	Appendix 5.1-5: RES # 8.	Appendix 5.1-6: Table 5.1-6g, LAND 1; Table 5.1-6h.
4. Removal/remediation of hydrocarbon contamination.	Meet the agricultural standard for hydrocarbon remediation.	Environmental Site Assessment.	N/A	N/A
5. Native vegetation used for rehabilitation work.	Record of species types used for revegetation work.	Sampling and Inspection	Appendix 5.1-4: RRP # 16.	N/A
6. Sites rehabilitated with plant cover have sufficient plant cover to stabilize land surfaces.	Vegetation cover (%) (*Reclamation research in place to address appropriate measurable closure criteria*)	Routine monitoring and sampling	Appendix 5.1-4: RRP # 17.	Appendix 5.1-6: Table 5.1-6g, LAND 2; Table 5.1-6h.

N/A = Not Applicable; RRP = Reclamation Research Plan; RES = Reclamation Engineering Study.

(continued)

Table 5.1-1d. Closure Objectives and Criteria – Processed Kimberlite Containment Areas (PKCA) (Phase 1 – Old Camp and Long Lake Containment Facility) (continued)

PKCA Closure Objectives	Closure Criteria	Actions/ Measurements	Research Reference	Monitoring Reference
WATER				
1. Surface drainage patterns are established to ensure runoff is channelled through the watershed.	Channel flow occurring through constructed channels to downstream watershed.	Physical inspection, and monitoring.	N/A	Appendix 5.1-6: Table 5.1-6g, WATER 1; Table 5.1-6h.
2. Water quality for the LLCF and Phase 1 meets water licence criteria.	Water licence criteria are met.	Routine monitoring and sampling.	Appendix 5.1-4: RRP # 12, 13 and 14. Appendix 5.1-5: RES # 9.	Appendix 5.1-6: Table 5.1-6g, WATER 2; Table 5.1-6h.
3. Cell E is safe for fish passage.	The WLWB, through consultation with regulators and communities agrees that conditions are safe for fish before fish passage is allowed.	Compliance with water licence criteria.	Appendix 5.1-4: RRP # 12.	N/A
WILDLIFE				
1. Surface of facility is safe for wildlife use and travel.	a) No surface hazards observed.	Physical inspection and survey control.	Appendix 5.1-4: RRP # 19.	Appendix 5.1-6: Table 5.1-6g, WILDLIFE 1; Table 5.1-6h.
	b) No identified risk from metal uptake from vegetation or processed kimberlite.	Risk assessment	Appendix 5.1-4: RRP # 15.	N/A
2. Wildlife are using the EKATI Claim Block.	Wildlife observed using the EKATI Claim Block.	Routine monitoring through WEMP.	Appendix 5.1-4: RRP # 27	Appendix 5.1-6: Table 5.1-6g, WILDLIFE 1; Table 5.1-6m.
HEALTH and SAFETY				
1. Surface of facility, channels and remaining dike and dam infrastructure are safe for human use.	No surface hazards observed.	Physical inspection and survey control.	Appendix 5.1-4: RRP # 19.	N/A

N/A = Not Applicable; RRP = Reclamation Research Plan; RES = Reclamation Engineering Study.

(continued)

Table 5.1-1d. Closure Objectives and Criteria – Processed Kimberlite Containment Areas (PKCA) (Phase 1 – Old Camp and Long Lake Containment Facility) (completed)

PKCA Closure Objectives	Closure Criteria	Actions/ Measurements	Research Reference	Monitoring Reference
2. Appropriate safety control measures in place for reclamation activities associated with reclaiming PKCA.	OH&S, HSEC Risk Registry, ISO 14001 compliance, Daily safety meetings, JSO's, SOP's, JHA's completed where necessary. *Mine Health and Safety Act* and Regulations are met.	Inspections, audits and reporting	N/A	Appendix 5.1-6: Table 5.1-6g, HEALTH and SAFETY 1; Table 5.1-6h.
3. PKCA mine components are left in a healthy state that supports continuation of human land use activities .	Human land use of the PKCA mine components at post closure does not compromise people's health through the use of air, land, water and wildlife.	Routine monitoring, physical inspection and survey control	Appendix 5.1-4: RRP # 12, 15, and 19.	Appendix 5.1-6: Table 5.1-6g, LAND 1, and WATER 2; Table 5.1-6h.
COMMUNITY				
1. Community land use expectations and TK have been considered in the closure planning.	Community engagement when designing and constructing surface cover of the LLCF.	Compliance with BHPB Billiton Sustainable Development Policy	Appendix 5.1.4, RRP # 26.	Appendix 5.1-6: Table 5.1-6g, COMMUNITY 1; Table 5.1-6h.
2. Transition Plan in place.	Transition planning aligns with BHP Billiton Sustainable Development Policy and Closure Standard.	Corporate reporting	N/A	N/A
OPERATIONS				
1. Compliance with legal, regulatory, and corporate obligations.	Compliance with Annual reporting requirements for regulatory, Compliance with Mines Inspection and reporting (*Mines Health and Safety Act*), Compliance with BHP Billiton Group Level Documents.	Compliance with BHPB Billiton Sustainable Development Policy	N/A	Appendix 5.1-6: Table 5.1-6, OPERATIONS 1; Table 5.1-6h.
2. Appropriate documentation is in place for PKCA closure operations.	Survey data for Cells D and E lake and outflow stream elevations.	Records management	N/A	N/A
3. Business procedures and policies in place for reclamation project development.	Application of BHP Billiton Investment Policy and Standards are applied through reclamation planning to operations stages (Identification, Selection and Definition, Execution and Operation)	Use of systems and protocols	N/A	N/A

N/A = Not Applicable; RRP = Reclamation Research Plan; RES = Reclamation Engineering Study.

Table 5.1-1e. Closure Objectives and Criteria – Dams, Dikes and Channels

Dams, Dikes and Channels Closure Objectives	Closure Criteria	Actions/ Measurements	Research Reference	Monitoring Reference
AIR				
1. Fugitive dust levels meet Canadian Ambient Air Quality Objectives.	Mean TSP concentrations do not exceed 60 $\mu g/m^3$ annual objective, and the 24 hr maximum acceptable concentration does not exceed 120 $\mu g/m^3$ for the Canada Ambient Air Quality Objectives (NAAQO), and the NWT Ambient Air Quality Standards.	Routine AQM monitoring and sampling.	N/A	Appendix 5.1-6: Table 5.1-6i, AIR 1; Table 5.1-6m.
LAND				
1. Channel banks are stabilized.	No significant slumping, subsidence or erosion. (*Engineering research in place to address appropriate measurable closure criteria*)	Physical inspection by qualified engineer	Appendix 5.1-5: RES # 10.	Appendix 5.1-6: Table 5.1-6i, LAND 1; Table 5.1-6j.
2. Dams, Dikes and channel remaining infrastructure are stabilized.	No significant slumping, subsidence or erosion. (*Engineering research in place to address appropriate measurable closure criteria*)	Physical inspection by qualified engineer	Appendix 5.1-5: RES # 11.	Appendix 5.1-6: Table 5.1-6i, LAND 1; Table 5.1-6j.
3. Remove (or cut to surface) surface infrastructure (i.e., pipelines, culverts, buildings, thermistors, electrical).	Surface infrastructure is removed or cut to surface.	Physical inspection	N/A	N/A
4. Remaining operational, engineered structures meet appropriate design levels.	Remaining operational structures are signed off by a professional engineer, and constructed to standards as applied to the Canadian Dam Association Guidelines and/or as determined by risk assessment.	As-built design plan	N/A	N/A
5. Removal/remediation of hydrocarbon contamination.	Meet the agricultural standard for hydrocarbon remediation.	Environmental Site Assessment.	N/A	N/A
6. Native vegetation used for rehabilitation work.	Record of species types used for revegetation work	Sampling and Inspection	Appendix 5.1-4: RRP # 20.	N/A
7. Sites rehabilitated with plant cover have sufficient plant cover to stabilize land surfaces.	Vegetation cover (%) (*Reclamation research in place to address appropriate measurable closure criteria*)	Routine monitoring and sampling	Appendix 5.1-4: RRP # 21.	Appendix 5.1-6: Table 5.1-6i, LAND 2; Table 5.1-6j.

N/A = Not Applicable; RRP = Reclamation Research Plan; RES = Reclamation Engineering Study.

(continued)

Table 5.1-1e. Closure Objectives and Criteria – Dams, Dikes and Channels (continued)

Dams, Dikes and Channels Closure Objectives	Closure Criteria	Actions/ Measurements	Research Reference	Monitoring Reference
WATER				
1. Surface drainage patterns are established to ensure runoff is channelled through the watershed.	Channel flow occurring through constructed channels to downstream watershed.	Physical inspection and monitoring.	N/A	Appendix 5.1-6: Table 5.1-6i, WATER 1; Table 5.1-6j.
2. Water quality in channels meets water licence criteria.	Water licence criteria are met.	Routine monitoring and sampling.	N/A	Appendix 5.1-6: Table 5.1-6i, WATER 2; Table 5.1-6j.
3. Water quality in setting ponds meets water licence criteria.	Water licence criteria are met.	Routine monitoring and sampling.	N/A	Appendix 5.1-6: Table 5.1-6i, WATER 2; Table 5.1-6j.
WILDLIFE				
1. Remaining dam, dike and channel infrastructure are safe for wildlife use.	No surface hazards observed.	Physical inspection and survey control.	N/A	Appendix 5.1-6: Table 5.1-6i, WILIDLIFE 1; Table 5.1-6m.
2. Fish access and habitat is in place in the PDC as required by Fisheries Agreements	As outlined in Fisheries Authorization File # SCA96021	Compliance with SCA96021	N/A	Appendix 5.1-6: Table 5.1-6i, WILDLIFE 2; Table 5.1-6m.
3. Fish habitat compensation agreements have been completed for Fisheries Authorizations at King Pond Settling Facility.	As outlined in Fisheries Authorization File # SC00028	Compliance with SC00028.	Appendix 5.1-4: RRP # 22 and 23.	Future monitoring program to be determined through discussions with DFO.
4. Wildlife are using the EKATI Claim Block.	Wildlife observed using the EKATI Claim Block.	Routine monitoring through WEMP.	Appendix 5.1-4: RRP # 27	Appendix 5.1-6: Table 5.1-6m.

N/A = Not Applicable; RRP = Reclamation Research Plan; RES = Reclamation Engineering Study.

(continued)

Table 5.1-1e. Closure Objectives and Criteria – Dams, Dikes and Channels (completed)

Dams, Dikes and Channels Closure Objectives	Closure Criteria	Actions/ Measurements	Research Reference	Monitoring Reference
HEALTH and SAFETY				
1. Dams, dikes and channels mine components are left in a healthy state that supports continuation of human land use activities.	Human land use of the dams, dikes and channels at post closure does not compromise people's health through the use of air, land, water and wildlife.	Routine monitoring, physical inspection and survey control	N/A	Appendix 5.1-6: Table 5.1-6i, LAND 1, WATER 2; Table 5.1-6j.
2. Appropriate safety control measures in place for reclamation activities associated with reclaiming dams, dikes and channels.	OH&S, HSEC Risk Registry, ISO 14001 compliance, Daily safety meetings, JSO's, SOP's, JHA's completed where necessary. Compliance with *Mine Health and Safety Act* and Regulations.	Inspections, audits and reporting	N/A	Appendix 5.1-6: Table 5.1-6i, HEALTH and SAFETY 1; Table 5.1-6j.
COMMUNITY				
1. Community land use expectations and TK have been considered in the closure planning.	Community engagement during reclamation of Dams, Dikes and Channels.	Compliance with BHPB Billiton Sustainable Development Policy	Appendix 5.1-4: RRP # 26.	Appendix 5.1-6: Table 5.1-6i, COMMUNITY 1; Table 5.1-6j.
2. Archaeological sites are protected.	Negligible residual effects on archaeological sites.	Physical inspection and survey control	N/A	Appendix 5.1-6: Table 5.1-6i, COMMUNITY 2; Table 5.1-6j.
3. Transition Plan in place.	Transition planning aligns with BHP Billiton Sustainable Development Policy and Closure Standard.	Corporate reporting	N/A	N/A
OPERATIONS				
1. Compliance with legal, regulatory, and corporate obligations.	Compliance with Annual reporting requirements for regulatory, Compliance with Mines Inspection and reporting (*Mines Health and Safety Act*), Compliance with BHP Billiton Group Level Documents.	Compliance with BHPB Billiton Sustainable Development Policy	N/A	Appendix 5.1-6: Table 5.1-6i, OPERATIONS 1; Table 5.1-6j.
2. Appropriate documentation is maintained.	Surveyed plans for any infrastructure remaining at closure (e.g., buried thermistors)	Records management	N/A	N/A

N/A = Not Applicable; RRP = Reclamation Research Plan; RES = Reclamation Engineering Study.

Table 5.1-1f. Closure Objectives and Criteria – Buildings and Infrastructure

Buildings and Infrastructure Closure Objectives	Closure Criteria	Actions/ Measurements	Research Reference	Monitoring Reference
AIR				
1. Fugitive dust levels meet Canadian Ambient Air Quality Objectives.	Mean TSP concentrations do not exceed 60 µg/m^3 annual objective, and the 24 hr maximum acceptable concentration does not exceed 120 µg/m^3 for the Canada Ambient Air Quality Objectives (NAAQO), and the NWT Ambient Air Quality Standards.	Routine AQM monitoring and sampling.	N/A	Appendix 5.1-6 : Table 5.1-6k, AIR 1; Table 5.1-6m.
LAND				
1. Remove (or cut to surface) surface infrastructure (i.e. buildings, pipelines, tanks, bridges, culverts, electrical).	Surface infrastructure is removed or cut to surface.	Physical inspection.	N/A	N/A
2. All demolition material has been removed.	Demolition materials are landfilled, and/or removed from the site.	Physical inspection	Appendix 5.1-5: RES # 6.	N/A
3. Hydrocarbon storage sites are decommissioned.	a) Bulk fuel and sludge have been removed from site.	Physical inspection	N/A	N/A
	b) Fuel tanks and containers have been cleaned and landfilled.	Physical inspection	N/A	N/A
	c) Fuel tank liners have been encapsulated in WRSA's with 5 m-deep waste rock cap.	Physical inspection and survey control	N/A	N/A
4. Removal/remediation of hydrocarbon contamination.	Meet the agricultural standard for hydrocarbon remediation.	Environmental Site Assessment	N/A	N/A
5. Removal of hazardous materials (ammonium nitrate, batteries, etc)	Hazardous materials have been removed from the site as per WCB requirements.	Physical inspection	N/A	N/A
6. Native vegetation used for rehabilitation work.	Record of species types used for revegetation work.	Sampling and inspection	Appendix 5.1-4: RRP # 24.	N/A
7. Sites rehabilitated with plant cover have sufficient plant cover to stabilize land surfaces.	Vegetation cover (%) (*Reclamation research in place to address appropriate measurable closure criteria*)	Routine monitoring and sampling	Appendix 5.1-4: RRP # 25.	Appendix 5.1-6: Table 5.1-6k, LAND 3; Table 5.1-6l.

N/A = Not Applicable; RRP = Reclamation Research Plan; RES = Reclamation Engineering Study.

(continued)

Table 5.1-1f. Closure Objectives and Criteria – Buildings and Infrastructure (continued)

Buildings and Infrastructure Closure Objectives	Closure Criteria	Actions/ Measurements	Research Reference	Monitoring Reference
8. Camp pads, laydown areas, sumps, roads and airstrip are stabilized.	No significant slumping, subsidence or erosion. (*Engineering research in place to address appropriate measurable closure criteria*)	Physical inspection by qualified engineer	Appendix 5.1-5: RES # 13	Appendix 5.1-6: Table 5.1-6k, LAND 1; Table 5.1-6l.
9. Quarry sites are stabilized to prevent permafrost degradation.	No significant thermokarst erosion or subsidence at the Airport Esker Quarry. (*Engineering research in place to address appropriate measurable closure criteria*)	Physical inspection by qualified engineer	Appendix 5.1-5: RES # 12.	Appendix 5.1-6: Table 5.1-6k, LAND 2; Table 5.1-6l.
10. EKATI Airstrip is decommissioned.	Airstrip decommissioned as per Dept. of Transportation Regulations.	Physical inspection	N/A	N/A
WATER				
1. Surface drainage patterns are established to ensure runoff is channelled through the watershed.	Bridges and culverts are removed.	Physical inspection.	N/A	N/A
2. Water quality downstream of ore storage pads is maintained.	Water licence criteria are met.	Routine monitoring and sampling.	N/A	Appendix 5.1-6: Table 5.1-6k, WATER 1; Table 5.1-6l.
WILDLIFE				
1. Remaining surface areas are safe for wildlife use.	a) Sumps and collection pond liners have been removed and have been filled in with waste rock.	Physical inspection and survey control.	N/A	Appendix 5.1-6: Table 5.1-6k, WILDLIFE 1; Table 5.1-6m.
	b) Concrete pads and ground cavities have been covered with waste rock.	Physical inspection.	N/A	Appendix 5.1-6: Table 5.1-6k, WILDLIFE 1; Table 5.1-6m.
	c) Road berms, culverts and bridges removed.	Physical inspection.	N/A	Appendix 5.1-6: Table 5.1-6k, WILDLIFE 1; Table 5.1-6m.

N/A = Not Applicable; RRP = Reclamation Research Plan; RES = Reclamation Engineering Study.

(continued)

Table 5.1-1f. Closure Objectives and Criteria – Buildings and Infrastructure (continued)

Buildings and Infrastructure Closure Objectives	Closure Criteria	Actions/ Measurements	Research Reference	Monitoring Reference
2. Wildlife are using the EKATI Claim Block.	Wildlife observed using the EKATI Claim Block.	Routine monitoring through WEMP.	Appendix 5.1-4: RRP # 27	Appendix 5.1-6k: Table 5.1-6m.
HEALTH and SAFETY				
1. Buildings and Infrastructure mine components are left in a healthy state that support continuation of human land use activities.	a) Human land use of decommissioned pads and roadways at post closure does not compromise people's health through the use of air, land, water and wildlife.	Routine monitoring, physical inspection and survey control	N/A	Appendix 5.1-6: Table 5.1-6k, AIR 1, LAND 1, WATER 1; Table 5.1-6l.
	b) Concrete pads and ground cavities have been covered with waste rock.	Physical inspection.	N/A	Appendix 5.1-6: Table 5.1-6k, LAND 1; Table 5.1-6l.
	c) Roads have been bermed and/or trenched to restrict motorized vehicle access.	Physical inspection.	N/A	Appendix 5.1-6: Table 5.1-6k, LAND 1; Table 5.1-6l.
2. Appropriate safety control measures in place for reclamation activities associated with reclaiming Buildings and Infrastructure.	OH&S, HSEC Risk Registry, ISO 14001 compliance, Daily safety meetings, JSO's, SOP's, JHA's completed where necessary. *Mine Health and Safety Act* and Regulations are met.	Inspections, audits and reporting	N/A	Appendix 5.1-6: Table 5.1-6k, HEALTH and SAFETY 1; Table 5.1-6l.
3. Sumps and collections ponds are safe for human use.	Sumps and collection ponds have been filled in with waste rock	Physical inspection and survey control.	N/A	Appendix 5.1-6: Table 5.1-6k, LAND 1; Table 5.1-6l.
COMMUNITY				
1. Community land use expectations and TK have been considered in the closure planning.	Community engagement during reclamation of Buildings and Infrastructure.	Compliance with BHPB Billiton Sustainable Development Policy	Appendix 5.1-4: RRP # 26.	Appendix 5.1-6: Table 5.1-6k, COMMUNITY 1; Table 5.1-6l.

N/A = Not Applicable; RRP = Reclamation Research Plan; RES = Reclamation Engineering Study.

(continued)

Table 5.1-1f. Closure Objectives and Criteria – Buildings and Infrastructure (completed)

Buildings and Infrastructure Closure Objectives	Closure Criteria	Actions/ Measurements	Research Reference	Monitoring Reference
2. Archaeological sites are protected.	Negligible residual effects on Archaeological sites.	Physical inspection and survey control	N/A	Appendix 5.1-6: Table 5.1-6k, COMMUNITY 2; Table 5.1-6l.
3. Transition Plan in place.	Transition planning aligns with BHP Billiton Sustainable Development Policy and Closure Standard.	Corporate reporting	N/A	N/A
OPERATIONS				
1. Compliance with legal, regulatory, and corporate obligations.	Compliance with Annual reporting requirements for regulatory, Compliance with Mines Inspection and reporting (*Mines Health and Safety Act*), Compliance with BHP Billiton Group Level Documents.	Compliance with BHPB Billiton Sustainable Development Policy	N/A	Appendix 5.1-6: Table 5.1-6k, OPERATIONS 1; Table 5.1-6l.
2. Appropriate documentation is maintained for closure operations of Buildings and Infrastructure.	Surveyed location of buried utilities and landfills.	Records management	N/A	N/A
3. Business procedures and policies in place for reclamation project development.	Application of BHP Billiton Investment Policy and Standards are applied through reclamation planning and execution (Identification, Selection and Definition, Execution and Operation).	Use of systems and protocols.	N/A	N/A

N/A = Not Applicable; RRP = Reclamation Research Plan; RES = Reclamation Engineering Study.

Appendix 5.1-2

Engineering Summary

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Appendix 5.1-2. Engineering Summary

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Panda Diversion Channel Site Plan

FIGURE 5.1-2a

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Fish Box Near PDC Outlet

Lower PDC Near Buster Pond

Canyon Area

North of Canyon Area

Near Road to Panda Pit

Near Grizzly Stream

Figure 5.1-2b

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Panda Diversion Channel Pictures

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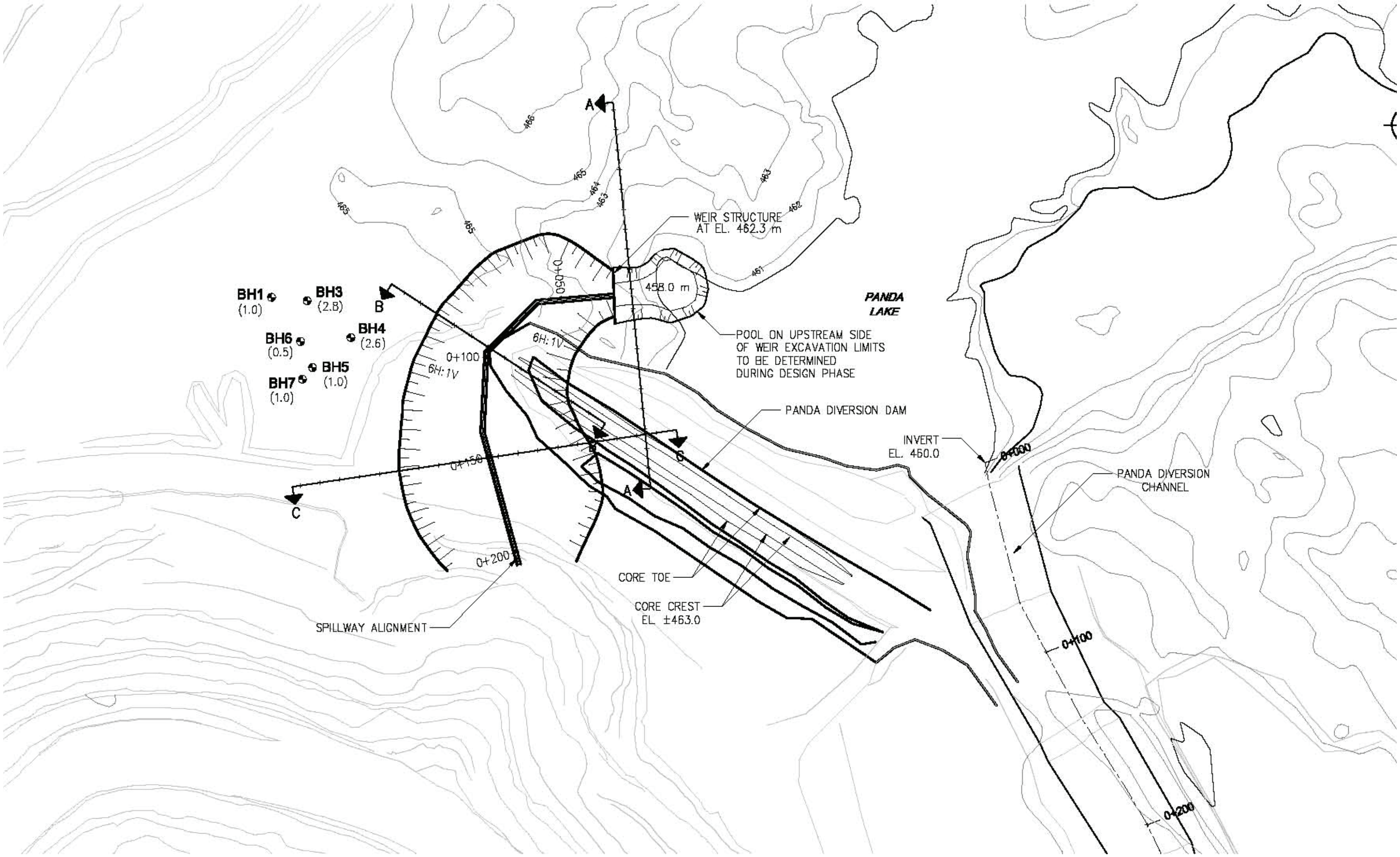
Figure 5.1-2b



Conceptual Spillway Alignment Panda Diversion Dam

Figure 5.1-2c

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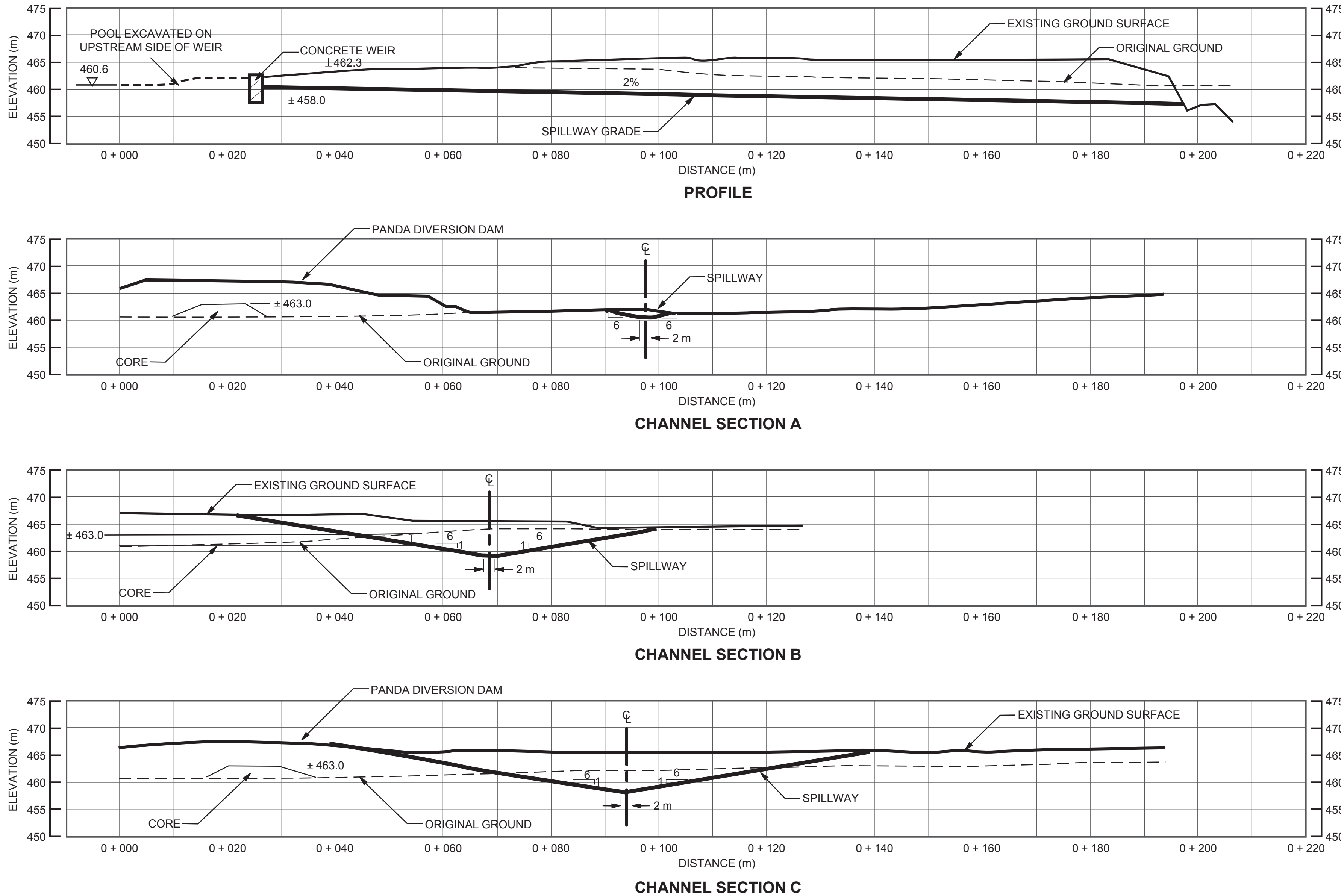

Figure 5.1-2d

Spillway Alignment Profile and Spillway Channel Cross-Sections

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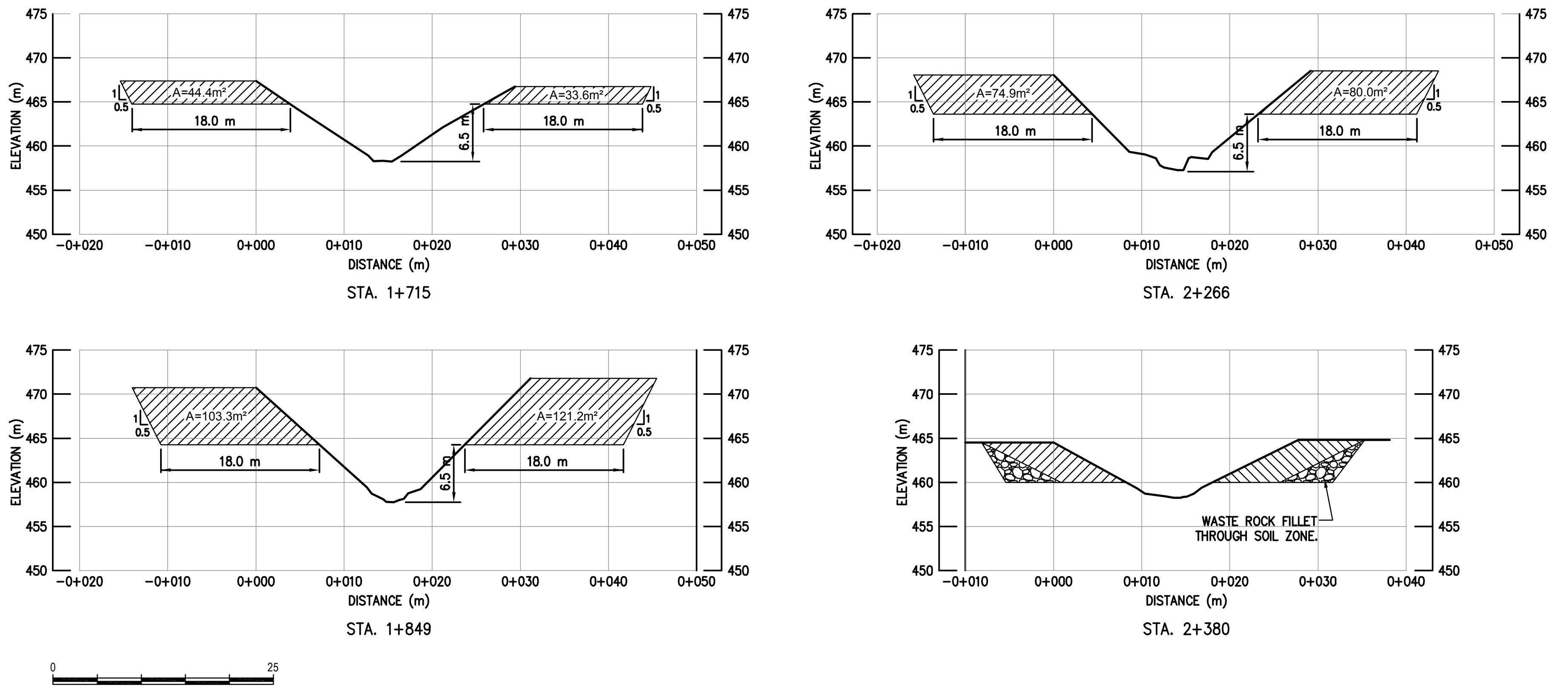

Figure 5.1-2e(a)

Canyon Reach Slope Modification

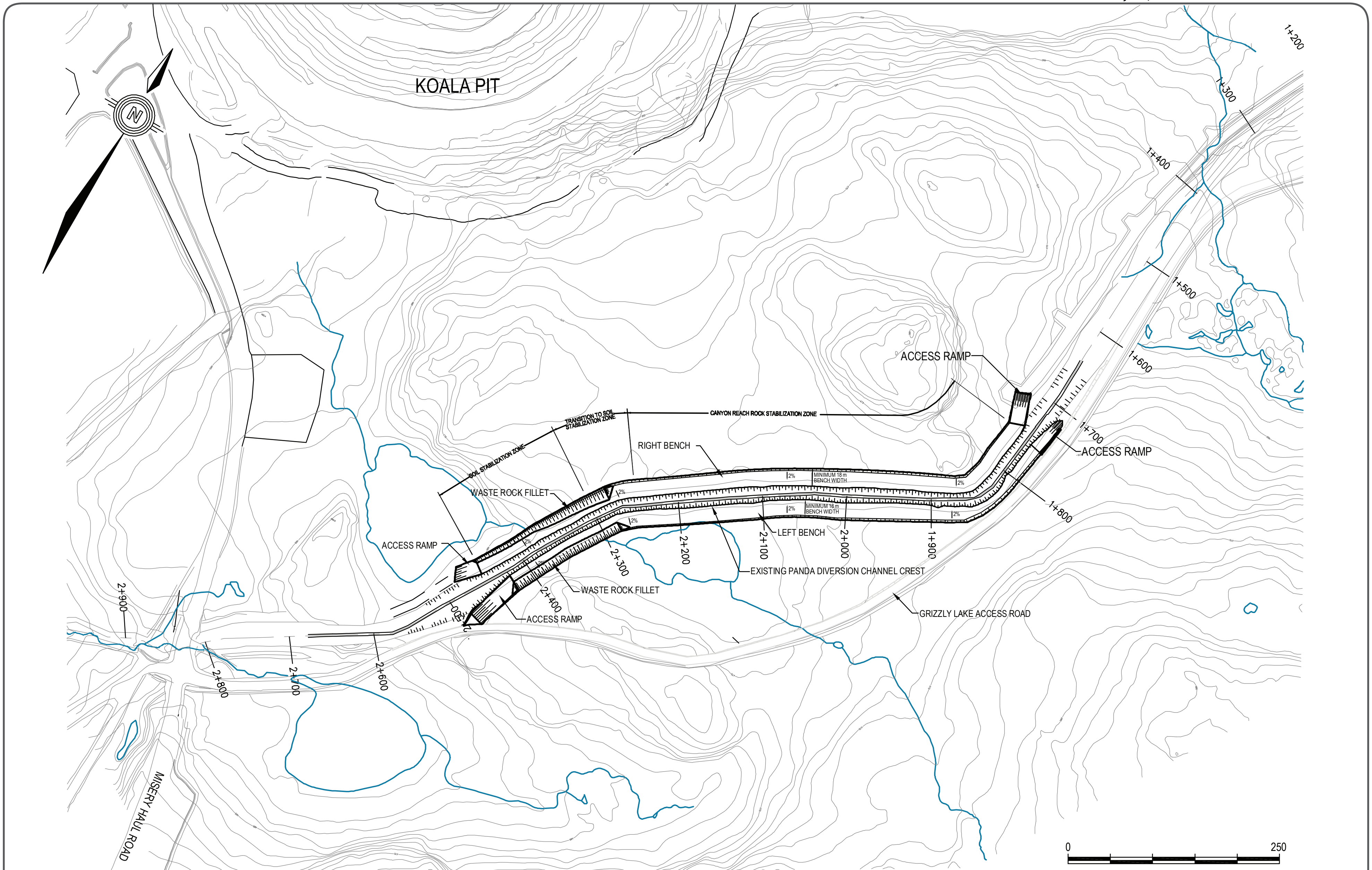

Figure 5.1-2e(b)

Panda Diversion Channel Stabilization Plan

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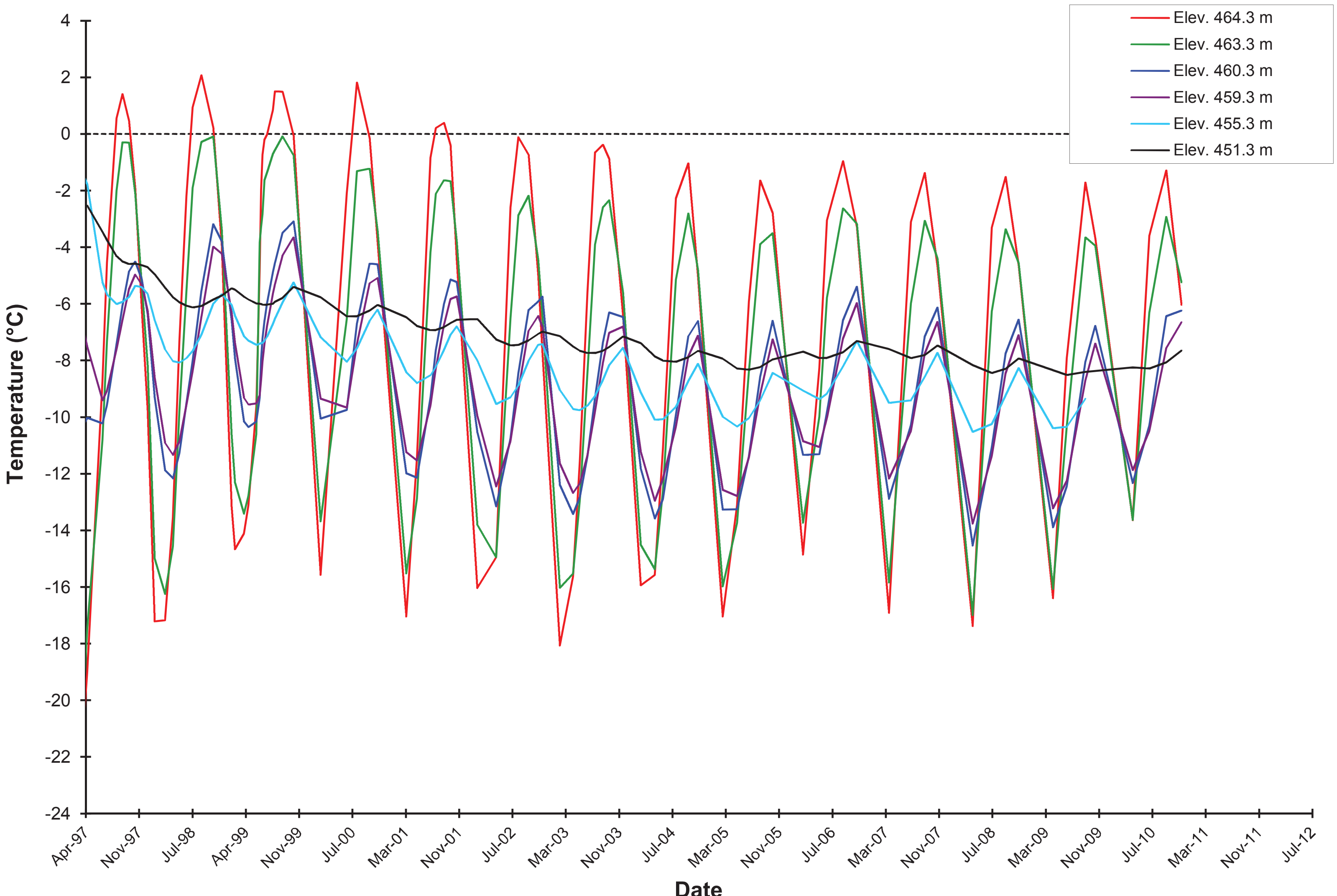

Serial No.: 1113
Date Installed: 97-03-19

Figure 5.1-2f(a)

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Ground Temperature History for Panda Diversion Dam
4 m South of Thermosyphon #17 & #18

Figure 5.1-2f(a)

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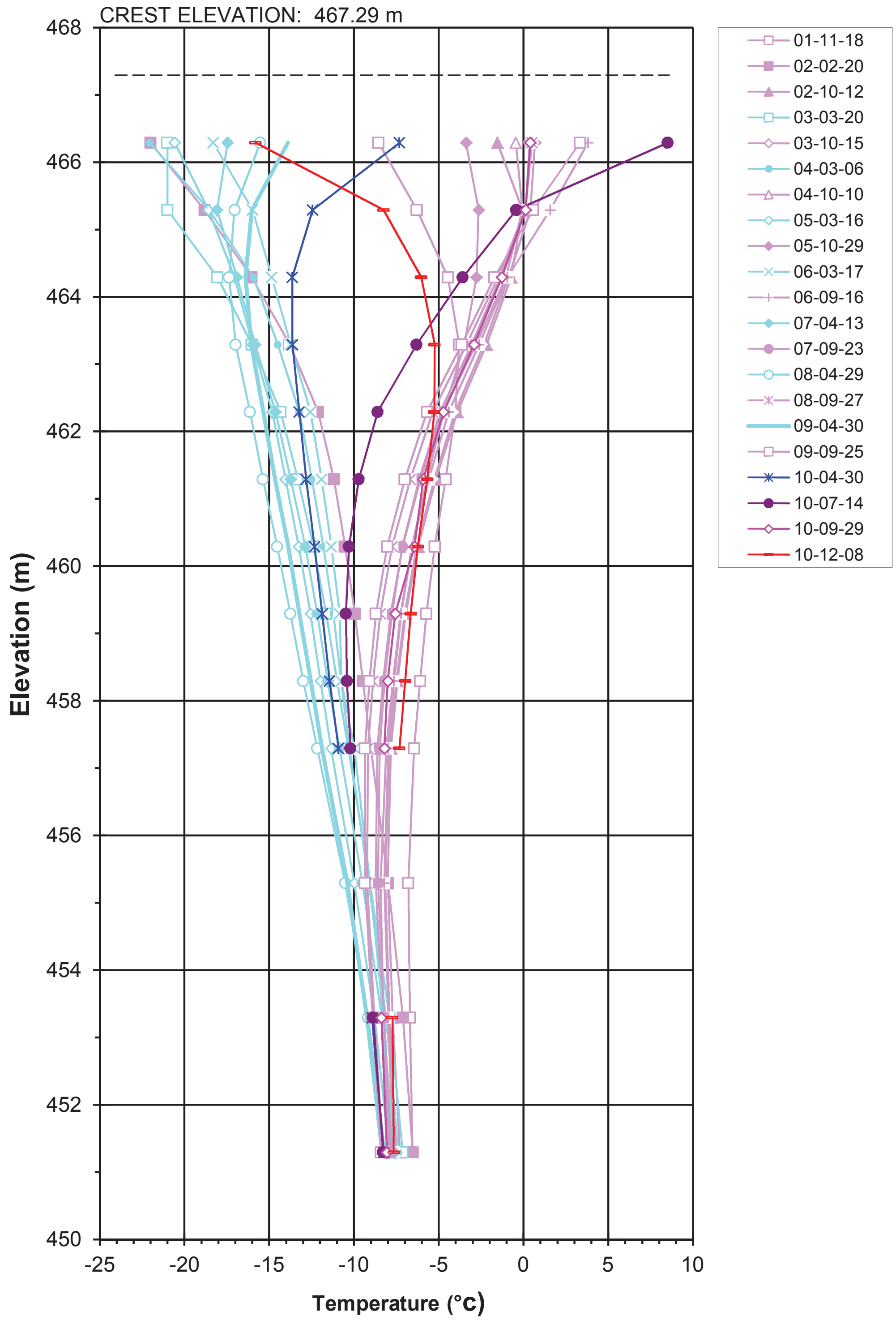

Serial No.: 1113
Date Installed: 97-03-19

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Ground Temperature Profile for Panda Diversion Dam
4 m South of Thermosyphon #17 & #18

Figure 5.1-2f(b)

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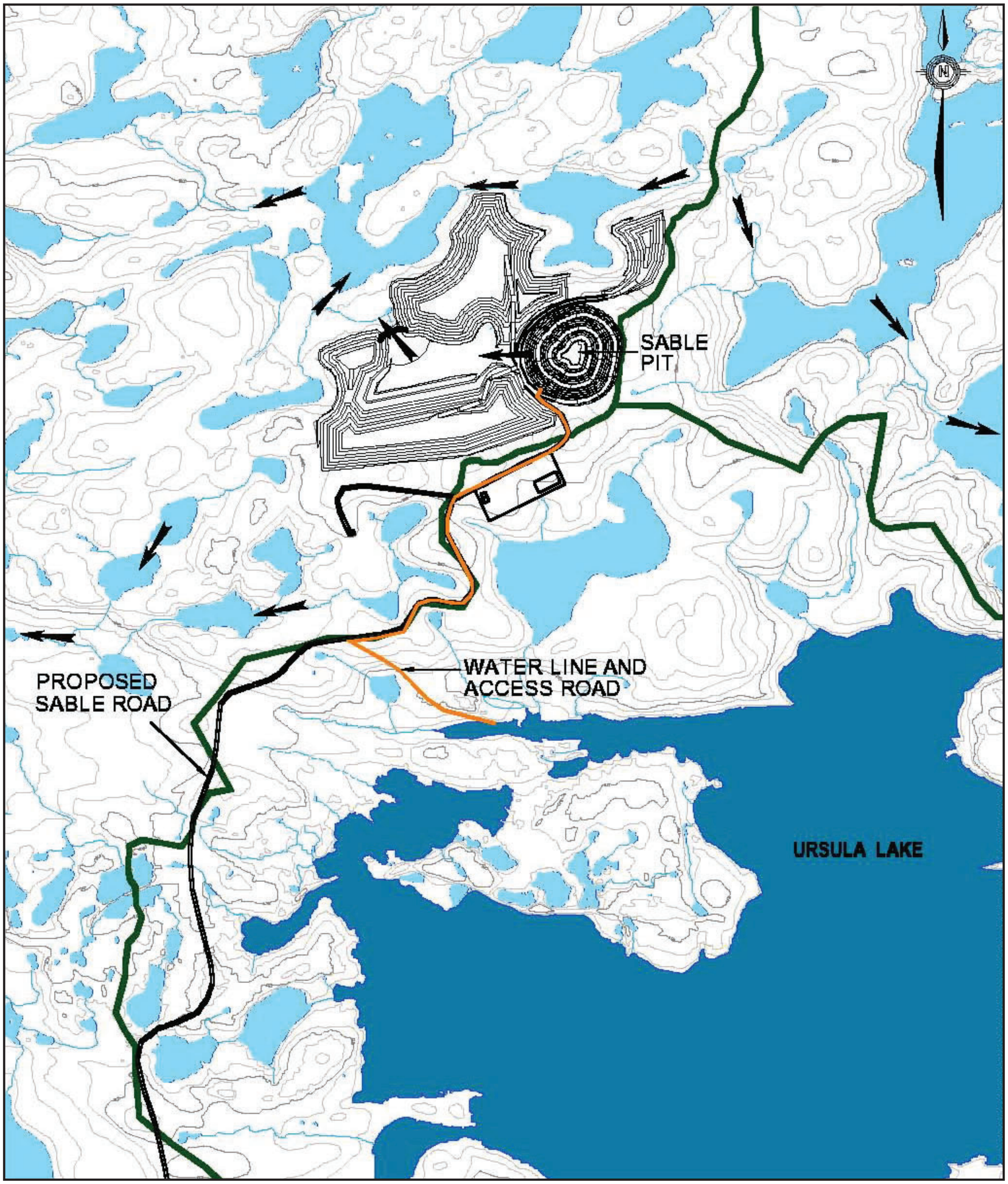

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Figure 5.1-2g

Pump Flooding Pipe Routing Sable Pit

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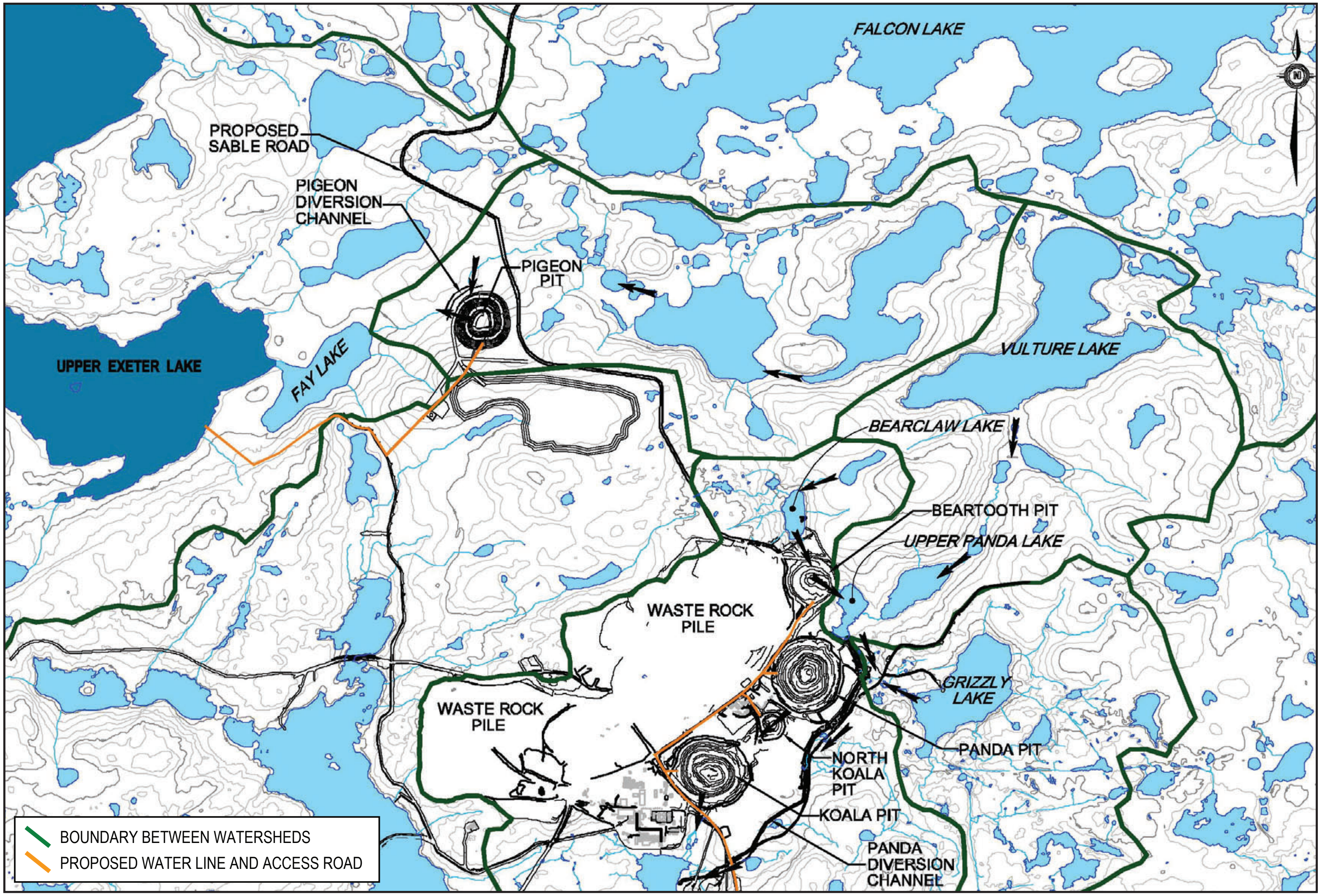

Figure 5.1-2h

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Pump Flooding Pipe Routing Pigeon Pit

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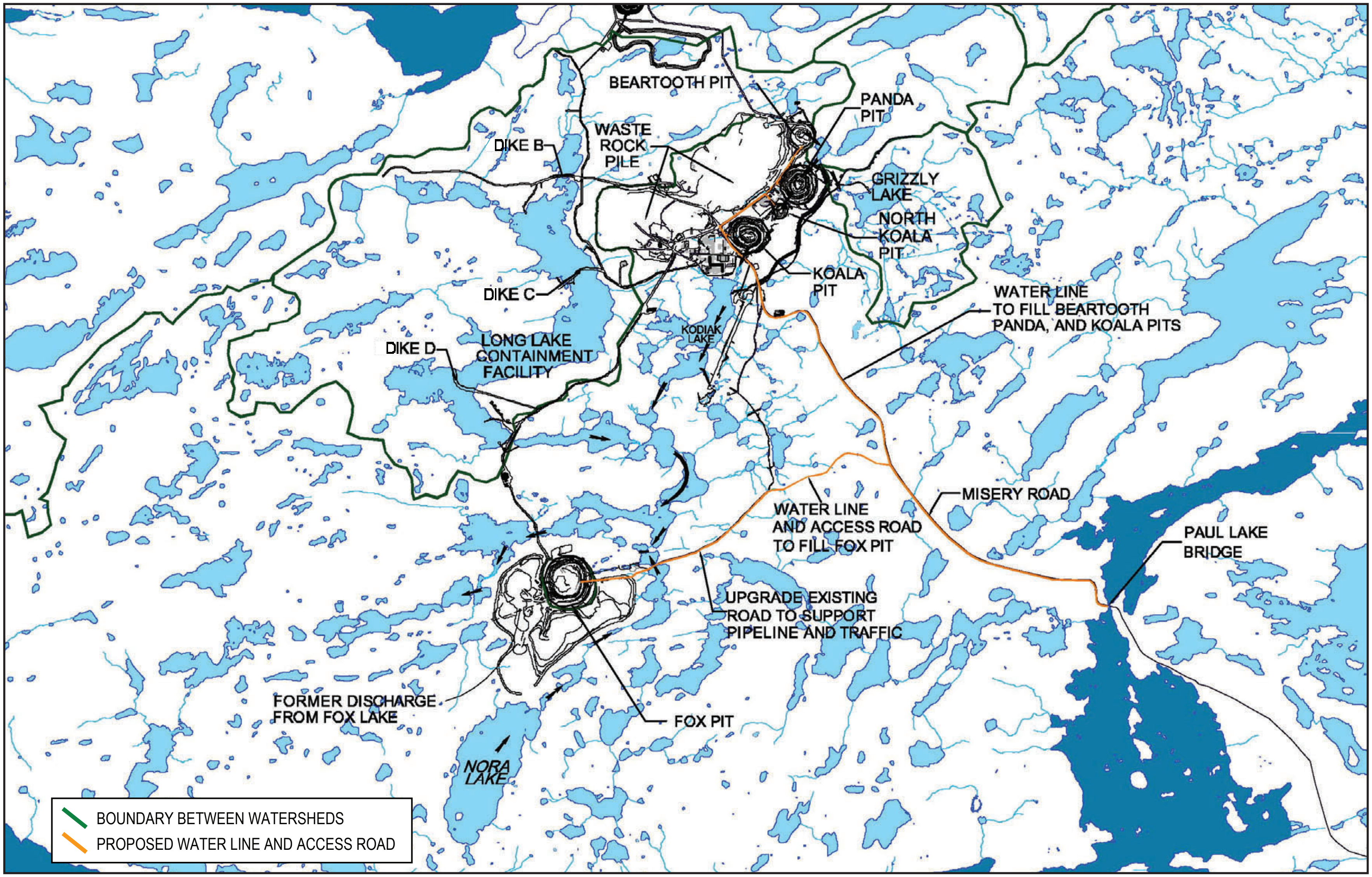

Figure 5.1-2i

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Pump Flooding Pipe Routing Panda, Koala, Beartooth and Fox Pits

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Figure 5.1-2i

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Pump Flooding Pipe
Routing Misery Pit

Figure 5.1-2j

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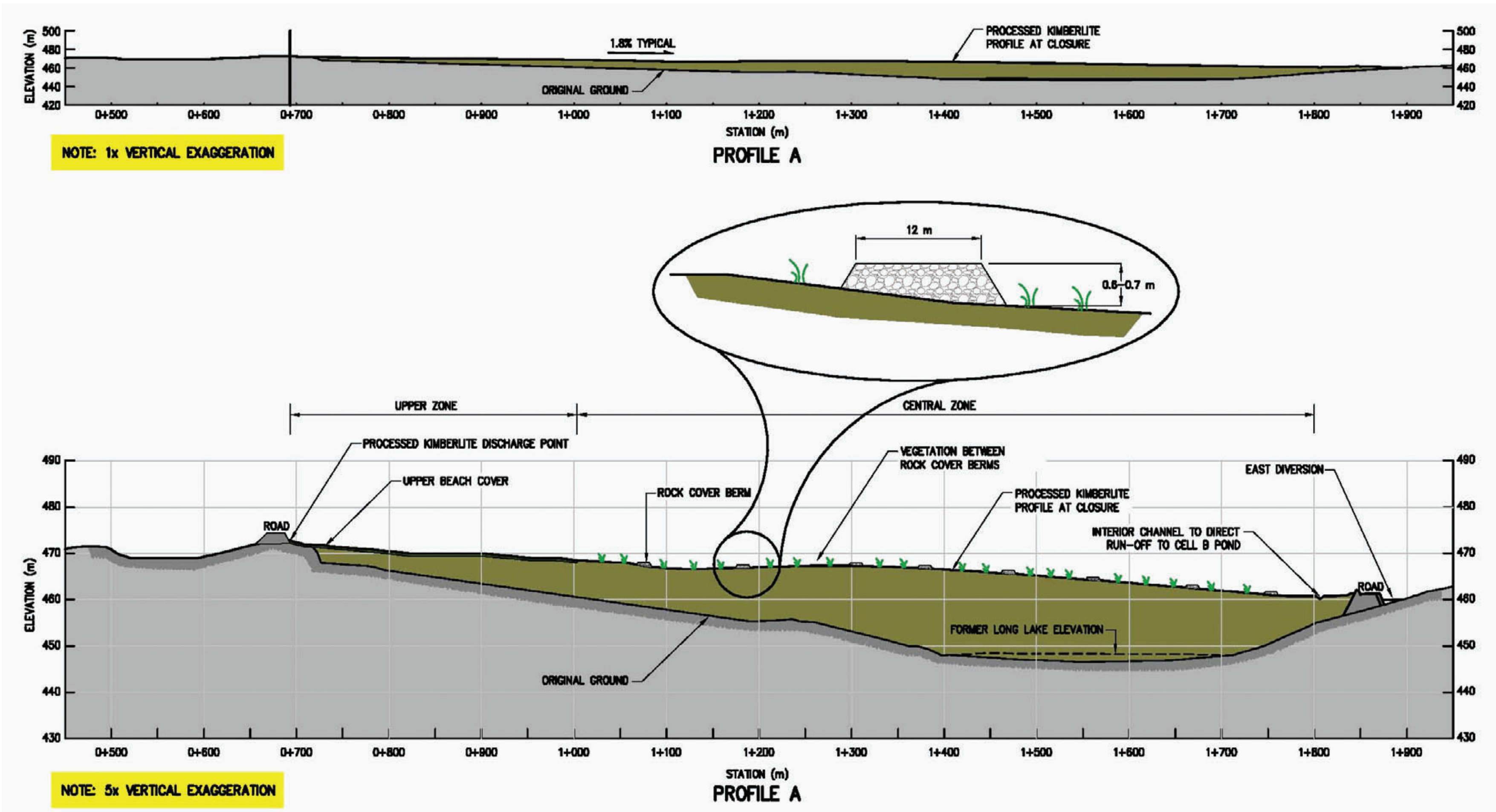

Figure 5.1-2k

LLCF Cover Cross-Section A - Conceptual Design

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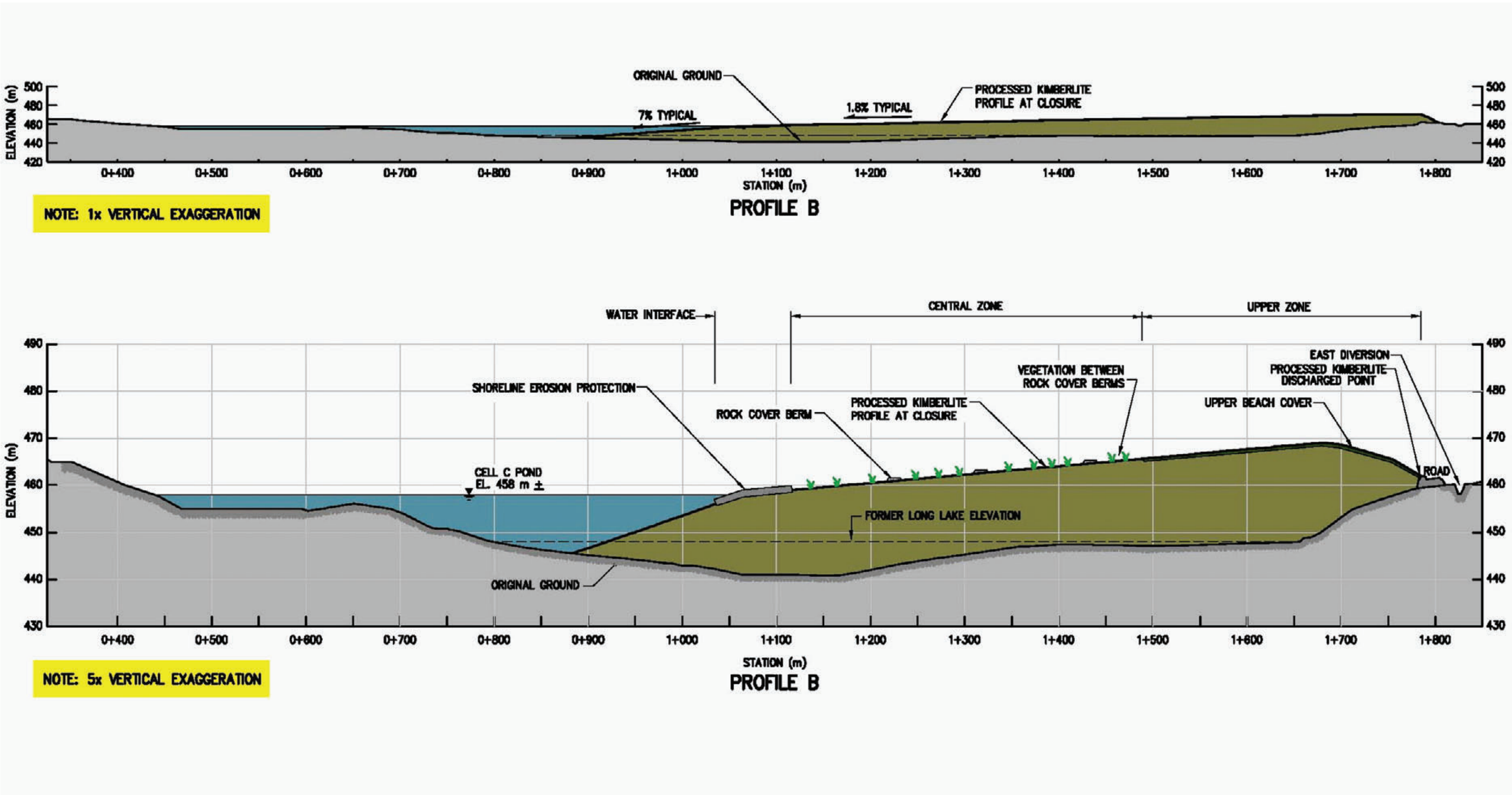

Figure 5.1-2l

LLCF Cover Cross-Section B - Conceptual Design

Figure 5.1-2l

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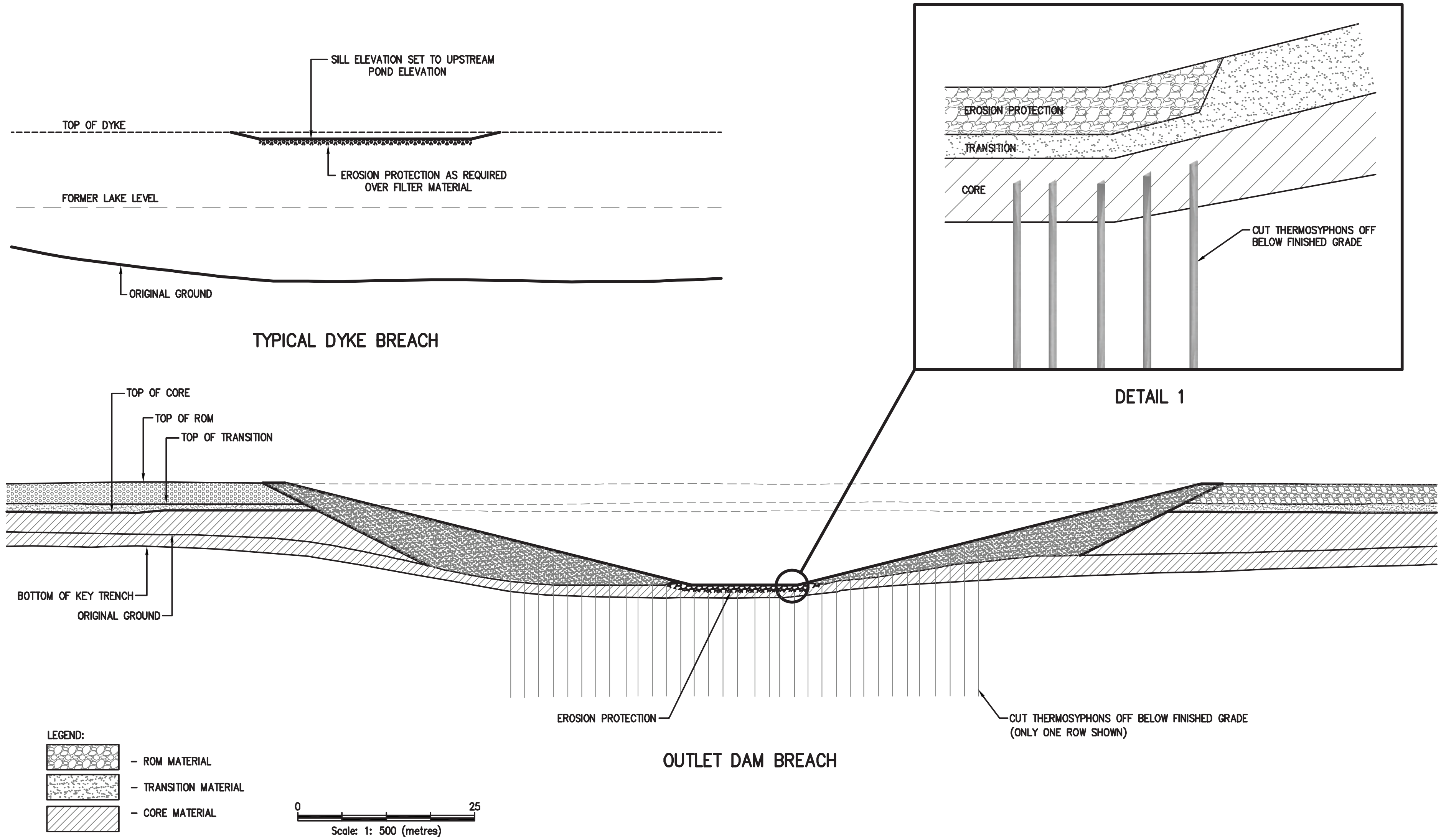

Figure 5.1-2m

Outlet Dam Breach and Typical Dike Breach

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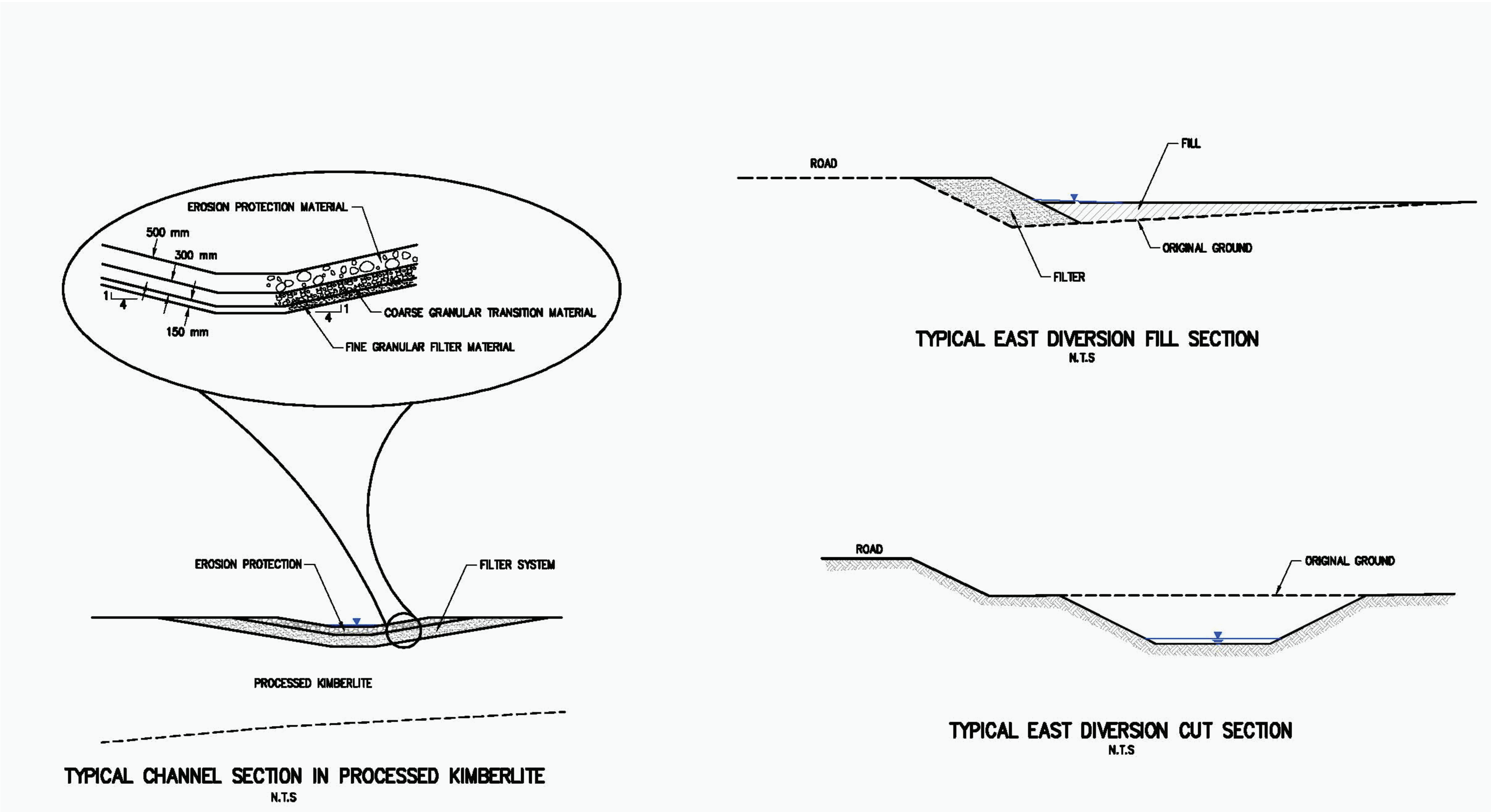

Figure 5.1-2n

Typical Channel and Diversion Sections

Table 5.1-2a. Panda Diversion Dam Design Specifications

Panda Diversion Dam	
Date Completed	April 1997
Canadian Dam Association Dam Classification	High consequence because of potential for loss of life resulting from catastrophic failure.
Original Design Operating Intent	To facilitate open-pit mining of the Panda Pit at the southern portion of Panda Lake, this diversion dam and a diversion channel diverts water to Kodiak Lake. Winter construction followed by near-immediate dewatering of Panda Lake (although in fact, lake was dewatered one month before dam completed).
Initial Foundation Conditions	Glacial till/lacustrine silt/esker sand and gravel overlying bedrock. Lake is naturally less than 1 m deep along dam alignment and naturally freezes to the bottom each winter. Warm permafrost (~-2°C).
Design Details	Low-head, zoned rockfill, frozen-core dam. Winter construction to promote natural freezing of frozen core. A row of 60 vertical thermosyphons installed to accelerate complete freezing of the permafrost foundation. Hydrologic: 1:1000 year hydrologic event.
Design Criteria	Designed to leak somewhat initially as the frozen core was freezing off.
Instrumentation	13 vertical ground temperature cables.
Dam Performance to Date	Nominally retains approximately 1 m head of water year-round. Shortly after construction, localized subsidence of fill on dam crest just downstream of vertical thermosyphons due to thawing of ice-rich overburden soils placed where rock fill was specified; no repairs were conducted or required. Overall cooling trend within and below the core of the dam. Frozen core colder than -2oC over 40-50 m width. Ground temperatures of lakebed and bedrock along row of thermosyphons between -5°C and -7°C. Top of frozen core colder than -2°C.
Anticipated Future Performance	Frozen core and permafrost foundation should remain colder than -2°C for another 30 years. Frozen core and permafrost foundation should remain frozen (colder than 0°C) for an additional 50 years.

Table 5.1-2b. EKATI Dam and Dike Structure

Structure	Type	Status	Design Return Period(1) Earthquake Event	Design Return Period(1) Flood Event
Panda Dam	Frozen Core	Constructed in 1997	1:10,000	1:1,000
Outlet Dam	Frozen Core	Constructed in 1998	1:10,000	1:1,000
LLCF Dike A	Semi-Pervious Dike	Not constructed	1:10,000	1:1,000
LLCF Dike B	Semi-Pervious Dike	Constructed to design elevation Completed 1999	1:10,000	1:100
LLCF Dike C	Semi-Pervious Dike	Constructed to El. 456 m (2006) (design El. 459 m)	1:10,000	1:100
LLCF Dike D	Semi-Pervious Dike	Constructed to El. 450 m (2002) (design El. 458 m)	1:10,000	1:100
King Pond Dam	Hybrid Lined Dam	Constructed in 2001	1:10,000	1:100
Saddle Dam	Semi-Pervious Dam	Constructed in 2001	1:10,000	1:100
West Desperation Pond Cofferdam	Lined Berm	Constructed in 2002	1:10,000	1:10(2)
East Desperation Pond Cofferdam	Lined Berm	Constructed in 2002	1:10,000	1:10(2)
Waste Rock Dam	Hybrid Lined Dam	Constructed in 2002	1:10,000	1:100
Bearclaw Dam	Frozen Core	Constructed in 2003	1:10,000	1:1,000
East Dam	Frozen Core	Proposed future development	Design to be Completed	
Spillway Dam	Frozen Core	Proposed future development	1:10,000	1:100
Carrie Pond	Hybrid Lined Dam	Proposed future development	Design to be Completed	
Pigeon Berm	Lined Berm	Proposed future development	Design to be Completed	
Two Rock Dam	Frozen Core	Proposed future development	1:10,000	1:100
Two Rock Pervious Dike	Semi-Pervious Dike	Proposed future development	1:10,000	1:100

[1] *All dams designed in accordance with Canadian Dam Association (CDA) guidelines.*
[2] *Cofferdams designed to accommodate 1:10 event with 1.0 m of freeboard. Cofferdams can accommodate up to 1:100 year event with reduced freeboard.*

Appendix 5.1-3

Risks and Contingencies

Appendix 5.1-3. Risks and Contingencies

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1.1 INTRODUCTION

An important step in the development of the ICRP is the completion of a risk assessment on the selected closure options for all the mine components and activities associated with implementation of the ICRP.

A risk-based approach is a requirement of the BHP Billiton Closure Standard. Requirement number 3 states that:

> "the closure planning process must involve identification of the full range of risks and potential outcomes associated with the closure of an operation in order to control or minimize negative HSEC, financial and other impacts."

The Terms of Reference for the ICRP requires the summarization of:

> "high level closure and reclamation risks, including any identified residual risks and effects"

In addition, the TOR expects that:

> "contingency measures will be included for the identified risks."

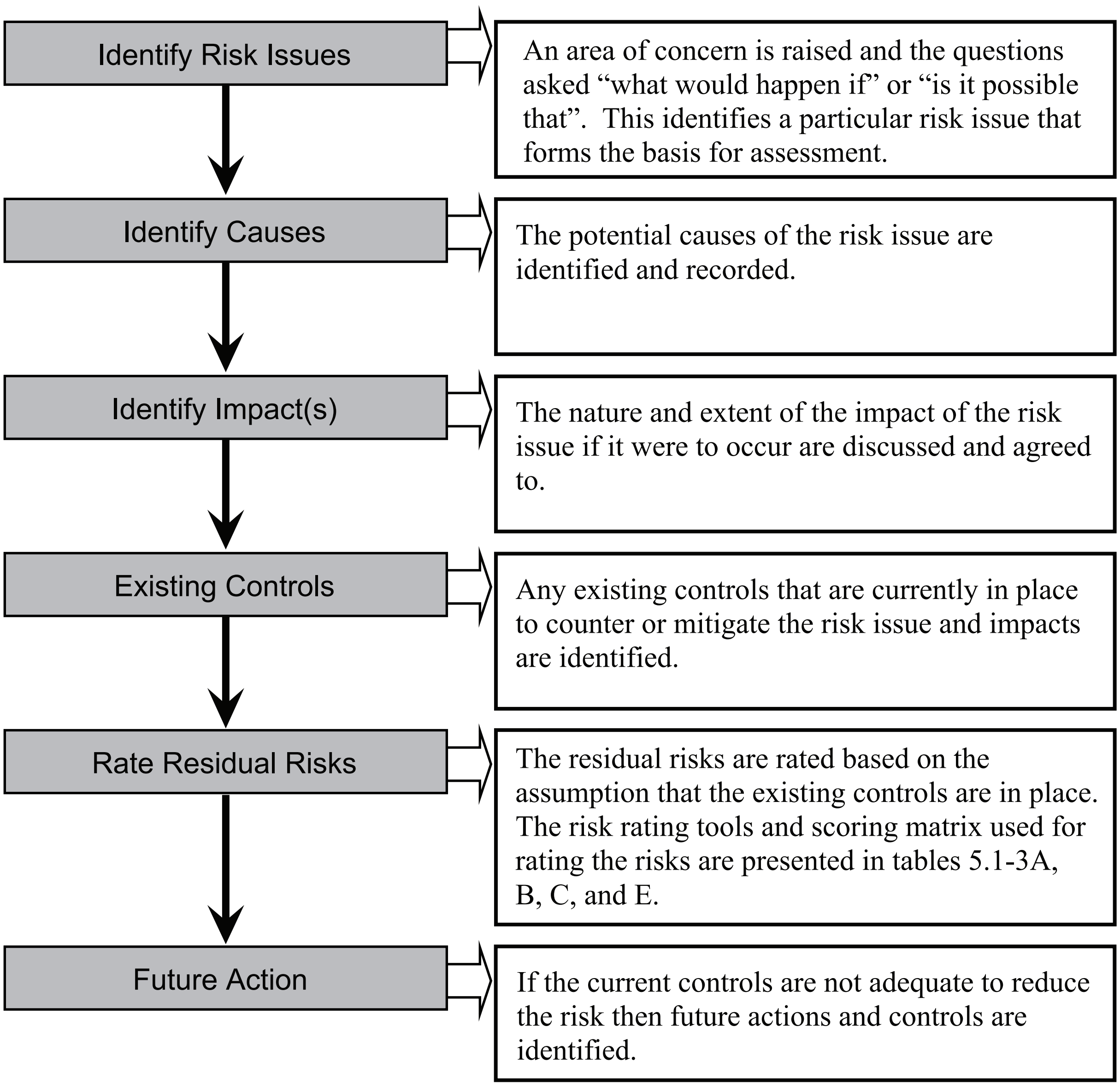
BHP Billiton's Charter values safety and the environment with an overriding commitment to health, safety, environmental responsibility and sustainable development. The Enterprise Wide Risk Management (EWRM) system is used to embed risk management in all activities carried out across the many assets in the company. EWRM is used to align strategy, processes, people, technology and knowledge with the purpose of evaluating and managing the uncertainties or inherent risks in strategic, operational and closure activity decisions. Where risks (such as environmental risks) are found to exist and are judged unacceptable, then, where practicable, specific controls are developed and adopted to reduce or mitigate the risk. The intent is to reduce the level of risk through the action or presence of one or several controls down to an acceptable level. For HSEC risks, a more demanding standard of 'as low as is reasonable practicable' has been adopted.

EWRM is recognized as an inter-industry standard for risk assessment because it increases the risk-sensitivity of the organization and reduces the inevitable functional, departmental and cultural barriers that exist in most organizations. It is an integrated, forward-looking and process-orientated approach to managing all key risks and opportunities (including safety and environment) with the intent of maximizing value as a whole for all stakeholders. EWRM is used to drive BHP Billiton's aspiration to Zero Harm to people, host communities and the environment while creating sustainable value for our shareholders, employees, contractors, suppliers, customers, business partners and host communities.

1.2 ENTERPRISE WIDE RISK MANAGEMENT PROCESS

1.2.1 Methodology

Figure 5.1-3a shows the methodology and individual steps involved in the EWRM process.



EWRM Process Steps

Figure 5.1-3a

1.2.2 Residual Risk Rating

To assist in the prioritization of actions, a risk rating is calculated that takes into account the controls that are already in place and their potential effectiveness. In other words, the residual risk that remains has existing controls in place. The residual risk rating provides the rationale for and the priority for any further risk control actions. Risk ratings cannot be converted to quantitative measures of risk such as dollars per year. However, they can be used to indicate those risk issues that warrant more detailed and quantitative analysis.

The Residual Risk Rating is a combination of severity, exposure and probability of occurrence, as shown below:

Residual Risk Rating = Severity Factor x Exposure Factor x Probability Factor.

The Severity Factor is a measure of the degree of gain, harm, injury or loss (impact) that is most likely to occur associated with an identified risk issue (Table 5.1-3a). The Exposure Factor is a measure of the frequency of occurrence of the "window of opportunity" during which BHP Billiton and/or its stakeholders could incur (or experience) the impact at the selected level of severity (Table 5.1-3b). The Probability Factor is a measure of the chance of an impact at that selected level of severity actually being incurred (experienced) during a "window of opportunity" (*i.e.*, during the Exposure) (Table 5.1-3c).

The Probability and Exposure Factors can be multiplied together to give a Likelihood Factor, as shown below:

Likelihood Factor = Exposure Factor x Probability Factor

1.3 ICRP EWRM WORKSHOP

1.3.1 Overview

A workshop on risk assessment for the reclamation and closure of the major mine area components was held from September 25-26, 2006 in the Yellowknife office of BHP Billiton. Attendees included representative from Mine Planning, Environmental Operations, Environmental Permitting and Traditional Knowledge, HSEC, External Affairs (Community Liaison) and BHP Billiton consultants. The workshop was completed using the EWRM process.

1.3.2 Workshop Objectives

The objectives of the EWRM workshop were to:

- Finalize the EKATI reclamation and closure objectives.
- Assess the risk associated with closure activities described in the ICRP.
- Identify risks that will be managed in the ICRP and any remaining Residual Risks which will be included in the Closure Evaluation and Provision.
- Develop an ICRP Risk Assessment which will be included in the BHP Billiton Risk Registry (CURA).

Table 5.1-3a. EWRM Severity Criteria Table

Health and Safety	Natural Environment	Social Environment	Reputation/Brand	Legal	Project Impact	Severity Factor
> 500 fatalities or very serious irreversible injury to > 5000 people.	Very significant impact on highly valued species, habitat or ecosystem.	Irreparable damage to highly valued items of great cultural significance or complete breakdown of social order.	Prolonged international condemnation.	Potential jail terms for executives and/or very high fines for company. Prolonged multiple litigations.	> US $5B	1000
> 50 fatalities or very serious irreversible injury to > 500 people.	Significant impact on highly valued species, habitat or ecosystem.	Irreparable damage to highly valued items of cultural significance or breakdown of social order.	International multi-NGO and media condemnation.	Very significant fines and prosecutions. Multiple litigation.	US $500M - $5B	300
Multiple fatalities, or significant irreversible effects to > 50 people.	Very serious long-term impairment of ecosystem function.	Very serious widespread social impacts. Irreparable damage to highly valued items.	Serious public or media outcry (international coverage).	Significant prosecution and fines. Very serious litigation, including class actions.	US $50M – $500M	100
Single fatality and/or severe irreversible disability (>30%) to one or more persons.	Serious medium-term environmental effects.	Ongoing serious social issues. Significant damage to structures of cultural significance.	Significant adverse national media/public/NGO attention.	Major breach of regulation. Major litigation.	US $5M – $50M	30
Moderate irreversible disability or impairment (>30%) to one or more persons.	Moderate short-term effects but not affecting ecosystem.	Ongoing social issues. Permanent damage to items of cultural significance.	Attention from media and/or heightened concern by local community. Criticism by NGOs.	Serious breach of regulation with investigation or report to authority with prosecution and/or moderate fine possible.	US $500K – $5M	10
Objective but reversible disability requiring hospitalization.	Minor effects on biological or physical environment.	Minor medium-term social impacts on local population. Mostly repairable.	Minor adverse local public or media attention and complaints.	Minor legal issues. Non-compliances and breaches of regulation.	US $50K – $500K	3
No medical treatment required.	Limited damage to minimal area of low significance.	Low-level repairable damage to commonplace structures.	Public concern restricted to local complaints.	Low-level legal issue.	< US $50K	1

Table 5.1-3b. EWRM Table for Determining Risk Event Exposure Factor

Frequency of the "Window of Opportunity"	Exposure Factor
At least once a week	10
Once a month or so	3
Once or twice a year	1
Once or twice every 10 years	0.3
Once or twice every 100 years	0.1

Table 5.1-3c. EWRM Table for Determining Risk Event Probability Factor

Chances of the Impact Actually Being Incurred (Experienced) during a "Window of Opportunity"	Probability Factor
Happens often	10
Could easily happen	3
Could happen and has happened here or elsewhere	1
Hasn't happened yet but could	0.3
Conceivable, but only in extreme circumstances	0.1

1.3.3 ICRP Objectives

The first step at the EWRM workshop was to review and finalize the EKATI closure objectives. These had to be established first so that a common set of objectives was used when assessing risks associated with implementation of the ICRP. The objectives of the EKATI ICRP that was developed at the workshop were to:

- Comply with legal and regulatory obligations, BHP Billiton corporate and other requirements.
- Protect public and wildlife health and safety.
- Mitigate significant adverse environmental effects to identified Valued Ecosystem Components (VECs) using a risk-based approach.
- Consider the expectations of stakeholders for post-closure land use, including biodiversity, sustainable development and respect of traditional values.
- Minimize negative socio-economic impacts in the area.
- Achieve closure criteria completion and return of securities as soon as practicable.
- Design the plan such that long-term care and maintenance is not required.
- Ensure that the reputation of BHP Billiton as a responsible corporate citizen is maintained.

1.3.4 Previous Workshops

Prior to the EWRM workshop, two separate workshops were completed to assess risk and evaluate alternative closure options for the major mine area components at EKATI. From April 24 to 28, 2006, an Options Evaluation risk assessment was held in Yellowknife with EKATI staff and technical consultants. The purpose was to assess the risk of closure options for large mine components such as open pits, PDC, waste rock storage areas and the LLCF.

From July 18 to 21, 2006, a Community Options Evaluation workshop was held in Yellowknife. It was attended by 38 participants representing regulatory agencies, Aboriginal communities, IEMA, technical consultants and BHP Billiton staff. Table 5.1-3d summarizes the go-forward closure plan for each of the major mine area components.

Table 5.1-3d. Closure Plan Activities for Major Mine Area Components

Mine Area Component	BHP Billiton Closure Plan Activities
Panda Pit	Pump flood (Alternative option to backfill with PK)
Koala/Koala North Pit	Pump flood
Beartooth Pit	Pump flood (Option to backfill PK if space required)
Misery Pit	Pump flood
Fox Pit	Pump flood
Sable Pit	Pump flood
Pigeon Pit	Pump flood
Panda/Koala WRSA	Not re-contour, no dome top, no vegetation. Wildlife access ramps
Misery WRSA	Not re-contour, no dome top, no vegetation. Wildlife access ramps
Fox WRSA	Not re-contour, no dome top, no vegetation. Wildlife access ramps
Sable WRSA	Not re-contour, no dome top, no vegetation. Wildlife access ramps
Pigeon WRSA	Not re-contour, no dome top, no vegetation. Wildlife access ramps
Panda Diversion Channel	Leave open, stabilize for long-term use
LLCF	Combination waste rock and vegetation cover

1.4 ICRP RISK ASSESSMENT RESULTS

The terms of reference for the ICRP requires identification of high-level risks and contingency measures associated with those risks. The primary objective of completing the EWRM process was for internal risk management and presentation purposes. Table 5.1-3a shows the ranking terminology as it relates to the EWRM risk rating score and presentation in the ICRP. Table 5.1-3e shows the severity criteria used in the ICRP for identification of major level risks, and Tables 5.1-3f to 5.1-3l show the individual risk assessment registers for each of the mine area components.

Table 5.1-3e. EWRM Rating Table for ICRP

Severity Level	EWRM Risk Score	Consequence Types					
		Health and Safety	Natural Environment	Social Environment	Reputation/Brand	Legal	Project Impact
Major	91-300	Single fatality and/or severe irreversible disability (>30%) to one or more persons.	Serious medium-term environmental effects.	Ongoing serious social issues. Significant damage to structures of cultural significance.	Significant adverse national media/ public/NGO attention.	Major breach of regulation. Major litigation.	US $5M-$50M
Moderate	31-90	Moderate irreversible disability or impairment (>30%) to one or more persons.	Moderate short-term effects but not affecting ecosystem.	Ongoing social issues. Permanent damage to items of cultural significance.	Attention from media and/or heightened concern by local community. Criticism by NGO's.	Serious breach of regulation with investigation or report to authority with prosecution and/or moderate fine possible.	US $500M-$5M
Minor	11-30	Objective but reversible disability requiring hospitalization.	Minor effects on biological or physical environment.	Minor medium-term social impacts on local population. Mostly repairable.	Minor adverse local public or media attention and complaints.	Minor legal issues. Non-compliances and breaches of regulation.	US $50M-$500M
Negligible	<10	No medical treatment required.	Limited damage to minimal area of low significance.	Low-level repairable damage to commonplace structures.	Public concern restricted to local complaints.	Low-level legal issue.	< US $50K

Table 5.1-3f. Risk Assessment – Open Pits

ID#	Risk Issue	Material or Non-Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
Health & Safety Issues										
1	Remaining highwall leads to public safety risk	M	Walls will be higher than final lake level elevation. Unsecured area. Unstable highwall. Human curiosity. Weather considerations.	Fatality - severe injury.	Safety berms constructed around pit perimeters per WCB requirements; Remote location reduces accessibility.	30	0.1	0.3	0.9	Leave berms around highwall as per WCB regulations; Signage in place during pit flooding and monitoring period.
2	Human health and safety to access reclaim pump (Operational Issue - Panda Tailings). *If reclaim pump is used for processed kimberlite discharge to Panda Open Pit*	NM	Exposure to slips, trips and falls at reclaim pump	Injury/Fatality	HSEC protocols, procedures.					This risk was regarded as non-material at the Sept/06 Risk Assessment because the mechanism for discharge of processed kimberlite into Panda Pit has not been decided. It will be reviewed in the next update of the ICRP
Air Quality – No Issues Identified										
Land										
3	Landscape Alteration	M	Removal of Sable, Pigeon, Beartooth, Panda, Koala, Fox and Misery Lakes, to become open pits.	Loss of fish habitat; Temporary loss of lake within drainage basin.	Fisheries compensation in place with DFO; Panda Diversion Channel and Bearclaw pipeline in place to divert drainage basin flow; Proposal for Pigeon Diversion compensation in place and under review.	10	0.1	10	10	Closure and Reclamation Plan to fill open pits after mining operations. Once pits filled will be hydraulically connected with drainage basin.

(continued)

Table 5.1-3f. Risk Assessment – Open Pits (continued)

ID#	Risk Issue	Material or Non-Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
Water										
4	Water Quality at discharge - does not meet water quality criteria	M	Water quality predictions not accurate - Poor water quality - Open pits take longer than expected to fill - Pit wall water runoff leads to poor water quality in pit - Pit wall instability impacts water quality in pit.	Environmental - downstream contaminant loading and extended monitoring period; Cost - Water Treatment and Delayed Security return; Company reputation.	Water quality modeling through Pit Lakes Studies to predict water quality in pit lakes.	100	0.3	1	30	Continue refining water quality model prior to and during pump flooding; Possible Water Treatment and Monitoring; Pump Flooding of fresh water from source lakes improves likelihood of good water quality; Pumping, rather than natural filling will improve likelihood of good water quality.
5	Use of Long Lake as a source for pit flooding leads to reduced pumping rates	M	Unexpected low flow available from Long Lake.	Environmental - Low downstream flows from LLCF - Compliance issues - Need to find alternate source lake; Cost and Legal.	Adherence to the LLCF Management Plan - Continued research studies	100	0.3	3	90	Identify alternate water source to LLCF as a contingency
6	Failure of pumping systems leading to diesel spills	M	Faulty equipment - Uncontrolled berm area - Spill not contained.	Environmental - impacts to local area from hydrocarbon contamination; Legal - compliance issues; Cost - to clean up.	HSEC controls in place to reduce likelihood of spills during construction, operations and demolition phases	3	3	3	27	HSEC will continue to be used during closure and reclamation period

(continued)

Table 5.1-3f. Risk Assessment – Open Pits (continued)

ID#	Risk Issue	Material or Non-Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
7	Pit lakes become nutrient sinks which causes downstream adverse water quality issues	M	Deep pit lake causes nutrients flowing in from Bearclaw to sink into lake.	Deep pit lakes causes nutrients flowing into the lake to sink into lake and not carry to downstream watershed.	Pit lake design includes construction of riparian habitat around pit lake perimeters and in re-connected channels.	10	0.3	3	9	Identified as a low risk since most pit lakes are headwater lakes and contribute relatively little nutrient flow. Research will continue on possible methods of nutrient addition.
8	Effects downstream of source water bodies	M	Water withdrawal too fast and/or too much, causing impact to fish habitat in source lakes, poor controls on flooding program.	Environmental - exposed shoreline leads to scouring/water quality impact; Community/Reputation - not as predicted; Cost - reduce extraction rate and extend fill time, extended monitoring; Legal - compliance issues.	Studies of water extraction rates are based on fish habitat protection. Current baseline monitoring of source lakes hydrology.	30	0.3	1	9	Continued monitoring of source lakes and downstream to determine natural hydrologic regimes. Monitoring while pumping to ensure volumes not exceeded. Reduced pumping rates, Alternate sources.
9	Natural hydrocarbons in residual kimberlite degrades water quality (Sable)	M	Preliminary analysis indicates potential for natural minor levels of hydrocarbons at Sable.	Environmental - Poor residual water quality in open pit at closure.	Continued test work on Sable kimberlite to determine level of hydrocarbon in ore.	1	0.3	1	0.3	As needed - pending results.

(continued)

Table 5.1-3f. Risk Assessment – Open Pits (continued)

ID#	Risk Issue	Material or Non-Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
10	Contribution of pit walls is much greater than anticipated, in terms of pit lake water quality	M	Pit wall water runoff leads to poor water quality in pit discharge.	Environmental - poor water quality downstream of pit lakes; Reputation - predictions in closure plan were wrong, credibility with stakeholders; Cost - delayed security return, extended monitoring period; Legal - potential compliance issue once pit is filled.	Research and data collection - Development of Pit Lakes Water Quality Model.	30	0.3	1	9	Further refinement of model; Monitor during operations and reclamation period to determine if further steps are necessary; Pumping of water into pits rather than slower natural fill reduces poor water quality potential; Water Treatment and Monitoring.
11	Pit takes longer than expected to fill, exposing wall rock to air for longer than anticipated	M	Occurrence of dry years during flooding period, incorrect modeling estimates for fill times, pumping difficulties (e.g., freezing).	Environmental - poor water quality downstream of pit lakes, Legal - potential compliance issue once pit is filled,Reputation - predictions in closure plan were wrong, credibility with stakeholders,Cost - delayed security return, extended monitoring period.	Research and data collection - Development of Pit Lakes Water Quality Model to better understand open pit wall contribution to water quality. Continued studies to determine source lakes and filling times.	10	0.3	1	3	Monitor during operations reclamation period to determine if further steps are necessary; Water Treatment and Monitoring.
12	Panda Pit Lake water quality degradation resulting from poor porewater in Processed Kimberlite	M	Diffusion of contaminants from Processed Kimberlite into water leading to poor water quality in pit lake.	Environmental - poor water quality downstream of Panda Pit Lake; Legal - compliance issue; Cost - water treatment.	Monitoring and research of water quality during operations as part of Waste Water and Processed Kimberlite Management Plan, and through Pit Lakes Studies.	30	0.3	1	9	Refinement of Pit Lakes Studies, Studies to determine type and rate of processed kimberlite fill into Panda open pit and how this influences water quality, Water treatment.

(continued)

Table 5.1-3f. Risk Assessment – Open Pits (continued)

ID#	Risk Issue	Material or Non-Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
13	Failure of plug in Panda/Koala Underground (during closure) leading to a change in water elevations	M	Poor design and construction.	Environmental - increased flows into Kodiak Lake (short term), water level in Panda Pit Lake would drop to same level as Koala Pit Lake, short term water quality impacts; Cost - increased monitoring.	N/A	10	0.3	0.3	0.9	Design plugs to ensure no leakage or failure. Full supervision of design and construction by qualified engineer; Research final lake elevations with and without plug.
14	Failure of plug in Panda/Koala Underground, during closure, leading to leakage of Processed Kimberlite into bottom of Koala pit lake	M	Poor design and construction.	Environmental - impacts to Koala pit lake water quality; Legal - compliance issues.	N/A	3	0.3	0.3	0.27	Design plugs to ensure no leakage or failure. Full supervision of design and construction by qualified engineer.
15	Impact on natural source lakes and catchment areas	M	Too rapid drawdown - change in climate.	Environmental - impacts to water quality and aquatic habitat in source lakes; Legal - compliance issues; Reputation and cost - delay in filling.	Pit Lakes Study to determine impacts to source lakes.	10	0.3	0.3	0.9	Based on continued research - monitor impacts on lakes - change in pumping plan - find alternate sources if required.
16	Inadequate outflow from Sable/Fox/ Misery pits once pits are flooded, causing downstream effects on fish habitat	M	Poor design planning and hydrologic modeling.	Environmental - impairment of fish habitat in outflow streams; Reputation and credibility - not as predicted in closure plan; Cost - litigation, extended monitoring; Legal - fish habitat loss.	N/A	10	0.3	0.3	0.9	Research studies to better understand potential hydrologic regime of headwater pit lakes. Monitoring of downstream watersheds when pit flooding complete.

(continued)

Table 5.1-3f. Risk Assessment – Open Pits (continued)

ID#	Risk Issue	Material or Non-Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
Wildlife										
17	Remaining highwall leads to wildlife falling into pit lakes (fatality or injury)	M	Migration path. Predation.	Legal - compliance issues; Community/Reputation - are thought to be unsafe for wildlife, poor effectiveness of barriers; Cost - upgrade barriers.	Safety berms constructed around pit perimeters. Inukshuks to deter caribou from moving near open pits (Traditional Knowledge).	30	0.3	0.3	2.7	Provide egress for wildlife access and escape; Wildlife berms constructed around pit perimeter. Reshape pit edges to reduce rapid transitions; Build additional Inukshuks to deflect wildlife.
18	Flooding would lead to a disruption of raptor habitat	NM	Raptor habitat created prior to and during pit flooding.	Environmental - Loss of raptor habitat with pit flooding; Legal - Injury/death of raptors during flooding;	WEMP to monitor bird use in Open Pits.					This risk was regarded as non-material at the Sept/06 Risk Assessment because it was assessed as a very low risk. It will be reviewed in the next update of the ICRP.
19	Migratory birds landing on pit lake	M	Uncontrolled open water - Pit Lakes in migratory flight path.	Community Concern - Perception generates concern.	Communications to communities to create awareness of low risks - Long Lake example.	1	1	3	3	Communications with communities to discuss concerns.
Operational										
20	Pit wall instability leads to localized failures impacting water quality in pit	M	Greater than anticipated effects of freeze/ thaw on wall stability.	Cost - focused geotechnical monitoring.	Geotechnical monitoring during operations.	3	0.3	1	0.9	Pump Flooding to fill pits with water sooner, which reduces pit wall exposure to freeze/ thaw weathering, Water Treatment and Monitoring.

(continued)

Table 5.1-3f. Risk Assessment – Open Pits (completed)

ID#	Risk Issue	Material or Non-Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
21	LLCF water volumes and quality not suitable as source lake for pit flooding	M	Predictions show that water volumes insufficient or that water quality in pit lakes would be impacted.	Cost (find alternative source); Legal (Closure Plan needs revision, revise water licence).	Adherence to the Waste Water and Processed Kimberlite Management Plan; Continued research studies - Water quality prediction models (routinely updated); Environmental Monitoring.	30	0.3	0.3	2.7	Identify and use alternate water source.
22	Cost risk increased and additional work due to longer fill times	M	Risk of model estimates to fill the pits are significantly wrong and it takes much longer - Operational difficulties (pipeline freezing, pump failure) - Effects observed on source lakes - Climate.	Cost - capital and operational.	Research tied into Life of Mine Plan, and which determines fill rates and timing of pump flood, capital and operations costs.	10	0.3	3	9	Monitor filling progress, and re-evaluate if required.
23	Fish returning to isolated pit lakes	M	Fish enter pit lakes during flooding, incidental fish movement into pit lakes (caused by humans, birds, wildlife).	Legal - for any fish kills, fish presence may lead to changes in licence/ authorizations; Community/ Reputation - concerns of fish health, human consumption.	Design of berms and spillway to reduce potential of fish introduction into pit lakes.	10	0.3	3	9	Fish barriers - screens on pump intakes which comply with DFO requirements. Possible Traditional Knowledge input.
24	Unable to obtain approval and licence to pump flood from natural source lakes	M	Regulators - Approvals - Unacceptable risks to downstream water sheds - delays due to regulatory system.	Unable to implement Interim Closure Plan; Cost - Delay to final closure.	Baseline work in source lakes - research studies to provide information to regulators.	30	0.3	1	9	Forward thinking plan - strategy - Revise Closure Plan.

Table 5.1-3g. Risk Assessment – Underground Operations

ID #	Risk Issue	Material or Non Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
Health & Safety										
1	Failure of underground access seals	M	Poor workmanship and/or design.	Cost of repair; Safety - fatality.	HSEC - Quality Control.	30	0.1	1	3	Inspection over monitoring period.
Air Quality – No Issues Identified										
Land – No Issues Identified										
Water										
2	UG wall instability impacts pit water quality	M	Exposing new rock surface in the kimberlite pipe.	Environmental - Poor water quality in pit.	Monitoring and research in LLCF to understand underground water quality issues (Waste Water and Processed Kimberlite Management Plan).	3	0.3	0.1	0.09	Water treatment.
3	Failure of underground plug	M	Diffusion of contaminants in pit lake water.	Poor water quality in pit.	Monitoring and research in LLCF to understand underground water quality issues (Waste Water and Processed Kimberlite Management Plan).	1	0.1	0.1	0.01	Water treatment.
4	Underground impact on pit water quality	M	Buried Equipment - leftover kimberlite - Underground ground water.	Potential impact on water quality in pit.	Monitoring programs during operations - predictive modeling.	1	0.3	0.3	0.09	Decommissioning plan to remove potential contributors of poor water quality, Water treatment.
Wildlife										
5	Failure of underground access seals	M	Poor workmanship and/or design.	Environmental - wildlife injury/ fatality.	HSEC - Quality Control.	10	0.1	1	1	Inspection over monitoring period.
Operational – No Issues Identified										

Table 5.1-3h. Risk Assessment – Waste Rock Storage Areas

ID#	Risk Issue	Material or Non Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
Health & Safety										
1	Public Safety	M	Access - Curiosity - Attractant - Hunting - Weather.	Fatality or serious injury.	Public access restricted during operations - HSEC Standards - Public Awareness - Communications - Remote location.	30	0.3	1	9	Communications, Remote location will reduce public accessibility.
Air										
2	Dust migration from wind erosion	M	Wind - weather, flat top surface of waste rock area. Short term risk during operations with haul traffic.	Environmental - Plants - vegetation - uptake by animals eating vegetation; Social - community perception.	Dust collection - test work underway, Fugitive dust monitoring and snow surveys.	10	1	1	10	Monitoring dust - review requirements for scarification.
Land										
3	Degradation of permafrost within the WRSA	M	Ponding - not built to design - removal of waste rock for construction.	Environmental - Increased seepage - release of contaminants; Compliance - water licence non compliance.	Waste Rock and Ore Storage Management Plan which details waste rock pile construction - Thermistor monitoring - design for closure (flat top to discourage snow cover and maintenance of permafrost).	30	0.1	0.1	0.3	Continued modeling as future data is available - manage material removal for reclamation projects - regrading of waste rock pile where needed.
4	Wind erosion from lake sediment and till storage piles leading to increased suspended solids in receiving environment	NM	Exposed lake sediments and fine till available for wind and water erosion.	Impacts to local vegetation.	Aerial fertilizer and grass seeding completed. Result - some vegetation cover. Current research studies on use of this material for vegetation.					Decision on moving and using for reclamation, or permanently covering unknown at this time. Will be assessed in the next ICRP update.

(continued)

Table 5.1-3h. Risk Assessment – Waste Rock Storage Areas (continued)

ID#	Risk Issue	Material or Non Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
5	Creation of new access ramps on already existing waste rock piles - possible effects on stability	NM	Loss of corporate knowledge; Excavation on already constructed infrastructure; Exposure of permafrost in pile.	Environmental - Permafrost exposure and degradation. Biotite schist and increase seepage concerns.	Wildlife access ramps constructed on Panda/ Koala WRSA during pile construction.					Number and location of wildlife access ramps for all WRSA needs to be assessed. The risk of sourcing materials will be assessed in the next ICRP update.
6	Landscape Alteration	M	Covering of tundra with waste rock from open pit mining operations.	Loss of wildlife habitat.	Construction of wildlife access ramps to allow caribou access to tops of WRSA. Provides insect relief.	10	0.1	10	10	Wildlife access ramps to allow caribou access to tops of WRSA. Provides insect relief.
Water										
7	Poor water quality seepage from waste rock storage area flows downstream into natural environment	M	Waste rock contaminants in seepage - incomplete freezing; Global warming - exposure of permafrost - reduced encapsulation due to removal of waste rock for reclamation projects.	Environmental - Degradation of water quality; Compliance - Unexpected increase in seepage leading to water licence non compliance (legal); Social - community concern with poor water quality downstream.	Toeberms constructed in sensitive areas at base of waste rock piles to collect and freeze seepage; Seepage monitoring program - thermistors monitoring during operations - Waste Rock and Ore Storage Management Plan; Continued design for closure of Waste Rock Piles; 5 m granite cap over Misery Waste Rock Pile to encapsulate biotite schist; Waste characterization included as a Task in the Pit Lake Studies; Seepage Monitoring and Reporting during operations.	10	1	1	10	Modeling of seepage from waste rock piles as part of Pit Lakes studies; Continued monitoring within a specified period - collect and treat seepage if required; Freeze encapsulation, toe berms.

(continued)

Table 5.1-3h. Risk Assessment – Waste Rock Storage Areas (continued)

ID#	Risk Issue	Material or Non Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
8	Mixed (internal) waste leading to water quality issues - e.g. landfill - Zone S - Racetrack - Residual ANFO	M	Loss of permafrost.	Contaminate loading into receiving environment	Waste Rock and Ore Storage Management Plan - thermistor monitoring - long term climate modeling - design for closure (flat top to discourage snow accumulation and maintenance of permafrost); Seepage Monitoring and Reporting during operations.	10	0.1	0.1	0.1	Manage material removal for reclamation projects. Collect and treat seepage.
9	In-pit kimberlite stockpile needs to be relocated to WRSA and cover (Misery)	NM	Temporary - low grade or no grade - not economic for processing - changing strategies concerning open pit and waste rock pile.	Cost of moving material - Dust - Water quality in pit	Located within the Misery pit drainage area.					Move it - Cover it, or process it. Future strategy for open pit and waste rock pile design unknown at this time. This will be assessed with the next ICRP update.
10	Residual kimberlite ore seepage from Misery WRSA and waste kimberlite at Fox WRSA	M	Change in mine planning - Inability to clean WRSA surface.	Environment - Release of contaminants into receiving environment	Removal of Misery Ore, and capping of Fox waste kimberlite. Water management structures at Misery, and toe berms at Fox to control seepage; Seepage Monitoring and Reporting during operations.	10	1	3	30	Covered or removed.
Wildlife										
11	Wildlife safety	M	Large rocks - predation - steep slopes.	Environmental - wildlife injury/ fatality; Community concern - dead wildlife.	Communications with communities.	10	1	0.3	3	Proper design of wildlife access/ egress ramps - Use of Traditional Knowledge.

(continued)

Table 5.1-3h. Risk Assessment – Waste Rock Storage Areas (completed)

ID#	Risk Issue	Material or Non Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
12	WRSA is unstable	M	Change in mine planning - less granite.	Environmental - Injury/fatality to people and/or wildlife; Cost – resloping.	WRSA's constructed to 25 degrees average angle of repose. This is lower than the natural angle.	10	0.3	10	30	Maintain current design.
Operational										
13	New material for ramp fill may cause problems from borrow locations	NM	Change in mine planning - less granite.	Cost - quarry of new material.	Wildlife access ramps constructed on Panda/ Koala WRSA during pile construction.					Number and location of wildlife access ramps for all WRSA needs to be assessed. The risk of sourcing materials will be assessed in the next ICRP update.

Table 5.1-3i. Risk Assessment – Processed Kimberlite Containment Areas (Phase I and LLCF)

ID#	Risk Issue	Material or Non Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
Health & Safety										
1	Public Safety	M	Public accessing loose fine processed kimberlite - Open Water - Bioaccumulation through consumption of caribou and other wildlife that forage on the LLCF vegetation.	Fatality, serious injury or disease/illness.	Risk Assessment for metal uptake (human ingestion) - Community Awareness - Remote Location reduces public accessibility.	30	0.3	0.3	2.7	Community Awareness - Discussion of Research and Studies on Metal Uptake.
Air										
2	Unavailability of clean rock cover material source	M	Competing with other construction sources - insufficient clean material in the WRSA.	Environment - Greenhouse gases for hauling from long distances (alternate waste rock sources), Residual nitrate issue on waste rock - Water Quality; Cost - additional hauling or accessing of cover material (i.e., Esker sand, granite quarrying); More emphasis on vegetation cover construction	Waste rock segregation - Waste Rock and Ore Storage Management Plan.	30	0.3	3	27	Design future waste dumps for closure - Use materials from "clean" areas. Identify future construction and reclamation waste rock requirements. Determine potential quarrying locations.
3	Dust generation and migration during cover construction	M	Increased haulage and equipment traffic during cover construction.	Environmental - Increased dust on vegetation, uptake by grazers, downstream effects on water quality; Community concerns on wildlife safety	N/A	1	1	3	3	Monitor ambient dust conditions during construction - Proper and mitigative construction techniques - (e.g., construction during winter).
4	Dust release and migration prior to completion of stable vegetation and rock cover at LLCF	M	Cover to take 2 to 3 years to establish - erosion in interim.	Environmental - Increased dust on vegetation, uptake by grazers, downstream effects on water quality; Community concerns on wildlife safety.	Progressive reclamation - vegetation trials.	10	1	1	10	Progressive reclamation - early design of waste rock and vegetation cover, binding agents, use of nurse crop to provide initial cover.

(continued)

Table 5.1-3i. Risk Assessment – Processed Kimberlite Containment Areas (Phase I and LLCF) (continued)

ID#	Risk Issue	Material or Non Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
Land										
5	Failure/setback of vegetation cover at the LLCF	M	Reclamation studies don't scale up fast enough, Chemistry changes in processed kimberlite (from different ore sources, kimberlite weathering), Weather/climate - drought, Overgrazing.	Environmental - Exposed processed kimberlite leading to erosion/dust generation; Community concerns - uptake by grazers; Cost - Maintenance of vegetation cover, or need for alternate cover construction.	LLCF Research - vegetation trials.	30	0.3	1	9	Revegetation - move from small research plots at Cell B to larger pilot study program - Progressive reclamation as processed kimberlite beach areas are available. Full rock capping.
6	Processed kimberlite boils resulting in kimberlite on top of rock cover	M	Poor cover design - Seasonal freezing and thawing.	Environmental - Exposure of processed kimberlite, potential for erosion; Cost - for cover maintenance; Community Concerns/ Regulatory concerns.	N/A	10	0.3	1	3	Design thickness to discourage kimberlite boils; Pilot program to understand and optimize construction methodology.
7	Landscape Alteration	M	Covering of Nancy Lake, upper reaches of Long Lake, and tundra area adjacent to the Long Lake with processed kimberlite.	Loss of aquatic habitat, and wildlife habitat.	Fisheries compensation in place with DFO.	10	0.1	10	10	Closure and Reclamation Plan cover processed kimberlite with vegetation and rock cover to blend with local tundra. Outlet Dam to be breached when water quality discharge meets closure criteria. Breach of Outlet Dam returns Long Lake to drainage basin hydrologic regime.

(continued)

Table 5.1-3i. Risk Assessment - Processed Kimberlite Containment Areas (Phase I and LLCF) (continued)

ID#	Risk Issue	Material or Non Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
Water										
8	Failure of rock cover at LLCF from unconsolidated processed kimberlite	M	Processed kimberlite unable to support load - Thawing of ice lenses.	Environmental - Sinking of cover - expulsion of poor quality pore water; Cost - Additional material requirements	Drilling - pore water studies underway - Thermal evaluation studies underway - Underwater density testing.	10	0.3	1	3	Progressive reclamation of beach processed kimberlite - evaluation of development of construction techniques - optimized management of the LLCF.
9	Poor water quality at discharge point (CELL E of LLCF)	M	Pore water discharging from processed kimberlite - Thawing of ice lenses - loading by waste rock - wind and water erosion; Natural hydrocarbons in Sable processed kimberlite.	Environmental - Downstream effects on water quality; Out of compliance; Cost - Water treatment, cap re-construction; Reputation - Not walk away solution.	Monitoring for water licence discharge criteria; Modeling Studies to predict long-term water quality for LLCF; Maximized dilution during spring freshet; Waste Water and Processed Kimberlite Management Plan - Incorporation of Design for Closure.	30	0.3	3	27	Continued monitoring and refinement of water quality modeling; Capping and vegetation to create stable cover over processed kimberlite; Deposition of processed kimberlite backfill into Panda Open Pit; Continued testing of Sable kimberlite.
10	Poor water quality seepage downstream of Phase 1 (Old Camp)	M	Poor reclamation design.	Environmental - Downstream effects on water quality in Larry Lake. Out of compliance.	Annual seepage monitoring at toe of Phase 1 dam; Preliminary design in place for Phase 1 reclamation; Risk assessment on designs prior to construction.	1	1	3	3	Cap of Phase 1 to encourage upstream flow away from the processed kimberlite containment area.

(continued)

Table 5.1-3i. Risk Assessment – Processed Kimberlite Containment Areas (Phase I and LLCF) (continued)

ID#	Risk Issue	Material or Non Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
11	Settlement of internal drainage channel in LLCF, leading to erosion and release of sediments downstream	M	Permafrost degradation - erosion - high flows - weather - ice blockage, poor design/construction.	Poor downstream(at Cell E compliance point) water quality and potential effects of downstream aquatic habitats.	Waste Water and Processed Kimberlite Management Plan - Deposition Planning with the Process Plant and Environment Depts at EKATI.	3	0.3	0.3	0.27	Managed deposition of processed kimberlite, Engineered design of internal drainage channel, monitoring or channel, processed kimberlite redirected to the Panda Open Pit.
12	Difficulty of constructing cover at water-processed kimberlite interface in LLCF	M	Low density material unstable - unsafe for vehicle traffic.	Environmental - poor water quality downstream of LLCF, Re-suspension of solids due to wave action, Fluctuation of water level; Cost - Excess material requirements, Improper design.	N/A	10	0.3	1	3	Pilot program to understand and optimize construction methodology.
13	Relocation of Phase 1 processed kimberlite (Old Camp processed kimberlite containment area)	M	Permafrost does not aggrade into the processed kimberlite. Upstream drainage flow carries processed kimberlite outside of the liner into downstream aquatic habitat.	Environmental - poor water quality downstream of Phase 1; Cost - to relocate processed kimberlite to LLCF and decommission Phase 1.	Annual seepage monitoring at toe of Phase 1 dam.	10	0.3	1	3	Risk assessment for Phase 1 closure design.
Wildlife										
14	Wildlife safety	M	Unstable landform.	Environmental - Injury to wildlife while traveling in LLCF; Community concern - Injury to wildlife.	Design rock cover for safe wildlife passage.	10	1	0.3	3	Design and Construct LLCF cover to reduce potential injury to wildlife; Construct Inukshuks to deter wildlife on LLCF - Use of Traditional Knowledge.

(continued)

Table 5.1-3i. Risk Assessment – Processed Kimberlite Containment Areas (Phase I and LLCF) (completed)

ID#	Risk Issue	Material or Non Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
15	Wildlife safety	M	Metal uptake in vegetation (consumed) or wildlife consuming processed kimberlite directly.	Environmental - Bioaccumulation in wildlife and Biomagnifications in people from processed kimberlite ingestion; Community concern - Contamination of caribou leads to community change in hunting lifestyle with caribou.	Metals Uptake Studies - Communications with Communities and Regulators.	10	1	0.3	3	Plant vegetation that is not an attractant for wildlife; Construct Inukshuks to deter wildlife on LLCF - Use of Traditional Knowledge; Construct Inukshuks to deter wildlife on LLCF - Use of Traditional Knowledge.
Operational										
16	Fish moving back into new ponds which form in the LLCF Cells, upstream from outside environment	M	Fish present in current ponds in LLCF - incidental habituation; Fish moving in from downstream after dams and dikes breached.	Legal - Death would result in legal proceedings (DFO requirements), Living community of fish could impact changes in regulations; Reputation - Community relations.	No fish access into LLCF currently available.	3	0.3	1	0.9	Fish barriers - (screens on pump intakes, rock weirs).

Table 5.1-3j. Risk Assessment - Dams, Dikes and Channels

ID#	Risk Issue	Material or Non Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
Two Rock Dam and Dike, Pigeon Diversion Stream, Bearclaw Dam, Beartooth Pipeline, Panda Dam and Spillway, Panda Diversion Channel, Outlet Dam, King Pond Dam, Waste Rock Dam, East/West Coffer Dams.										
Health & Safety - No Issues Identified										
Air - No Issues Identified										
Land - No Issues Identified										
Water										
1	Risk of sediment and other contaminants release during Panda DC stabilization work.	M	Heavy rainfall - Global warming - Earth Works to layback canyon walls - Removing culverts.	Environmental - Sediment loading impacts on downstream aquatic habitats; Legal - Impacts and destruction of fish habitat (DFO); Cost - Extended PDC monitoring - Repair work.	Preliminary Design for stabilizing in place for PDC - Ongoing performance monitoring during operations; Sediment curtains in place.	30	1	3	90	Final design - Monitoring (ensure stability) - Quality Control during winter construction - streamlined PDC Monitoring.
2	Fish over the Panda Spillway and down the Panda highwall during peak flows could result in fish kill	M	High freshet and PDC not clearing of snow.	Environmental - Legal (DFO) - Fish Fatality; Cost - fines, review and construction of alternate fish barriers.	Preliminary Design in place for fish barriers.	10	1	1	10	Modify Design - Construction of the spillway near the end of the flooding period to include fish catch/grate.
3	Panda DC fails to perform over the long-term	M	Poor design for longevity - significant storm event causes overflow, scouring and environmental impacts.	Environmental - impacts to downstream aquatic habitat; Legal - Non-compliance with Fisheries Authorization - Reputation/Community - Credibility; Cost - Modify Panda DC.	PDC Management Plan monitors current channel performance; Preliminary PDC re-design plan in place for long-term stabilization of channel.	30	0.3	1	9	Final design & Approval to build spillway & laybacks sooner.
4	Pigeon DC fails to perform over the long-term	M	Poor design for longevity - significant storm event causes overflow, scouring and environmental impacts.	Environmental - impacts to downstream aquatic habitat; Legal - Non-compliance with Fisheries Authorization - Reputation/Community - Credibility; Cost - Modify Panda DC.	Preliminary design of Pigeon DC in place from Environmental Assessment Sable, Pigeon and Beartooth.	30	0.3	1	9	

(continued)

Table 5.1-3j. Risk Assessment - Dams, Dikes and Channels (completed)

ID#	Risk Issue	Material or Non Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
5	Additional water from Grizzly Lake and Stream flows into Panda DC at closure	M	Potable water use stopped at final mine closure, and return to natural flow regime.	Environmental - High water levels at freshet - scouring, impacts to downstream aquatic habitats.	Grizzly water used for camp operations. Water use is monitored through AEMP, and reported for Water Licence.	3	1	1	3	Review of the design - Remodel the current work to include high water flow.
6	Sediment release during and after construction of dam breaches	M	Breaching dams.	Environmental - Impacts to downstream aquatic habitat; Compliance - Legal; Cost - Potential fines, stabilization work.	Winter construction, silt curtains and monitoring.	30	0.3	1	9	Designs and construction methodologies - Sufficient monitoring period (progressive reclamation) to ensure stability.
7	Poor performance with flow rate when dams breached - insufficient flow following breaching	M	Poor design - Poor benchmarking - Climate change - water levels dropping or increasing.	Environmental - Possible effects on aquatic habitat; Physical stability - Long term monitoring; Cost - Return of security delayed.	NA	10	0.3	1	3	Design and modeling - modeling range of flow rates - evaluation of other northern mine sites.
8	Overtopping of the Panda Dam - Long-term viability	M	Spillway and Panda DC not working; contribute to water overflowing the Dam - Thermal instability due to high-water.	Environmental - Impacts to downstream aquatic habitats; Legal - Community - Reputation; Cost - Potential fines, reconstruction work.	Preliminary Spillway design- removing snow from Panda DC each spring.	30	1	1	30	Approved design.
9	Newly created habitat in King Pond Settling Facility, Desperation and Carrie does not meet expectations of DFO	M	Poor flow - poor colonization - design problems - shallow lakes - small fish populations.	Environmental - Impacts to aquatic habitat in King Pond, Desperation and Carrie; Cost - Further Habitat creation - Legal - Longer Monitoring.	Fisheries Compensation Plan in place - Baseline Studies.	10	0.3	3	9	Studies.
Wildlife - No Issues Identified										
Operational - No Issues Identified										

Table 5.1-3k. Risk Assessment - Buildings and Infrastructure

ID#	Risk Issue	Material or Non Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
Equipment, petroleum and chemical storage facilities, borrow pits (quarry sites), landfills and waste disposal sites, sedimentation ponds, laydown and camp pads, ore storage pads, surface structures and buildings, roads and airstrip, satellite facilities and exploration camps										
Health & Safety - No Issues Identified										
Air - No Issues Identified										
Land										
1	Improper Demolition - risk of release of contaminants	M	Poor planning.	Environmental - impacts on local environment; Reputation; Cost - for cleanup.	HSEC, Spill reporting - First Priority - Remediation of Spills.	3	0.3	3	2.7	Test work around fuel dumps - Environmental Site Assessment; Develop Decommissioning Plan.
2	Discovery of unknown and un-identified buried materials at closure	M	Landfill material has not been properly disposed and/or not recorded for type and location.	Landfill material exposed during future quarrying operations.	All landfill materials report to the designated landfill sites (Misery and Main camp). All contaminated materials report to the Panda/ Koala/Beartooth Landfarm, CSCF and Zone S.	3	0.3	1	0.9	Landfills, Landfarms etc will continue to be the designation for waste materials. Historical Landfill sites have also been identified in the Closure Plan; Removal to designated landfill and/or encapsulation with waste rock.
3	Incorrect material buried during decommission and demolition	M	Procedures for landfilling types of material not followed.	Potential for hazardous or food waste burial.	Waste Management education provided to all EKATI employees and contractors. Designated disposal receptacle for all waste types. Hazardous waste collected at the Waste Management Building and shipped down Winter Road.	1	0.3	1	0.3	Develop Decommissioning and Salvage Plan; Encapsulation with waste rock.

(continued)

Table 5.1-3k. Risk Assessment – Buildings and Infrastructure (continued)

ID#	Risk Issue	Material or Non Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
4	Failure of vegetation over camp pads	M	Reclamation studies don't scale up - weather/climate - drought - overgrazing, unsuitable amendment materials.	Environmental - exposure of disturbed surface to erosion; Cost - To repair reclamation work; Community concerns - impacts to vegetation and wildlife grazers.	Research - Vegetation trials.	3	1	1	3	Revegetation - research plots; Progressive reclamation.
5	Landscape Alteration	M	Construction of infrastructure over tundra landscape.	Loss of wildlife habitat.	Monitoring of wildlife use within the claim block, wildlife access ramps on haul roads, incineration of food wastes to prevent wildlife attractants during mining operations. Progressive reclamation to remove disturbance and return minesite to productive habitat.	10	0.1	10	10	Closure and Reclamation Plan to remove buildings, as well as berms and culverts from roads. Use of topsoils and site manipulation to assist with vegetation colonization which stabilizes disturbed landscape.
Water										
6	Erosion of any quarry sites	M	Ineffective Quarry Management Plan, exposure of ice lenses, climate.	Environmental - Impacts to downstream aquatic habitat; Legal, Reputation; Cost - remediation work.	Revegetation work currently conducted at Airstrip Esker - Fred's Channel construction at Airstrip Esker - vegetation monitoring.	10	0.3	1	3	Update and implement Quarry Management Plan, Remediation of potential erosion sites (e.g., armoring, vegetation cover).
7	Long-term contamination issues from landfill and landfarm sites	M	Improper waste disposal procedures during operations - Lack of permafrost development.	Environmental - Poor seepage from WRSA; Community - Poor public perception; Legal - Cost.	Waste Rock and Ore Storage Management Plan in place to control waste deposition; Communications with internal and external stakeholders on waste management - Documentation of volumes and placement of waste material.	10	0.3	3	9	Develop mitigation plan for contamination issues.

(continued)

Table 5.1-3k. Risk Assessment – Buildings and Infrastructure (continued)

ID#	Risk Issue	Material or Non Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
8	Surface Water Contamination at Laydowns, Ore Storage and/or Camp pads	M	Improper storage of materials - Hydrocarbons - AN - Use of dust suppressants - Metal Mobility.	Environmental - impacts on downstream aquatic habitats; Cost - Remediation work - Possible removal of dust suppressants; Community - Concerns for wildlife and aquatic habitats.	Materials Management Storage Plans - Dust Suppression Application Procedures - Ongoing Monitoring; Communications - specific to regulators.	30	0.3	0.3	2.7	HSEC - controls on materials storage; Research Studies - Long term effects of dust suppressant use.
9	Water quality concerns from removal of culverts, other infrastructure	M	Disturbance to land.	Environmental - Sediment release - poor water quality.	Best practices used in construction techniques.	3	0.3	0.3	0.27	Road reclamation to be included in Demolition Plan. Proper erosion control in place.
10	Hydrocarbon contamination at Old Camp Pad	M	Fuel Spills - Lack of recording - Sewage Disposal.	Water Quality - Environmental - water quality; Cost - Environmental Site Assessment (ESA) and clean-up.	ESA at Old Camp currently underway.	10	0.3	1	3	Pending findings.
11	Hydrocarbon contamination at Norm's Camp	M	Fuel Spills - Lack of recording - Sewage Disposal.	Environmental - impacts to water quality; Cost - site assessment and clean-up.	Land Use Permits - requirements for closure.	10	0.3	1	3	Inclusion in the ICRP.
Wildlife										
12	Noise	M	Demolition of Buildings and Structures - Machinery/Blasting.	Environmental - Noise concerns for Wildlife - Dust - Deterrence of wildlife.	Occupational Health and Safety (OH&S) - WCB Regulations in place for noise levels for people. WEMP program monitors wildlife reactions to operations, and adjust noise accordingly.	1	0.3	1	0.3	Wildlife monitoring during demolition.

(continued)

Table 5.1-3k. Risk Assessment – Buildings and Infrastructure (completed)

ID#	Risk Issue	Material or Non Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
13	Wildlife Accessibility and Safety on Roads	M	Stakeholders desire to improve unlimited access for caribou on and off roads - Inaccessibility - steep slopes - large rocks on road sides.	Environmental - injury to wildlife crossing roads and pads; Community - Public Perception/Reputation - Community Concerns; Costs - road reconstruction.	Wildlife access ramps on Misery Road - construction of roads at tundra surface to allow caribou access (Misery Road) - Monitoring wildlife behaviour.	30	0.3	0.3	2.7	Berms and culverts will be removed from roads at closure. Road surfaces will remain available for wildlife travel routes. (similar to eskers).
Operational										
14	Existing mine equipment is not suitable and needs replacement during closure activities	M	Not planning for closure.	Cost - additional time - inefficient use of wrong sized equipment.	N/A	30	0.3	1	9	Develop a Decommissioning Plan which includes equipment needs.
15	Larger volume of contaminated soils than estimated	M	Unknown and unreported spills - failed lining systems - no lining systems. Poor documentation of spills during operations.	Cost - Excavation and remediation of contaminated soils.	HSEC (Spill reporting and remediation).	10	0.3	3	9	Environmental Site Assessment and remediation.
16	Lack of existing landfill space to bury demolition material	M	More material than anticipated - incorrect volumes - no salvage value - insufficient waste rock for encapsulation.	Have to find alternate landfill locations.	Preliminary estimate of demolition volume in place, and preliminary landfill site designated in Panda/ Koala WRSA.	10	0.3	0.3	0.9	Develop Decommissioning and Salvage Plan.
17	Location of demolition material landfill site	M	Poor location. Not deep enough.	Need to remove and relocate landfill material. Need to find more capping material.	Land fill material volume estimated and designated landfill site for demolition material in Panda/Koala/ Beartooth WRSA.	10	0.3	1	3	Develop Decommissioning and Salvage Plan.
18	Airstrip to remain active longer than planned	M	Government - Compliance Issues - Longer Closure period than planned.	Costs - for continued airstrip operation and maintenance.	N/A	10	1	0.3	3	Discussions with Government to ensure agreement on closure.

Table 5.1-3l. Risk Assessment - General

ID#	Risk Issue	Material or Non Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
Health & Safety										
1	Public Safety (post closure)	M	Use of roads as travel corridors, curiosity, removal of bridges and culverts, uneven ground.	Single fatality or serious injury.	Remote location, designing stable structures.	30	1	0.3	9	Communication to communities potentially using area.
Air - No Issues Identified										
Land - No Issues Identified										
Water										
2	Cumulative effects of water extraction	M	Timing with other projects - Delays.	Environmental - possible changes in hydrologic regime downstream of Lac de Gras; Cost - Extending filling time to accommodate multiple resource needs; Community Perception - That drop in water level will impact downstream communities.	Communication with stakeholders and other industry users.	10	0.3	3	9	Research into cumulative use requirements.
3	Larger volume of contaminated soils than estimated	M	Spills - incorrect reporting and/or unreported.	Environmental - downstream water quality concerns; Cost - Environmental Site Assessment and Cleanup.	Spill Management Plan in place.	10	0.3	0.3	0.9	Environmental Site Assessment.
4	Hazardous materials on backhaul Winter Road	M	Increases with additional traffic during closure.	Environmental - Potential spill, loss of containment, impacts to aquatic habitat; Reputation - Public Health & Safety - Legal.	Winter Road Management Procedures/Protocols, Approved contractors that have HSEC obligations.	30	1	1	30	Continue with Winter Road Management Plan, Ensure approved locations for future hazardous materials.

(continued)

Table 5.1-3l. Risk Assessment - General (continued)

ID#	Risk Issue	Material or Non Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
Wildlife – No Issues Identified										
Operational										
5	Factors which influence the cost of reclamation: (fuel, transportation, labour, interest rates).	M	Inflation - Price fluctuation - Labour shortage - Under-estimate of labor/materials costs – Regulation change.	Cost - Delays in reclamation and return of securities.	Cost Model - Probabilistic Model.	30	0.3	1	9	Cost Model - Probabalistic Model.
7	Difficulty to manage site water quality at closure	M	Two different water licences (Sable, Pigeon and Beartooth water discharge criteria, versus Main Water Licence discharge criteria).	Legal - Compliance Issues - Cost.	Discussions with regulators on harmonizing water licences.	10	0.3	1	3	Ongoing current controls - Renewal of Licence before closure.
8	Expiration of fisheries authorization prior to development of Pigeon and Sable	NM	BHP Billiton and Regulators unable to agree on terms of renewal.	Unable to develop Sable and Pigeon as planned.	N/A					Iniate early renewal process (2006). This will be assessed in the next ICRP update.
9	Winter road availability	M	Climate change reduces season - Increased traffic demands from other users - Permit delays.	Cost - Delay in Closure.	Strategic Transportation Study in progress.	100	0.3	1	30	Ongoing discussions by Winter Road Joint Venture.
10	Regulators unwilling to provide sign off after meeting Completion Criteria for Reclamation Objectives. Cannot Walk Away	M	Lack of precedence in returning money - Dispute between BHP Billiton and Regulators in meeting completion criteria.	No release of Security - Long Term care and maintenance, No incentive for company to progressively reclaim; Costs - Litigation.	Reputation - Ongoing Consultations, Development of Closure Criteria for the ICRP.	100	0.3	3	90	Develop completion criteria for the securities release within the closure plan - Dispute resolution.

(continued)

Table 5.1-3l. Risk Assessment - General (completed)

ID#	Risk Issue	Material or Non Material Risk	Cause(s)	Impact (s)	Current Controls	Sev	Exp	Prob	Rate	Further Actions
11	Lack of clean rock available for general site reclamation work	M	Poor planning - More rock needed than anticipated; Poor designation of clean rock vs contaminated rock in WRSAs.	Cost - Quarrying; Environmental.	Information on materials placement exists but not yet compiled.	30	0.3	0.3	2.7	Update Waste Rock Management Plan to include identification of clean rock areas.
12	Hazardous materials on backhaul	M	Unable to source destination for hazardous materials.	Cost - find alternative sites.	Current approved locations with hazardous materials.	3	0.3	1	0.9	Ensure approved locations for future hazardous materials.

Appendix 5.1-4

Reclamation Research Plan

Appendix 5.1-4. Reclamation Research Plan

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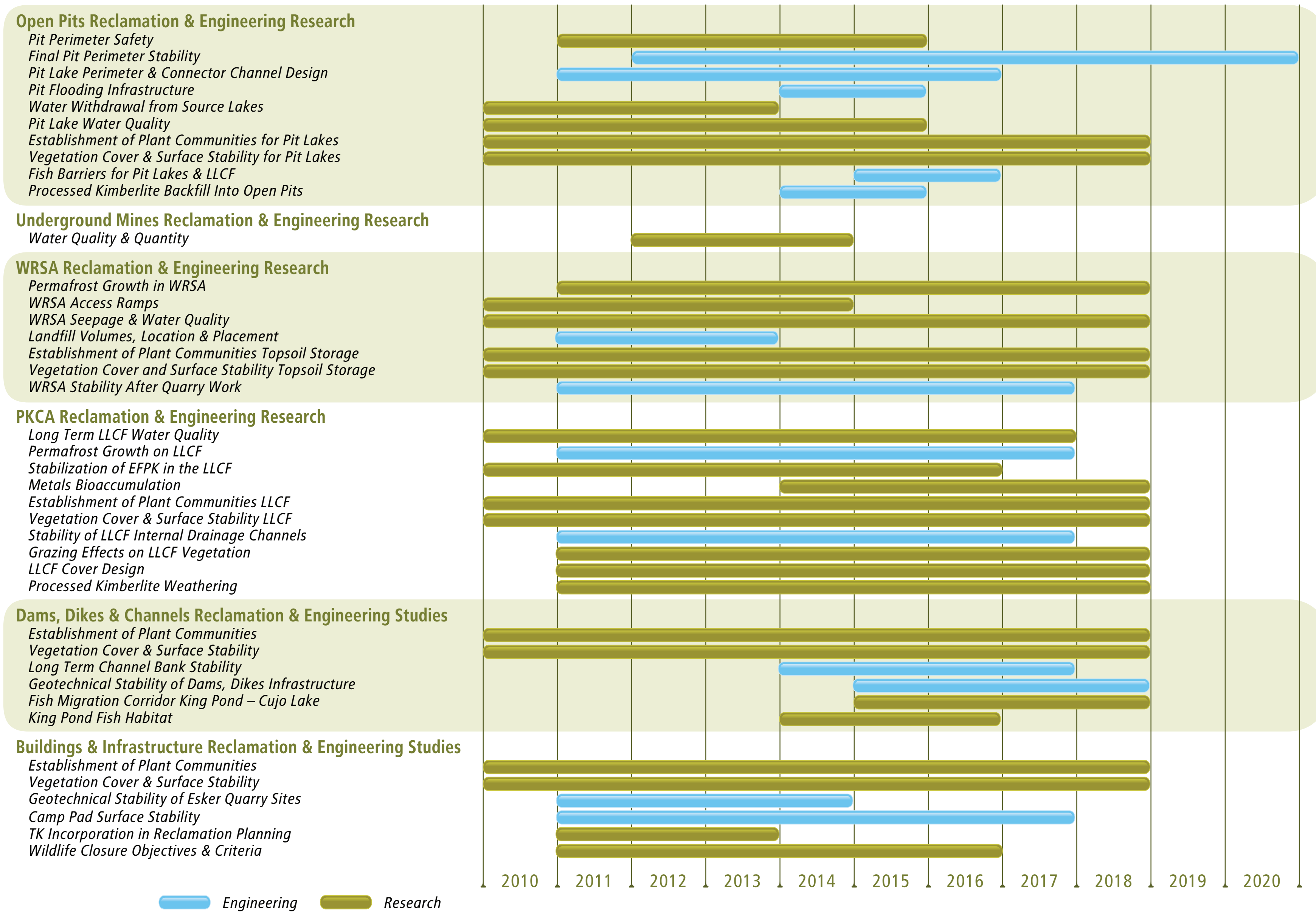

Figure 5.1-4a

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Reclamation Research and Engineering Plan Schedule

Figure 5.1-4a

Rescan Engineers & Scientists

1. Pit Perimeter Safety

1.1 UNCERTAINTY

Safety of wildlife and people near open pits during pit flooding and post closure.

1.2 RESEARCH OBJECTIVE

The research has two objectives, each determined by the timing in the pit reclamation.

The first objective of the research is to design barriers around open pits perimeters that will deter people and wildlife from accessing open pits over the period of flooding, and

The second research objective is to design a landscape around the pit lake perimeters that will be accessible but safe for people and wildlife to use after pits are flooded.

The research is linked to the timing of final ore extraction of open pits and underground mines in the 2005 LOM Plan (see Figure 1.1-1 in the ICRP). The research objectives will focus on individual pits, starting with Fox pit, which is expected to end mining operations in 2014. Lessons from the reclamation of each pit will be passed on with each successive pit as they become available.

1.3 RESEARCH PLAN

1.3.1 Tasks Completed or Initiated

See Section 1.4.0 for more detailed description of the research.

Work completed to date, but not specifically focused on the construction or monitoring of pit safety at closure is summarized below. The majority of the data and information is derived from project assessment or operational monitoring programs, and will be used to assist future tasks listed in Sections 1.3.2 and 1.3.3.

1. WEMP Reports

The annual Wildlife Effects Monitoring Program (WEMP) provides data and observations of wildlife interactions with the Misery Road.

2. Caribou and Roads Project

Caribou and Roads project has looked at the effect of Misery Road as a barrier to caribou movement, and conversely the use of deflectors to move caribou away from potentially unsafe areas of the mine.

3. Gyrfalcon Nesting Characteristics

Research has been completed by Court (1985) and Poole (1987) on gyrfalcon nesting characteristics in northern environments. Pit wall raptor survey data has been collected by Rescan as part of the WEMP (Rescan 2008).

4. Pit Stability Analysis

Pit stability analyses and design. Early reports have been developed as part of the open pit and underground operations. Further stability analysis will be required for post closure, and the operations designs will be used as a reference for the long-term analysis. The research for pit stability is covered under the Final Pit Perimeter Stability Engineering Study # 1, and will assist the creation of safe areas for pit lake use after reclamation.

1.3.2 Short-term Tasks (to be started/continued in the next three years)

See Section 1.5.1 for more detailed description of the research tasks.

1. Literature Review

Conduct a literature review to assess where wildlife barriers have previously been used at similar sites. The review should consider areas with similar topography and wildlife conditions.

2. Test and Monitor Barrier Designs

Develop a research program, possibly linked to the WEMP and the previous Caribou and Roads project, to assess wildlife interactions with existing infrastructure barriers, and if determined from the literature review the use of other types of barriers at EKATI.

1.3.3 Long-term Tasks (2014 and following)

See Section 1.5.2 for more detailed description of the research.

3. Identify Pit Perimeter Areas Requiring Barriers

Identify areas prone to pit wall failure by reviewing the long-term stability analysis and determine where barriers will be required in order to limit access to the pit lakes. Information for this task will come from the Engineering Study of the Final Pit Perimeter Stability, in Appx 5.1-5 of the ICRP.

4. Identify Safe Shoreline Access

Determine the location and type of egress points along pit lake shorelines, as well as safe locations where people and wildlife could access pit lakes post closure.

1.4 FINDINGS OF RESEARCH COMPLETED

1.4.1 Research Summary Results

1.4.1.1 Wildlife Interactions with the Misery Road

The WEMP has conducted long-term monitoring of the Misery Road with the focus on road permeability to caribou. The WEMP has noted that 'roads can act as barriers and filter animal movement and migration.' The objectives of the current WEMP study are to use caribou tracks in snow to determine:

- if the Misery Road acts as a barrier to caribou movement during the northern migration; and
- if caribou crossing frequency varied with traffic activity, roadside snow bank height, the length of time the road has been in existence (year), caribou group size, and location on road.

Results from the study indicated that caribou were deflected from crossing Misery Road in approximately 60% of the observed events between 2002 and 2008. This suggests that Misery Road, at times, is acting as a semi-permeable barrier to caribou movement. Of the four effects included in the model, only vehicle activity did not have a significant effect on the probability of caribou crossing the road. Conversely, snow bank height, group size, and year all significantly influenced the road crossing behaviour of caribou groups. Increased snow bank height adjacent to Misery Road significantly reduced the likelihood of caribou crossing the road (Rescan 2009).

1.4.1.2 Caribou and Roads TK Studies

Between 2002 and 2007 the Caribou and Roads Project, held annually with the Inuit Elders Advisory Committee from Kugluktuk, examined how infrastructure might negatively affect caribou movement as they pass through the minesite, and conversely how deflectors might keep caribou away from equipment and infrastructure (such as open pits). Deflection ideas were:

- Inokhok placed above the Pigeon Creek, at Fox Pit, and near the EKATI Airstrip.
- Beartooth Pit Snow Fence.

In general, the results from the project are unclear, because of the difficulty in observing effects of deflection when caribou are present, and to date few results have been collected. In one case snow tracks near the Beartooth fence did indicated a caribou had made its way to the fence and had turned away (Rescan 2007).

1.4.1.3 Bird Nesting on Pit Walls

BHP Billiton monitors pits to identify bird nesting activity, as a variety of bird species (including common ravens, peregrine falcons, rough-legged hawks, gyrfalcon, and golden eagle) have attempted to use pit walls in the past as nesting habitat at EKATI. In 2008 no observations of birds, nests, or potential nesting activity were reported at Koala North, Panda, and Koala pits, or the Long Lake Road power station and Fox fuel farm. Very little bird activity was observed at Misery Pit, and no nesting activity was documented. The presence of rough-legged hawk, common raven, and peregrine falcon were reported in Fox Pit, and one active peregrine falcon nest was observed with three fledglings. Both peregrine falcons and rough-legged hawks were frequently sighted at Beartooth Pit; however, only rough-legged hawks were observed nesting, with at least three fledglings (Rescan 2008).

1.4.2 Application of Lessons Learned

Although no formal research has been conducted on the use of barriers to deter wildlife access to mine infrastructure, the information gathered to date (particularly through the WEMP) indicates that barriers do affect direction of caribou movement.

1.4.3 Data and Information Gaps

The following data gaps were identified in evaluating the pit safety components for human and wildlife use:

Although operational monitoring programs will be drawn upon to assist with the study a focused research plan is needed to understand what type of barrier would effectively deter wildlife from pit perimeters, be effectively maintained over a number of years, can be removed after pit flooding to allow wildlife access and maintain surface runoff into the pit lake. BHP Billiton will seek opportunities to include specific research and monitoring of barriers in the WEMP.

1.5 REMAINING SCOPE TO BE COMPLETED

1.5.1 Detailed Work Scopes (next three years)

Table 5.1-4a provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Literature Review

Conduct a literature review to assess where wildlife barriers have previously been used at similar sites. The review will consider areas with similar topography and wildlife conditions. This information will be drawn from internal (e.g., Communities of Practice - Geotechnical and Closure), and external sources. The review will include assessment of minesites and other infrastructure where barriers have been used in Arctic environments, and beyond, with particular focus on the use of Traditional Knowledge.

Task 2. Test and Monitor Barrier Designs

This research task will have two objectives. The first will be to design a temporary barrier for the period of pit flooding, and the second objective is for a longer term barrier for unstable areas of the pit perimeter, after reclamation.

EKATI currently has a WEMP in place which monitors caribou behaviour at key infrastructure deflection points (eg Misery Road). Opportunities will be examined to expand on current monitoring studies in the WEMP, or the design of a research study focused specifically at addressing the uncertainty of barrier types, construction methods, and maintenance, and how effective the various types of barriers are in deflecting caribou movement. The Caribou and Roads Project has also been important in bringing Traditional Knowledge into wildlife protection at the minesite. Opportunities will be examined to include Traditional Knowledge in the research studies.

1.5.2 Conceptual Work Scopes (2014 and following)

Table 5.1-4a provides an outline and schedule of conceptual tasks to be undertaken in 2014 and following.

Task 3. Identify Pit Perimeter Areas Requiring Barriers

Open pits at EKATI have been designed to safely support mining operations over the term of the expected mine life. At closure the pits will be flooded. Geotechnical studies (included in the Final Pit Perimeter Stability Engineering Study # 1) will look at those areas of the pit lake perimeter that have the potential for instability. This Task will examine those sites that are expected to be unsafe for people and wildlife after the pits are flooded and design a form of barrier that will be used to prevent access over the long term. Unstable areas may be those areas of geotechnical instability, or remaining steep pit walls above the pit lake surface.

Task 4. Identify Safe Shoreline Access

After the pits are flooded the reclamation plan proposes access and egress to the pit lake shoreline. Tasks 3 and 4 will work in conjunction with each other, where Task 3 will identify those areas were access will be prevented, and Task 4 where safe access areas can be constructed. Accessible shoreline areas may include shallow zones at the lake water interface, remaining pit ramps and shallow bench areas. Residual pit wall benches that remain above the lake surface may also be used by raptors, so the research will also identify characteristics of preferred nesting sites for raptors, and the potential for raptor use of remaining pit walls post closure.

1.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on how to design a safe landscape for people and wildlife near open pits during pit flooding and post closure in the Open Pits mine component is linked to:

- Research on the final pit lake surface water elevation in relation to physical topography and morphology of the final pit perimeter, and future wildlife use of pit perimeter and shallow zones in the pit lakes.
- Research on the establishment of self-sustaining plant communities in the Open Pits mine component.
- Research on the physical stability of land surface around pit perimeters. This information is the major focus of the Final Pit Perimeter Stability Engineering Study and information will be drawn from this work with respect to deflecting caribou away from areas of the final pit lake perimeter that have the potential for instability.
- Research on Traditional Knowledge inclusion in reclamation planning for the EKATI mine components.

Research on the design of effective barriers can be developed early in the mine life even before pits have completed mining operations. Berm construction around open pits during flooding, and around areas of instability after pit flooding (if required) will commence at the end of each pit operation and prior to pit flooding. Fox pit will be the first pit in the 2005 LOM Plan to end ore extraction and this pit will be the first to need a form of deflection to prevent access during flooding. Fox pit will take approximately 13 years to flood. Pigeon pit, although it will cease operations after Fox pit, in 2017, will take one year to flood. The early learnings from barriers at Fox will be used for Pigeon. Because Pigeon pit will finish flooding earlier it will be the first pit to have a shoreline designed to allow safe access and egress. The final design of pit lake perimeter landscapes will be dependent on other studies related to final water elevations, pit perimeter stability, and vegetation studies.

1.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-4a. Pit Perimeter Safety

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short-term Research Tasks (within next 3 years)				
1	Literature Review	Literature Review	2011	2012
2	Test & Monitor Barrier Designs	Design Plan, Field Surveys, TK Incorporation	2012	2013
Long-term Tasks (2014 and following)				
3	Identify Pit Perimeter Areas Requiring Barriers (Fox)	Desktop Evaluation	2014	2014
4	Identify Safe Shoreline Areas (Fox)	Desktop Evaluation	2015	2015

1.8 COST

Total expected costs are $150,000 - $200,000.

1.9 REFERENCES

Court, S. 1985. Some Aspects of the Reproductive Biology of Tundra Peregrine Falcons. Masters thesis submitted to the Faculty of Graduate Studies, University of Alberta. December 1985.

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Rescan. 2007. EKATI Diamond Mine Caribou and Roads. Prepared for BHP Billiton Diamonds Inc. by Rescan Environmental Consultants Ltd. and the Kugluktuk Elders Advisory Committee. October 2007.

Rescan. 2008. EKATI Diamond Mine: 2007 Wildlife Effects Monitoring Program. Prepared for BHP Billiton Diamonds Inc. by Rescan Environmental Consultants Ltd. February 2008.

2. Water Withdrawal from Source Lakes

2.1 UNCERTAINTY

Effects of water withdrawal on aquatic habitat in source lakes and adjoining streams.

2.2 RESEARCH OBJECTIVE

The open pits at EKATI will be flooded from source lakes as each of the pits and connected underground mines completes mining operations. The ICRP proposes water withdrawal from Ursula Lake for the Sable open pit, Upper Exeter Lake for the Pigeon open pit, Lac de Gras (at the Paul Lake Bridge) for the Beartooth, Panda, Koala and Fox open pits, and Lac de Gras for the Misery open pit. Initial estimates for flooding volumes were completed by EBA Engineering for the ICRP (EBA 2006). The work included extraction rates and timing of water withdrawal. In 2007, Rescan provided update on the predicted effects of extraction rates on source lake elevations and outflows, as well as downstream watershed effects (Section 7.4.4 – 7.4.6 of the ICRP). The initial work also included a study of fish habitat in source lake littoral zones, and how impacts to fish habitat in source lakes could be minimized (Section 7.4.7 of the ICRP). The research on water withdrawal from source lakes will continue as BHP Billiton refines the hydrology for the source lakes, timing of the Diavik pit flooding, updates to the pit closures in the EKATI LOM Plan and any changes made to source lake locations for each of the pits to be flooded. The objective of the research is to:

- Determine the volumes, rates and threshold limits for water withdrawal from source lakes for individual pit flooding that does not negatively impact aquatic habitats in the source lakes, and downstream water bodies.

2.3 RESEARCH PLAN

2.3.1 Tasks Completed or Initiated

See Section 2.4.1 for more detailed description of the research.

1. Regional Baseline Data Collection

Regional baseline data (hydrology, meteorology, water quality and fish habitat) were collected prior to the commencement of mining operations at EKATI (e.g., BHP-Dia Met 1995; Rescan 1995a, 1995b).

2. Hydrological Evaluation of Potential Water Sources

The initial evaluation of water sources for the flooding of open pit is to use Lac de Gras for all pits, with the exception of Ursula Lake for Sable Pit and Upper Exeter Lake for Pigeon Pit.

3. Estimation of Diavik's Water Requirements at Closure

The estimated lake water use from Lac de Gras for the Diavik Diamond Mine closure was referenced from the Diavik Diamond Mines 1998 Environmental Effects Report.

4. Estimation of Required Water Flows for Pit Flooding

Open Pit Flooding Study completed in August 2006 defines the required flow rates to flood the open pits (EBA 2006).

5. Evaluation of Fish Habitat in Upper Exeter and Ursula Source Lakes

A field program was initiated in 2006 to evaluate shoreline bathymetry, fish and fish habitat in Upper Exeter and Ursula lakes.

6. Analysis of Potential Effects on Fish Habitat from Sourcing Water from Upper Exeter and Ursula Lakes

Using the assessment of fish habitat in Upper Exeter and Ursula lakes, the recommended water extraction rates from EBA (2006) numerical modeling was initiated to assess extraction rates for their potential effects on fish habitat in the two proposed source lakes.

2.3.2 Short-term Tasks (to be started/continued in the next three years)

See Section 2.5.1 for more detailed description of the research tasks.

1. Fish Habitat Evaluation

Complete the documentation of shoreline bathymetry, fish and fish habitat evaluation of Upper Exeter and Ursula lakes using data from the 2006 field survey.

2. Potential Effects on Fish Habitat

Using the assessment of fish habitat in Upper Exeter and Ursula lakes, and the recommended water extraction rates from EBA (2006) complete the documentation of the numerical modeling study to assess these extraction rates for their potential effects on fish habitat in the two proposed source lakes.

3. Lac de Gras Hydrology

Implement workplan to measure Lac de Gras outflow and establish rating curve with lake levels.

4. Potential Effects in Lac de Gras

Once the Lac de Gras outflow is estimated in relation to lake water, undertake a modeling analysis to determine the likely water level changes that would occur from extracting water from Lac de Gras for flooding EKATI pits in consideration of Diavik closure activities. Extraction rates from EBA (2006) will be used.

2.4 FINDINGS OF RESEARCH COMPLETED

2.4.1 Research Summary Results

2.4.1.1 Regional Baseline Data Collection

Baseline data (hydrology, meteorology, and water quality and fish habitat) collected prior to the commencement of mining operations at EKATI (e.g., BHP-Dia Met 1995; Rescan 1995a, 1995b) does not include specific hydrology for Upper Exeter, Ursula lakes and Lac de Gras lakes. However, the regional information is useful for water balance studies which assess precipitation and runoff. Analysis of site specific precipitation data, topographic information, and the hydrology of a number of local watersheds of varying sizes has provided the basis for the development of a site specific average annual runoff coefficient of 0.5.

2.4.1.2 Hydrological Evaluation of Potential Water Sources

Automated water level dataloggers and manual stream flow measurements were used to collect lake levels (2001 to 2003) and outlet stream flow (2001 to 2003, 2005) data at Ursula Lake to understand pumping of water from this lake for flooding Sable open pit. Lake levels (2002, 2003, 2005, 2006) and outlet stream flow (2001 to 2003) were also monitored at Upper Exeter Lake to understand pumping of water from this lake for flooding Pigeon open pit.

2.4.1.3 Estimation of Diavik's Water Requirements at Closure

Lac de Gras is the intended source lake for the Koala, Panda, Beartooth, Fox, and Misery pits, as well as the Diavik closure of A154 (North and South) and A418 open pits. The estimated lake water use from Lac de Gras for the Diavik Diamond Mine closure was referenced from the Diavik Diamond Mines 1998 Environmental Effects Report. To estimate the potential additive effects of sourcing water from Lac de Gras for flooding EKATI open pit estimates of the potential effects of water removal on the lake level in Lac de Gras is required. Site reconnaissance surveys of the outlet of Lac de Gras will be completed and a stream flow monitoring station will be set up at the Lac de Gras outflow.

2.4.1.4 Estimation of Required Water Flows for Pit Flooding

Open Pit Flooding Study completed in August 2006 defines the required flow rates and the timing for flooding the open pits at EKATI (EBA 2006). This concept level study of the logistics and order-of-magnitude cost to flood the exhausted open pits concluded:

- Modeling work focused on Upper Exeter and Ursula Lakes. Due to the very large catchment area for Lac de Gras, at the proposed pumping rate of 0.4 m^3/s, water could readily be extracted from the lake without impacting lake levels or the hydrologic regime.
- Pumping would only occur during the open water season (June 1 to October 30) in order to draw water solely from the summer recharge volume and to eliminate the requirement to heat water pipelines during winter.
- A pumping rate of 0.4 m^3/s from Upper Exeter Lake will result in a reduction in lake surface elevation of 0.03 m and in a reduction in Upper Exeter Outflow volume of 18.1%. At this pumping rate, a minimum flow of 0.45 m^3/s will be maintained in Upper Exeter Outflow from June to September. These calculations were based on average hydrological conditions and did not consider variation due to wet and dry years.
- A pumping rate of 0.2 m^3/s from Ursula Lake will reduce the lake surface elevation by 0.02 m and reduce Ursula Outflow volume by 21.5%. At this pumping rate, a minimum flow of

0.40 m^3/s will be maintained in Ursula Outflow from June to September. These calculations were also based on average hydrological conditions.

- Pumping from both lakes will cease in mid-October to avoid pumping more water than allowed by natural discharge rates.

2.4.1.5 Evaluation of Fish Habitat in Upper Exeter and Ursula Source Lakes

The evaluation of shoreline bathymetry, fish and fish habitat in Upper Exeter and Ursula lakes was completed in as a field program in 2006.

Surveys from 2001 to 2006 showed that both lakes probably support all or most of the ten fish species that have been found to date in the EKATI claim block. The scientific literature showed that each of those species has at least one life stage with high preference for shallow (i.e., <2 m depth) littoral zone habitat, that all substrate types (e.g., boulders, cobble, gravel and sand or silt) except bedrock are equally valuable as fish habitat, and that stream habitat is as important as littoral zone habitat for at least seven of the ten species.

A survey of the upper 1.2 m of the littoral zones of the two lakes in August 2006 showed that they are dominated by boulders, followed by cobble, gravel and sand in roughly equal proportions, and that there are no consistent trends in substrate type with elevation or depth.

2.4.1.6 Analysis of Potential Effects on Fish Habitat from Sourcing Water from Upper Exeter and Ursula Lakes

Using the assessment of fish habitat in Upper Exeter and Ursula lakes, the recommended water extraction rates from EBA (2006) numerical modeling was used to test the EBA (2006) assumptions (and confirm the conclusions) by conducting additional water balance modeling of the two source lakes and hydraulic modeling of the outlet streams over a range of potential pumping rates and precipitation conditions (10 year wet (468 mm), average (333 mm), and 10 year dry (231 mm)). For each simulation, precipitation conditions were held constant (e.g., the model assumed consecutive 10 year dry conditions through the model run, which is a very conservative assumption).

Mass balance modeling of the two lakes for the 1 in 10 year wet and dry conditions predicted reductions in lake surface elevation as a result of water extraction. For the recommended pumping rates (0.4 m^3/s for Upper Exeter Lake and 0.2 m^3/s for Ursula Lake), reductions in elevation for the low-flow month of October from average conditions were predicted to range from -0.008 to -0.08 m in Upper Exeter Lake and from 0.02 to -0.12 m in Ursula Lake. These losses are small relative to the 1.2 m depth range of littoral zone habitat measured in August 2006 and to the seasonal ranges for both lakes (0.35 m for Upper Exeter Lake and 0.40 m for Ursula Lake). Since littoral zone habitat is homogeneous over this depth range there will be no loss of any specific fish habitat types.

Modeling also showed that for the recommended pumping rates, decreases in stream flow will range from 35 to 60% for Upper Exeter Outlet and from 20 to 50% for Ursula Outlet (for the 1 in 10 dry and wet years, respectively). HEC-RAS hydraulic modeling of Upper Exeter Outflow and Ursula Outflow predicted that despite these reductions, the reductions in wetted perimeter, water depth, wetted width and wetted depth during the October low-flow period was relatively minor over pumping rates of 0.1 to 0.5 m^3/s for an average precipitation year. The wide, shallow morphometry of these streams means that large reductions in flow will result in small changes in stream dimensions. Even under 1-in-10 year dry conditions, for the proposed pumping rates, the predicted minimum water depths should continually allow open passage for fish through both streams.

Watersheds downstream of the source lakes will also be affected by water extraction. The maximum proposed pump rate for Upper Exeter Lake is predicted to reduce October flow from Upper Exeter Outflow by up to 44% during an average precipitation year. This corresponds to a 13% reduction in Lower Exeter Outflow. The pumping rate proposed for Ursula Lake will result in a reduction of Unnamed Outflow by 13% and of Duchess Inflow by 11%.

These results indicate that the recommended pumping rates will not significantly reduce fish habitat in Upper Exeter and Ursula lakes or in their outflow streams or in downstream watersheds.

After pumping ceases, the lakes will require time to rebound to their natural elevation. Rebound time was defined as the time in the model from the end of pumping until lake surface elevation returned to within 1 mm of the pre-pumping value. Under average precipitation conditions, Upper Exeter Lake is predicted to rebound within 50 days after the end of pumping. Depending on the exact time in the open water season that pumping ceases, rebound may not occur before the end of the open water season, in which case rebound time is extended for approximately 200 days, and is completed the following spring. Rebound time for Ursula Lake was estimated to be 380 days, which includes one winter season. Depending on when pumping ceases, rebound may not be complete before the start of the second winter season, in which case rebound would be extended to approximately 580 days.

2.4.2 Application of Lessons Learned

The results of on-going and completed studies have contributed to the understanding of the interaction between hydrologic conditions and near shore fish habitat in relatively large lakes in the EAKTI area.

The method used to evaluate fish habitat in Upper Exeter and Ursula source lakes provided useful information that could be used in combination with numerical modeling of lake levels and stream wetted perimeter to evaluate potential effects to fish habitat. The incorporation of dry period scenarios into the modeling provided for estimate of potential effects during extreme conditions where fish and fish habitat would be at greatest risk from water extraction. This approach can be used for Lac de Gras if required.

2.4.3 Data and Information Gaps

The following data gaps were identified in evaluating water withdrawal from source lakes:

- Effect of water withdrawal on lake level in Lac de Gras.
- Additional information on seasonal source lake fluctuations (e.g., dry seasons).
- Thresholds, volumes, rates and durations that will adequately protect the lake fish habitat from adverse impacts.
- Refined lake and stream bathymetry and channel profiles (i.e., shallow sections in exit streams).
- Identification of regulatory process (licenses and permits).

2.5 REMAINING SCOPE TO BE COMPLETED

2.5.1 Detailed Work Scopes (next three years)

Table 5.1-4b provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Fish Habitat Evaluation

Complete the documentation of shoreline bathymetry, fish and fish habitat evaluation of Upper Exeter and Ursula lakes using data from the 2006 field survey.

Task 2. Potential Effects on Fish Habitat

Complete the documentation of the numerical modeling study to assess these extraction rates for their potential effects on fish habitat in these two proposed source lakes.

Task 3. Lac de Gras Hydrology

Implement workplan to measure flows at Lac de Gras outlet and establish rating curve, if practical. Implementation would take place in spring of 2010, and flow monitoring would continue at this location for a period of two to three during open water seasons, at which point the requirement for further monitoring will be reviewed.

For large streams it is often not possible to wade across the channel during peak flow conditions. In such cases, alternative measurement methods are required, such as Acoustic Doppler Current Profiling (ADCP). The ADCP method is likely most appropriate for the Lac de Gras Outflow where there is a wide and relatively fast outflow channel. An ADCP uses acoustic-doppler technology to measure both water depths and stream velocities as the instrument moves across the channel. ADCP measurements will be made approximately every two to three weeks starting once freshet conditions allow.

Task 4. Potential Effects in Lac de Gras

Once the Lac de Gras outflow is estimated in relation to lake water lakes undertake a modeling analysis to determine the likely water level changes that would occur from extracting water from Lac de Gras for flooding EKATI pits in consideration of Diavik closure activities. Extraction rates from EBA (2006) will be used as extraction rates.

Mass balance modeling of Lac de Gras will be undertaken for the 1 in 10 year wet and dry conditions to predict reductions in lake surface elevation as a result of planned water extraction in EBA (2006).

HEC-RAS hydraulic modeling of Lac de Gras outflow will be used to predict the effect of lake level reductions on the outflow wetted perimeter, water depth, wetted width and wetted depth during the October low-flow period for average and dry conditions.

2.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on the effects of water withdrawal on aquatic habitat in source lakes and adjoining streams is linked to:

- Research on the infrastructure requirements to pipe water from source lakes to flood open pits.

Research on water withdrawal from source lakes in the Open Pits mine component began in 2007 with the Open Pit Flooding Evaluation Report completed by EBA. Refinement of the research will continue through to 2015, prior to the pumping water to flood Fox pit in 2015.

2.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-4b. Water Withdrawal from Source Lakes for Open Pits

Research Task #	Task	Project Tracking (Reporting, Modeling, Field Work, Engineering Designs)	Research Start	Research Finish
Short-term Research Tasks (within next 3 years)				
1	Fish Habitat Evaluation	Report	2006	2010
2	Potential Effects on Fish Habitat	Report	2006	2012
3	Lac de Gras Hydrology	Report	2010	2012
4	Potential Effects in Lac de Gras	Report	2013	2013

2.8 COST

Total expected costs are $200,000 - $300,000.

2.9 REFERENCES

Diavik Diamond Mines Inc. (DDMI). 1998. Environmental Effects Report, Fish and Water.

EBA. 2006. EKATI Diamond Mine: Open Pit Flooding Study. Prepared for BHP Billiton Diamonds Inc. by EBA Engineering Consultants Ltd. August 2006.

Rescan 1995a. Meteorology, Hydrology and Water Quality 1995 Baseline Study Update. Prepared for by BHP Minerals Canada by Rescan Environmental Services Ltd. December 1995.

Rescan, 1995b. Fisheries and Aquatic Life: 1995 Baseline Study Update. Prepared for BHP Minerals Canada by Rescan Environmental Services Ltd.

3. Pit Lake Water Quality

3.1 UNCERTAINTY

Water quality of the flooded open pits in the EKATI Mine Plan, at mine closure.

3.2 RESEARCH OBJECTIVE

The ICRP proposes flooding of all open pits at EKATI at mine closure. Pit lake water quality will be governed by initial loadings during the pit flooding and by loadings that will continue over the long term. Loads that will be introduced during pit filling include source lake water and initial flushing of pit benches and walls. Loads that will continue over the long term, past the end of the mine life will include surface inflows, surface runoff over exposed pit walls and, possibly, connate groundwater. In addition, processes that could impact pit lake water quality would be the suspension of fine materials and salt exclusion from ice. The source lakes will make up the bulk of the pit lake volume, thereby offering a high capacity for dilution of water from other sources. Whereas after closure, watershed run-off will likely be the source of greatest volume of water recharging pit lakes. The research on pit lake water quality will assist in the development of applicable water quality criteria for pit lakes that ensures no negative effects on the down stream watershed.

The objective of the research is, through the use of modeling, predict pit lake water quality during and after flooding and identify the key drivers for water quality.

3.3 RESEARCH PLAN

3.3.1 Tasks Completed or Initiated

See Section 3.4.1 for more detailed description of the research.

1. Review of the State of Knowledge of Pit Lakes

There is a large amount of existing knowledge and literature relating to the creation of pit lakes from open pit mines. Drawing on this knowledge base can improve the design and implementation of the pit lakes closure concept for EKATI. This task brings together the available relevant literature on mining pit lakes to improve the understanding of the state of knowledge of pit lakes research before undertaking further EKATI pit lakes research tasks. The EKATI *Pit Lake Studies Task 1: Review of the State of Knowledge of Pit Lakes* (Rescan 2005a) reviewed existing literature relating to reclaiming mined open pits to pit lakes.

2. Review of Data Requirements, Available Data and Data Gaps

The EKATI *Pit Lakes Studies Task 2: Review Data Requirements, Available Data and Data Gaps* (Rescan 2005b) identified information required to establish the physical and environmental conditions of mined pits to be converted into pit lakes. For this task, a matrix of data requirements was prepared for each of the relevant project tasks. After a review of the existing dataset data gaps were identified before engaging in further tasks. Implicit in the gap analysis of each dataset, was the review of data from water bodies both upstream and downstream of the proposed pit lakes, as well as from the source water bodies proposed to flood the pits.

3. Development of Rock Leaching Source Terms as Model Input

A large amount of data exist that characterize the type and leaching characteristics of waste rock at EKATI, and any seepage from the rock (e.g., SRK 2008). These data are being used to develop leaching estimates from rock walls as the pits are flooded, and any seepage into the pits.

4. Site Meteorological Data as Model Input

Extensive meteorological data exists for the EKATI site and these are reported annually in the AEMP reports (e.g., Rescan 2008b). These data are being assembled for input into numerical models.

5. Site Hydrological Data as Model Input

Extensive hydrological data exist for the EKATI site and these are reported annually in the AEMP (e.g., Rescan 2008b) and in numerous baseline studies (e.g., see BHP-Dia Met 1995). Up to date data are being reviewed and analyzed to provide current estimates of runoff within the relevant pit catchments.

6. Salt Exclusion from Lake Ice as Model Input

Physical limnology of lakes at EKATI is monitored as part of the AEMP (e.g., Rescan 2008b) and ice thickness has been monitored for a number of lakes (unpublished data). The ice thickness of the LLCF is also being monitored and sampled for water quality to determine the extent of salt exclusion that occurs in the LLCF ice. A salt exclusion of 80% has been adopted for LLCF modeling studies (Rescan 2008a) which can be used for pit lake water quality modeling.

7. Estimation of Water Quality of Source Lake as Model Input

Water quality for the proposed source lakes has been sampled. All pits will be flooded with water from Lac de Gras, with the exception of Sable Pit (Ursula Lake) and Pigeon Pit (Upper Exeter). Water quality estimates from Diavik can be used for Lac de Gras. Ursula Lake data are published in Rescan (2007c), and Upper Exeter data are published in Rescan (2003, 2006b, 2007b).

8. 3D Configuration/Morphology of Open Pits at Closure

The physical configuration/morphology of the open pits at closure is being defined in three dimensions using operational data and long-range mining designs.

9. EKATI Examples of Flooded Pits as Test Cases (Misery Pit)

The Misery Pit currently contains water originating from direct precipitation and from pit wall run-in. The following water volumes were estimated from pit hypsometry (level-volume relationship) and available water elevation measurements:

June 26, 2005	31,463 m^3
July 10, 2005	31,463 m^3
September 15, 2005	58,946 m^3
August 23, 2007	170,408 m^3
September 5, 2007	88,309 m^3
September 16, 2007	82,657 m^3
November 5, 2007	86,797 m^3
August 17, 2010	405,946 m^3

Only Misery Pit has water quality data available for the period of shutdown when water was present in the pit. These data are being used to evaluate geochemical leaching estimates.

10. Underground Water Quality as Model Input

Underground water flow and quality data are measured by the mine. Data current to 2005 are published in Rescan (2006a) and on-going monitoring in the underground provides updates to the data set.

11. Select Numerical Model and Initial Modeling Steps

A number of options exist for modeling the initial condition of the open pits once flooding is completed. There are also options for modeling the long-term stability of the pit lake water columns. These options are being reviewed in the context of the available data to provide a modeling method that is realistic and that allows sensitivity to key parameters to be undertaken.

3.3.2 Short-term Tasks (to be started/continued in the next three years)

See Section 3.5.1 for more detailed description of the research tasks.

1. Waste Characterization

This task will focus on characterizing wastes related to pit filling. The primary focus of the waste characterization will be on waste rock surrounding the pit lakes and potential leaching from pit walls during flooding. In 2009 Beartooth Pit started being used as a retention pond for underground water and surface mine water from the AN (Ammonium Nitrate) storage facility sumps (BHP Billiton 2010). These waters are enriched in nitrate and chloride. The quality of water placed in the pit will be considered in the model in terms of its effect on the long term pit lake water quality.

2. Water Balance at Closure

Once the pits have been flooded, the plan is to connect the pit lakes hydraulically with streams and lakes in their natural watersheds which would allow water levels within the pit lakes to be controlled by the local drainage basin water balance. This task will involve the development of predictive tools to assess the water budgets for each of the new pit lakes under a range of scenarios covering the short, medium and long-term life of the pit lakes.

3. Pit Lake Stability Modeling

The task will model the physical stability of the proposed pit lakes to determine the likelihood, or otherwise, of permanent meromixis. A semi-analytic model (Lawrence and Pieters 2003a, 2003b) will be used to identify the crucial factors that may affect meromixis of the proposed pit lakes.

4. Water Load Balance Modeling

This task will involve the development of a water quality model that will be linked to the water balance model. The load balance model will combine water quality inputs with the water balance model to provide a mass-balance model for predicting the water quality conditions of each pit once flooded. The load balance model will include a number of sensitivity analyses to estimate the key drivers of the future water quality of the EKATI pit lakes.

5. Pit Lakes Study Summary

Complete a summary report of all pit lake studies that documents the pit lake water quality predictions.

3.3.3 Long-term Tasks (2014 and following)

6. Review of Model Inputs and Updated Model Runs

On-going monitoring data from the EKATI operation provides the opportunity to update the pit lake numerical models in the future. There is no defined timeline for updating these models, however, it is anticipated that models will be updated prior to pit flooding.

3.4 FINDINGS OF RESEARCH COMPLETED

3.4.1 Research Summary Results

3.4.1.1 Review of the State of Knowledge of Pit Lakes

The EKATI *Pit Lake Studies Task 1: Review of the State of Knowledge of Pit Lakes* (Rescan 2005a) reviewed existing literature relating to reclaiming mined open pits to pit lakes. The literature survey focused on identifying physical, chemical, and biological aspects of pit lakes. Literature on physical aspects included numerical modeling. Literature on natural stratified lakes was also acquired to provide long-term information on the stability of stratification. Literature on the chemistry of pit lake water, wall rock, and waste material provided many examples of the geochemical complexity of pit lakes and models that have been used for predicting pit lake water quality. Over 100 reports and journal papers were reviewed.

3.4.1.2 Review of Data Requirements, Available Data and Data Gaps

The EKATI *Pit Lakes Studies Task 2: Review Data Requirements, Available Data and Data Gaps* (Rescan 2005b) identified information required to establish the physical and environmental conditions of mined pits to be converted into pit lakes. The purpose of the gap analyses was to review appropriate information requirements for future studies and modeling tasks, the quality and quantity of data already collected, and recommend future data needs. Data gaps were identified through meetings with key personnel. Through these meetings specific gaps in datasets were identified for meteorology, hydrology, surface water quality, hydrogeology, acid rock drainage, aquatic biology and ultimate pit geometry. The data gap analysis of each dataset included the review of data from water bodies both upstream and downstream of the proposed pit lakes, as well as from the source water bodies that have been proposed for pit flooding.

Data gaps were identified for hydrology, surface water quality and aquatic biology. Other data, such as pit geometry and pit groundwater conditions, are available but require further processing to extract information. Ongoing monitoring of meteorology, hydrology, water quality, aquatic and waste rock characterization is providing additional data for the pit lake studies.

3.4.1.3 Water Quality and Stability Modeling

Preliminary research on water quality of pit lakes and pit lakes stability modeling was completed for the ICRP. This information is summarized in Sections 7.4.2 and 7.4.3 of the ICRP.

3.4.2 Application of Lessons Learned

The pit lake literature suggests that these water bodies can be complex to model, particularly when predictions are required with respect to future pit lakes (i.e., that do not yet exist). Numerical modeling of lake stability and lake water quality has been done at several existing pit lakes; however, considerable input data are required for these complex models. In the case of the EKATI pit lakes certain input data are extensive (e.g., meteorology and hydrology), but there can be no data of actual flooded pit lakes until such time as flooding is completed (e.g., wind sheltering, detailed water column information).

A modeling program initiated for the future EKATI pit lakes attempts to predict the water balance and water quality of each of the post closure pit lakes. Predictions are being made for the infilling phase and post-infilling phase when surface water from the lakes spill and enter the downstream receiving environment. In addition, the modeling attempts to predict the likelihood of meromixis (physical and chemical stratification) within each of the pit lakes. Meromixis can often occur in pit lakes due to their morphology (narrow and deep) and the presence of sources of saline or higher density water (e.g., groundwater, pit wall runoff). Pit lakes which experience meromixis do not undergo full mixing between upper and lower layers of the water column and as a result denser, poorer quality water can be retained at depth within the lakes. Meromixis may or may not be desirable for any specific pit lake. However, an assessment of the potential for meromixis is important to understand and predict the evolution of pit lake water quality over the long term.

Two different modeling approaches are being considered. For the pit infilling process where the kinetic energy generated by the water cascading down pit walls is expected to limit the formation of stratification, a mass balance box modeling approach is being used. In order to predict the potential for meromixis and to estimate the quality of the upper layers of the pit lake post-infilling, a multi-layer compartment model is being used that includes a representation of ice-cover formation, salt exclusion from ice, mixing at ice-off, summer surface-layer deepening and fall mixing. With the available information more complex modeling approaches are not warranted. The initial results of the modeling assessment suggest that water in most of the pit lakes will be of good quality and likely acceptable to discharge soon after infilling. This is a result of the dominance of pumped inflow water in the water balance of each pit lake. The pumped clean inflows to the pit lakes are important controls on the final pit lake water quality. With respect to pit lake water quality, the initial modeling suggests that where possible higher pumping rates should be considered to fill the lakes as quickly as possible to limit the exposure of pit walls post-closure and limit groundwater inflows through increased hydraulic head within each pit lake.

Initial stability modeling results suggests that there is a potential for meromixis to occur in the EKATI pit lakes that receive groundwater inflows during filling (Fox, Panda, Koala and Koala North). In addition, these pit lakes (with the exception of Koala North) have the potential for relatively higher concentrations of parameters such as chloride sourced from groundwater. There is a high degree of uncertainty associated with groundwater inflow rates during operations and post-closure. Additional groundwater monitoring has been initiated by EKATI to address this data gap and modeling would be required to improve predictions of the groundwater contribution to the pit lakes.

Pit wall runoff (post-infilling) is identified as a key control on the long-term water quality in the upper layers of the pit lakes. If the area of pit wall exposed once the pit lakes have been filled is large relative to the natural watershed flowing to the pit lake and if the pit wall runoff quality is poor, there is the potential for an effect on the water quality in the upper layers of the pit lakes.

3.4.3 Data and Information Gaps

No data and information gaps have been identified at this time.

3.5 REMAINING SCOPE TO BE COMPLETED

3.5.1 Detailed Work Scopes (next three years)

Table 5.1-4c provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Waste Characterization

This task will focus on characterizing wastes related to pit filling. The primary focus of the waste characterization will be on waste rock surrounding the pit lakes and potential leaching from pit walls during flooding. Focus will also be on geochemical rock-water interactions and reaction rates under various conditions. Specific aspects of this task include:

a) Determine pit wall runoff contributions, and characterize waste related to potential impacts to future pit lake water quality.

b) Determine rock type and area by elevation for each pit at closure.

Task 2. Water Balance at Closure

Once the pits have been flooded, the plan is to connect the pit lakes hydraulically with streams and lakes in their natural watersheds which would allow water levels within the pit lakes to be controlled by the local drainage basin water balance. This task will involve the development of predictive tools to assess the water budgets for each of the new pit lakes under a range of scenarios covering the short, medium and long-term life of the pit lakes.

Task 3. Pit Lake Stability Modeling

Mined pit lakes differ from most natural lakes because they are deep and have relatively small surface area. As with natural lakes in the area, the proposed future pit lakes at EKATI would also be ice-covered during winter. These and other characteristics may result in water bodies that are meromictic, i.e., they do not mix throughout their depth. The task will model the physical stability of the proposed pit lakes to determine the likelihood, or otherwise, of permanent meromixis. A semi-analytic model (Lawrence and Pieters 2003a and 2003b) will be used to identify the crucial factors that may affect meromixis of the proposed pit lakes. The semi-analytic model estimates the salinity stability of the pit lake at maximum heat content using a surface layer box model for the warming period in summer. Note that salinity inputs to the pit lakes could be from various sources, including groundwater inputs. The model also estimates the potential for destratification as a result of wind, penetrative convection and inflow. The model output can be used to estimate whether meromixis will occur. The modeling work will also identify which data are critical, be it pit salinity, ice thickness, wind, and/or inflows, to the predictive modeling of stability of the pit lakes.

Task 4. Water Load Balance Modeling

The water quality of the proposed pits will be somewhat site-specific, and will be influenced to a large degree by input water quality. The source lake water used to flood a pit will represent the largest volume of new water to the pit. Natural runoff and direct precipitation will affect the immediate drainage area of the pit lakes. Runoff from waste rock piles within the watershed of the pit lakes may also influence the water quality of the lakes. During pit flooding water quality could be affected by leaching of the exposed pit walls.

This task will involve the development of a water quality model that will be linked to the water balance model. Linking the load balance to the water balance will allow the simultaneous consideration of:

- source lake water flow and quality;
- natural runoff and precipitation inputs;
- runoff quantities and qualities from waste rock piles;
- leaching rates and qualities from pit walls;
- loading from residual pit material;
- leaching from pit fill material, such as waste rock and kimberlite tailings;
- groundwater quantity and quality.

The load balance model will combine water quality inputs with the water balance model to provide a mass-balance model for predicting the water quality conditions of each pit once flooded. The load balance model will include a number of sensitivity analyses to estimate the key drivers of the future water quality of the EKATI pit lakes.

Task 5. Pit Lakes Study Summary

Tasks 1 to 4 will be compiled into a single document that reports on the modeling approach, model inputs, and model outcome and model sensitivity. Based on the modeling results recommendations will be made on further data requirements to improve future predictions, key areas of uncertainty in the calculations, and possible pit lake management options.

3.5.2 Conceptual Work Scopes (2014 and following)

Table 5.1-4c provides an outline and schedule of conceptual tasks to be undertaken in 2014 and following.

Task 6. Review of Model Inputs and Updated Model Runs

On-going monitoring data from the EKATI operation provides the opportunity to update the pit lake numerical models in the future. There is no defined timeline for updating these models, however, it is anticipated that models will be updated prior to pit flooding.

3.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on pit lake water quality is linked to:

- Research on the quality and quantity of ground water associated with loads of chloride that will contribute to pit lake water quality.

Pit lake water quality studies have already been initiated, and will be completed by end of 2010. Further refinement of models and loadings will be required as more information comes available during mining operations.

3.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-4c. Pit Lake Water Quality

Research Task #	Task	Project Tracking (Reporting, Modeling, Field Work, Engineering Designs)	Research Start	Research Finish
Short-term Research Tasks (within next 3 years)				
1	Waste Characterization	Documented in Task 5	2008	2010
2	Water Balance at Closure	Documented in Task 5	2008	2011
3	Pit Lake Stability Modeling	Documented in Task 5	2008	2011
4	Water Load Balance Modeling	Documented in Task 5	2008	2011
5	Pit lakes study summary	Summary report detailing Tasks through 4	2010	2012
Long-term Tasks (2014 and following)				
6	Review of Model Inputs and Updated Model Runs	Model update report	TBD	TBD

3.8 COST

Total expected costs are $350,000 - $400,000.

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4. Establishment of Plant Communities for Pit Lakes

4.1 UNCERTAINTY

The development of plant communities on pit lake edges that are compatible with the surrounding tundra environment, and facilitate sustainability of pit littoral zones.

4.2 RESEARCH OBJECTIVE

Reclamation strategies for open pits at EKATI include the construction of littoral zones at pit water edges, and stabilization of pit perimeters to reduce the potential for erosion.

The study of vegetation growth on open pit perimeters is divided into two research plans. This research plan focuses on finding the plant species and identification of substrate materials that will affect plant community composition. The second research plan (Vegetation Cover and Surface Stability for Pit Lakes) focuses on the expected percentage of cover that will maintain surface stability.

The research objective is to determine what plant community type(s) can be established on pit lake edges to provide surface stabilization.

4.3 RESEARCH PLAN

Research on the development of plant communities within the Open Pits mine component has not yet begun as suitable sites are not yet available. The target areas identified for revegetation are pit lake edges. Research conducted at the Panda Diversion Channel (PDC) and at Fred's Channel is directly applicable to site conditions anticipated at near shore areas of pit lakes and is reviewed here.

This research will be used to develop methods for establishing plant communities with native vegetation, both planted and naturally colonizing, to enhance surface stability at pit lake edges.

4.3.1 Tasks Completed or Initiated

1. Tundra Plant Species

Survey of tundra plant species with potential for revegetation of pit lake edges. BHP Billiton has committed to using native regional plants for revegetation work at EKATI. Native plant research for Open Pits includes identifying plants that would grow and sustain on pit lake edges and finding sufficient quantities of native plants that could be propagated to reclaim the pit lake edges. The survey of established and disturbed tundra plant communities within the EKATI mine area and the surrounding region has identified tundra species with potential for revegetating selected areas of Open Pits. Potential species will be assessed, additional species may require testing.

2. Seed Collection, Storage and Propagation

A Standard Operating Procedure (SOP) has been developed that identifies seed sources and provides guidelines for collecting and processing seeds for use in revegetation. The SOP will be expanded as needed, to include updated species lists and related information.

3. Natural Colonization and Successional Trends

Natural colonization of the PDC and Fred's Channel has been documented in the course of revegetation research. Continued monitoring is required. Literature will also be reviewed to determine how natural colonization of pit lake edges and similar sites can be encouraged.

4. Weeds Monitoring

The presence of weeds at EKATI and at abandoned mines in the NWT has been assessed in the course of monitoring revegetation and rehabilitation. This practice will continue on pit lake edges.

4.3.2 Short-term Tasks (to be started/continued in the next three years)

See Section 4.5.1 for more detailed description of the research.

1. Tundra Plant Species

This research will build on previous work.

2. Seed Collection, Storage and Propagation

This research will build on previous work.

3. Natural Colonization and Successional Trends

This research will build on previous work at the PDC and Fred's Channel.

4. Weeds Monitoring

This research will build on previous work.

4.3.3 Long-term Tasks (2014 and following)

1. Revegetation Locations

Determine pit lake edge locations where vegetation establishment will be needed.

4.4 FINDINGS OF RESEARCH COMPLETED

4.4.1 Tundra Plant Species

4.4.1.1 Research Summary Results

Ecological mapping and vegetation inventories for EKATI were completed early in project development (BHP Billiton 1995), followed by an inventory of soils and vegetation for the Misery Esker (Kidd 1999). A traditional knowledge perspective on biodiversity in the mine area was provided by the Dogrib Treaty 11 (Dogrib 2000).

Ongoing revegetation studies at EKATI have identified potentially useful native species (Kidd 1996; Kidd and Rossow 1997, 1998; Kidd and Max 2000a; Martens 2005).

In 1999, seed of several legume species was sown in a field plot at EKATI, with the intention of establishing a collection area. Species included were *Hedysarum mackenzii* (liquorice root), *Oxytropis deflexa* (deflexed oxytrope) and *Astragalus eucosmus* (elegant milkvetch) (Kidd and Max 2000a). Seed of several graminoid species was collected from wetland stands for testing of viability and germination (Kidd and Max 2000a). Species tested were *Eriophorum angustifolium* (tall cottongrass), *Carex aquatilis* (water sedge), *Arctagrostis latifolia* (polargrass), *Calamagrostis purpurascens* (bluejoint) and *Arctophila fulva* (pendant grass).

- After two years, fewer than 10 seedlings had established in the collection plot, although the same species have germinated elsewhere at EKATI.
- Percentage of viable seed ranged from 5% for *A. fulva* to 41% for *E. angustifolium*, but no seeds of any species germinated in the tests. The low viability and lack of germination may have been caused partly by collecting too early in the season, before seed was mature.
- Excellent first-year legume seedling establishment was recorded in Rock Pad Reclamation Study, apparently contributed to scarfication of the seed prior to seeding. Species included were *Hedysarum mackenzii* (liquorice root), *Oxytropis deflexa* (deflexed oxytrope) and Maydell's Oxytrope (*Oxytropis Maydelliannia)* (Martens 2010).
- Native plant species (other than native-grass cultivars) potentially useful for revegetation of various site types, including pit lake edges, include *Epilobium angustifolium*, *E. latifolium*, and the legumes *Astragalus alpinus* (alpine milkvetch), *Hedysarum mackenzii*, *Oxytropis deflexa*,

and *O. maydelliana* (Maydell's oxytrope). Species adapted to riparian habitats include *Salix* spp. (willows) and *Arctophila fulva*.

- Survival of transplanted willows and Arctophila sprigs was moderately good at most locations within the PDC and Fred's Channel, except where high stream velocities or rapid changes in hydrology occurred (Kidd and Max 2000b, 2001).
- The legume Hedysarum mackenzii established well at the PDC, and some seedlings flowered in 2001 (Kidd and Max 2001). By 2006, healthy stands of *Oxytropis deflexa* had also established at several locations and the Hedysarum stand was used for seed collection (Martens 2007).

4.4.1.2 Application of Lessons Learned

- A number of promising tundra species and native-grass cultivars have been identified for revegetation of pit lake edges.

4.4.1.3 Data and Information Gaps

- The need for additional species adapted to growth along pit lake edges.
- Cultivation methods and practices to enhance establishment of tundra species by means of direct seeding, use of containerized stock or planting into an existing grass cover.

4.4.1.4 Recommendations for Future Work

- Research cultivation methods and practices that promote the establishment of tundra species by means of containerized stock or direct seeding.
- Review the list of promising species to determine whether additional species need to be added for successful revegetation of pit lake edges, and similar sites.

4.4.2 Seed Collection, Storage and Propagation

4.4.2.1 Research Results

A SOP has been developed to identify seed sources and provide guidelines for collecting and processing seeds for use in reclamation (BHP Billiton 2004; Martens 2003, 2005).

The SOP provides information on locations, collection techniques and recommended harvesting dates for seed of several shrub, forb and graminoid species that have been found to be useful for reclamation at EKATI. Species listed include:

- *Arctostaphylos rubra*, *A. alpina* (bearberry)
- *Betula glandulosa* (dwarf birch),
- *Carex aquatilis* (water sedge)
- *Dryas integr*ifolia (white dryad)
- *Empetrum nigrum* (crowberry)
- *Epilobium angustifolium*, *E. latifolium* (fireweed)
- *Eriophorum vaginatum* (cotton grass)
- *Hedysarum mackenzii* (Liquorice root)

- *Oxytropis deflexa* (reflexed locoweed), *O. maydelliana* (Maydell's oxytrope), **O. hudsonica* (Hudsons locoweed)
- *Vaccinium uliginosum* (bilberry)

Seed of tundra plants was collected between 2000 and 2004, for the LLCF reclamation research, cleaned and stored in a deep freeze at the EKATI Minesite. Germination tests conducted in 2008 indicated that the viability of all three *Oxytropis* spp. remained high (in excess of 90%, with scarification) after 4 to 8 years of storage. Viability of dwarf birch and fireweed seed, collected in 2004, remained at 55% and 69%, respectively.

4.4.2.2 Application of Lessons Learned

- A number of promising plant species for use in revegetation of pit lake edges have been identified through previous studies.
- Storage conditions optimum for legume seed may not be optimum for seeds with a thin seed coat, such as those from dwarf birch and fireweed.
- A commercial nursery was retained to develop methods and procedures for the large-scale production of containerized seedling stock.

4.4.2.3 Data and Information Gaps

- Review the existing information sources, including the SOP, to determine whether sources of seeds and/or live plant materials have been identified for all desired species. If needed, research additional collection sites.
- Species that can be readily established by direct seeding and species that are best established with containerized stock.
- Optimum time when seed should be collected
- Collection methods:
  - by hand or machine assisted.
  - specialized methods for certain species.
- Estimated volumes of seed required by species
- Storage conditions for each species to retain seed viability.
- Out-planting regime to minimize mortality.

4.4.2.4 Recommendations for Future Work

- Build on and expand the existing Seed Collection SOP to include potentially useful species for pit lake edges and address missing information.
- Work closely with Coast to Coast Nursery in the development of methods and practices that will minimize out-planting mortality, including practices such as forced senescence and planting dormant stock.

4.4.3 Natural Colonization and Successional Trends

4.4.3.1 Research Results

- At Fred's Channel, natural colonizers present in 2006 in fluvial gravel deposits included the grass *Calamagrostis canadensis* (bluejoint), the sedges *Eriophorum angustifolium* (tall cottongrass), *E. vaginatum* (tussock cottongrass) and *Carex bigelowii* (Bigelow's sedge), and *Salix planifolia* (diamondleaf willow). Natural colonizers present in 2008 in fine-textured alluvial deposits, in the lower reaches of the channel included *C. canadensis*, *Eriophorum* spp., *Carex aquatilis, Equisetum* spp., *Empetrum nigrum* (crowberry), and *S. planifolia* (Martens 2007, 2009).

- At the PDC, in 2006, stands of the legumes *Hedysarum mackenzii*, *Oxytropis deflexa* and *Astragalus alpinus* were established at several locations. In total, at least 41 vascular and 6 nonvascular species were present, including *C. canadensis*, *Betula glandulosa* (dwarf birch), *Salix* spp., *Equisetum* spp. (horsetail), *Epilobium angustifolium*, *Eriophorum* spp. and *Carex* spp. It appeared that areas with abundant fine-grained sediment were relatively favorable for natural colonization, as well as for the establishment of seeded species (Martens 2007).
- In 2006, the seeded native-grass cultivars were well established at the PDC, and were colonizing adjacent areas of fine-grained sediment (Martens 2007).
- Shrubs, [*Betula glandulosa* (dwarf birch) and *Vaccinium uliginosum* (bilberry)] and herbaceous species [*Oxytropis deflexa* (reflexed locoweed), *Epilobium angustifolium* (fireweed), *Carex aquatilis* (water sedge), *Eriophorum vaginatum* (cotton grass)] were successfully established on coarse textured soils using containerized stock developed from a local seed collection (Martens 2007).

4.4.3.2 Application of Lessons Learned

- Research at Fred's Channel and the PDC, sites with similar characteristics to conditions anticipated at pit lake margins, indicates that natural colonization is occurring with the establishment of a number of indigenous species.
- Containerized stock can be used to assist the establishment of shrub and herbaceous tundra species.

4.4.3.3 Data and Information Gaps

- Pit lake margin conditions for colonization by tundra species
- Methods to accelerated natural colonization
- Changes in plant community composition and structure with time.

4.4.3.4 Recommendations for Future Work

- Determine site conditions requirements for the target tundra species.
- Research methods to assist establishment of tundra species in lake margins.
- Continue monitoring successional trends at Fred's Channel and the PDC and similar sites.

4.4.4 Weeds Monitoring

4.4.4.1 Research Results

The presence of weeds at EKATI has been assessed periodically in the course of conducting rehabilitation monitoring. As of 2007, the only invasive weed recorded at EKATI is *Hordeum jubatum* (foxtail barley), which is limited to the area around the airport.

At the Giant Mine, near Yellowknife, extensive colonization by *H. jubatum* was noted in 2001 (Kidd and Max 2001). The only other non-native species present was *Equisetum pratense* (meadow horsetail). Non-native weed species recorded at the Rae Mine included *H. jubatum*, *Phalaris arundinacea* (reed canarygrass), *Taraxacum* spp. (dandelion) and *Polygonum* spp. (knotweed). At the Discovery Mine, weed species recorded included *H. jubatum*, *E. pratense*, and *Erigeron* sp. (fleabane). Martens (2007) assessed natural colonization at several disturbed sites in the region, but did not report the presence of any weedy species.

4.4.4.2 Application of Lessons Learned

Although the EKATI mine is remote, opportunity still exits for weeds to establish at the mine site – through natural vectors, via the winter road, or as contaminants in seed of native grasses grown on agricultural lands.

4.4.4.3 Data and Information Gaps

None

4.4.4.4 Recommendations for Future Work

- Continue to watch for weeds when monitoring revegetation success and moving about on the mine site.
- Take appropriate action if weeds are found
- Request Certificate of Analysis for every seed lot prior to purchase to ensure that no problem weeds are included. Refuse contaminated seed lots or request that they be cleaned again and sampled again for weeds. Note: many weeds common in agricultural fields will be killed by the harsh winters at EKATI (Hardy BBT 1986).

4.5 REMAINING SCOPE TO BE COMPLETED

4.5.1 Detailed Work Scopes (next three years)

Table 5.1-4d provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Tundra Plant Species

Survey tundra communities within the EKATI mine area and the surrounding region, to identify additional plant species with potential for revegetating pit lake edges (including shallow zones). Surveys could include the plant communities and landscape characteristics of natural lakes within the mine area.

Task 2. Seed Collection, Storage and Propagation

The immediate purpose of this program is to provide seed and suitable stock for the LLCF Pilot Revegetation Study, expected to begin in 2013. The ultimate purpose is to develop a program that will provide suitable native stock for revegetation of all mine components that require revegetation. Pigeon Pit will be the first pit available for reclamation. Pit flooding is scheduled to be completed in 2019. Because native seed production is generally low and infrequent, seed collection and development of suitable methods and procedures must start early in the research program. In 2010-2013 the research will build on previous studies, by including seed collection, storage and propagation work specific to those plants already identified as candidates for the establishment of an early protective cover, and for a long-term succession cover.

Sub-tasks to be undertaken:

a) Select Species

This will include species known to do well plus others identified in the assessment trials outlined above in Section 4.5.1.

b) Seed Collection

1. Seed Needs. Determine estimated quantity of seed of the target species required for revegetation research and the reclamation of pit lake edges. Seed requirements and storage viability will determine species collection priorities and quantities collected for future use.
2. Collection Sites. Identify accessible stands of selected species, where seed or other plant materials can be collected. Several locations (three or four) for each species will be selected to avoid intensive collection from the same area year after year. This may require the addition of two or three sites for those species already addressed in the SOP. Sites will be GPS referenced and marked on a collection site map.
3. Seed Harvesting. Research the use of handheld equipment to increase efficiency of seed collection.
4. Collection Schedule. Through germination testing, determine the phenology of seed ripening and visual cues to identify mature seed.
5. Seed Storage. Test various storage methods to maximize seed survival and germination. Research to date has shown that legume viability is maintained at a high level, after eight years of storage in a deep freeze. Small seeds with a thin seed coat, such as fireweed and dwarf birch may require different conditions to maintained viability.

c) Plant Propagation

Research into direct seeding and growing containerized seedling stock in the greenhouse for later planting will be continued. Research into the large-scale propagation of tundra species as containerized stock began in 2008. Coast to Coast nurseries, in Smokey Lake Alberta, are currently rearing six tundra species [*Betula glandulosa* (dwarf birch), *Vaccinium uliginosum* (bog bilberry), *Oxytropis deflexa* (reflexed locoweed), *Epilobium angustifolium & E. latifolia* (fireweed), *Empetrum nigrum* (crowberry) and *Hedysarum mackenzii* (Liquorice root)] for out-planting in the Rock Pad Reclamation Study in 2009 and 2010 (Martens 2009). These species all have promise for revegetation of the upper zone of the pit lake edges. On-going research on the rearing of seedlings and development of practices to increase survival of out-planted seedlings will be directly applicable to revegetation of the Pit Lakes. Other species with potential for pit lake margin revegetation will be added to the Coast to Coast seedling propagation program and the on-site field testing program.

Task 3. Natural Colonization and Plant Successional Trends

A number of species have colonized along the PDC and Fred's Channel as indicated in Section 4.4.3, above (Martens 2007 and 2008). Research during the next three years will include, but not be limited to:

- Review of literature on plant colonization community succession on comparable habitats in NWT and YT.
- Field assessment of natural colonization of pit lake edges in the NWT and YT. Operations with comparable site conditions will be targeted.

Integral to this research will be the characterization, to the extent possible, of the expected plant community and the successional changes that might occur over time.

Task 4. Weeds Monitoring

Continue to monitor reclamation sites within the EKATI mine area for the presence of introduced weeds. Determine whether weed control is needed, and develop a plan if appropriate.

4.5.2 Conceptual Work Scopes (2014 and following)

Task 5. Revegetation Locations

This information will be obtained by reviewing maps and final schematics of the mine area, in order to determine site characteristics after all infrastructure development and removal is complete. In particular, identify areas of high risk for erosion and what erosion control measures should be implemented to protect pit lake margins from erosion while vegetation is being established. This research will include analysis of moisture regimes, substrate types, and areas of instability where vegetation cover will be needed. If hydraulic erosion is a concern, determine whether erosion control structures or geotextiles need to be in place prior to or in place of revegetation efforts. Research will include assessment of surface flow patterns, severity of flood events, and sensitivity of substrate to erosion.

Final pit lake edge site conditions will not be known until operations are complete and individual pits have been flooded. Pigeon Pit is the first pit to be scheduled to be flooded with pumping to begin in 2018 and completed in 2019. The next pit (Beartooth) will not be fully flooded until approximately 2024.

4.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on the use of native plants and establishment of plant communities for pit lakes are linked to:

- Research on the establishment of plant communities in other mine components. In many cases site conditions, plant species present, and other community characteristics will be similar across mine components.
- Research on vegetation percent (%) cover and surface stability for the pit lakes mine component and other mine components.
- Research on Traditional Knowledge inclusion in reclamation planning for the EKATI mine components.

Based on the current LOM Plan the first open pit available for reclamation will be Pigeon Pit, in 2019. Vegetation research on pit lake edges will initially be conducted in the Panda Diversion Channel (PDC) and the Pigeon Diversion Channel. These two channels are ideal sites for research on plant community establishment in this mine component, because their physical conditions are similar to those of pit lake edges. Learnings from the Pigeon pit lake reclamation will also be carried forward to other pit lakes as they are reclaimed and closed.

4.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-4d. Establishment of Plant Communities for Pit Lakes

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short-term Research Tasks (within next 3 years)				
1	Tundra Plant Species	Field work, nursery studies, monitoring	2010	2014
2	Seed Collection, Storage and Propagation	Field work, nursery research (germination tests), monitoring.	2010	2014
3	Natural Colonization and Plant Successional Trends	Literature review, field assessments, pilot study.	2010	2014
4	Weeds Monitoring	Ongoing monitoring, adaptive management (if required)	2010	On going
Long-term Tasks (2014 and following)				
5	ID Revegetation Locations	Field work, monitoring.	2014	2018

4.8 COST

Total expected costs are $100,000 - $150,000.

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5. Vegetation Cover and Surface Stability for Pit Lakes

5.1 UNCERTAINTY

Plant cover required for long-term surface stabilization of disturbed sites around the pit perimeter to prevent erosion, as well as emergent and submergent vegetation that facilitate littoral zone sustainability.

5.2 RESEARCH OBJECTIVE

Reclamation strategies for open pits at EKATI include the construction of shallow zones at pit water edges, and stabilization of pit perimeters to reduce the potential for erosion.

The study of vegetation growth at pit lakes edges is divided into two research plans. This research plan focuses on the expected percentage of cover that will effectively maintain surface stability. The second research plan (Establishment of Plant Communities for Pit Lakes) focuses on plant species and identification of substrate materials that will affect the plant community composition.

The research objective is to determine what percentage of vegetation cover will be needed to effectively provide surface stability on pit lake edges and to meet the closure objective.

5.3 RESEARCH PLAN

Open Pits will not be available for revegetation until later in the life of the mine. The first pit, Pigeon Pit is expected to be fully flooded and available for research in 2019. Research on the development of plant cover along pit lake edges – the target areas for pit lake revegetation, has begun at the Panda Diversion Channel (PDC) and at Fred's Channel. Conditions at these sites are directly applicable to site conditions anticipated within the pit lakes after flooding.

5.3.1 Tasks Completed or Initiated

Information is available on the establishment of plant cover on the PDC and Fred's Channel, sites with similar characteristics to those along channel banks. The Rock Pad Reclamation study, constructed in 2008 with recultivation treatments to be completed in 2010 (Martens 2009), will provide information on the establishment of vegetation on waste rock and substrates, i.e., growth materials, available at EKATI (salvaged topsoil, lake sediment and glacial till). No work has been initiated or completed on the relationship between plant cover and surface stability on these materials.

5.3.2 Short-term Tasks (to be started/continued in the next three years)

To determine what percentage of vegetation cover will be needed to effectively provide surface stability on pit lake edges, the research will determine:

1. Plant Cover and Community Structure

Levels of plant cover and canopy structure needed to provide surface stability on vegetated sites. Emergent and submergent vegetatation that would facilitate aquatic ecosystems as part of pit lake littoral zones. This information will be obtained in part by monitoring the results of ongoing revegetation studies at EKATI, and the review of relevant literature on revegetation of similar sites.

2. Plant Community Stability Characteristics

Assess plant community characteristics needed to indicate stability, and how they can be assessed. This research will include quantitative descriptions of reference tundra communities in the EKATI area, as well as a review of criteria that have been used to indicate stability in other northern reclamation projects.

3. Development Rates

Rates of development of plant cover and community structure with time. This information will be obtained primarily by monitoring the results of ongoing revegetation studies at EKATI, particularly the studies already established at the Panda Diversion Channel (PDC), Fred's Channel, and the Rock Pad Revegetation Study. This research will be expanded in scope to include the assessment of the physical characteristics of surfaces to be revegetated (terrestrial and aquatic habitats), in order to assess the relevance of results from other sites. In addition, relevant literature on revegetation of similar sites will be reviewed.

5.3.3 Long-term Tasks (2014 and following)

Short-term tasks identified in Section 5.3.2, above, will continue in 2013 and following. Because plant cover and community development is a slow process in the Low Arctic tundra, existing studies will be monitored to track long-term changes in plant cover and surface stability. Additional study sites may be added, at newly disturbed sites, to provide information on the dynamics of early plant cover and surface stability at a time when disturbed sites are most vulnerable to erosion.

5.4 FINDINGS OF RESEARCH COMPLETED

5.4.1 Development Rates

5.4.1.1 Research Summary Results

Plant cultivation treatments, including seed of native-grass cultivars and native forbs, shrub cuttings, and sprigs of the aquatic grass *Arctophila fulva*, were applied at the PDC and Fred's Channel in 1999-2001 (Kidd and Max 2000b, 2001, 2002). Additional willow cuttings and bundles were planted at Fred's Channel in 2004 (Martens 2005, 2009).

- Native grass cultivars and native forbs were well established along the PDC six years (in 2006) following broadcast seeding targeting areas with fine-grained surface soil.
- Establishment of *Arctophila fulva* (Arctic pendant grass) was very successful in areas of fine-grained sediments, in the channel and near the outlet into Kodiak Lake. Lower success was observed in areas of higher flow velocity.
- Healthy stands of *Hedysarum mackenzii* (liquorice root), *Oxytropis deflexa* (reflexed locoweed), *Astragalus eucomus* (elegant milkvetch) and *Epilobium* spp. (fireweed) have established at several locations.
- Willow cutting survival at the PDC was reasonably good (74% to 92%).
- Willow cutting survival along Fred's Channel was low (27% two years after planting). Lack of success was contributed to a coarse (gravely susbtrate) and the shifting of the channel following planting.
- Several herbaceous species were colonizing the gravel flats adjacent to Fred's Channel in 2008, including *Calamagrostis canadensis* (bluejoint), *Eriophorum vaginatum* and *E. angustifolium* (cotton grass), and *Carex bigelowii*. *Salix planifolia* (diamond-leaf willow) and *Carex* seedlings provided a uniform, although sparse cover on the lower reaches of the channel with finer-grained soils. Total plant cover seven years after construction in the middle and lower channel reach, was 0.8% and 1.3%, respectively.

5.4.1.2 Application of Lessons Learned

- Native legumes and other tundra species can be successfully established along channel banks and in shallow waters with low current.
- Natural colonization and plant community development along lake edges is expected to be a slow process.

5.4.1.3 Data and Information Gaps

- Levels of plant cover, canopy height, etc. needed to stabilize the surface of sites along the pit lake shoreline, taking into consideration such factors as substrate and slope angle, and the importance of root biomass.
- Characteristics of adjacent and/or predisturbance tundra plant communities, to assist in developing criteria for a stable post-reclamation community.
- Longer-term data on plant community development on revegetated sites along pit lake shorelines and other sites with similar characteristics.

5.4.1.4 Recommendations for Future Work

- Build on the plant cover assessment work at the PDC, Fred's Channel and Rock Pad Revegetation Study, and expand the study scope to include assessment of surface stability in relation to type and amount of plant cover.
- Add additional study sites as disturbed areas when suitable site characteristics become available.

5.5 REMAINING SCOPE TO BE COMPLETED

5.5.1 Detailed Work Scopes (next three years)

Table 5.1-4e provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Plant Cover and Canopy Structure

- Monitor and assess the relationship between vegetation cover/canopy structure and surface stability at the PDC and Fred's Channel, sites with established cover, and at the Rock Pad Revegetation Study, a newly disturbed site with establishing plant cover.
- Assess the physical characteristics of sites to be revegetated (e.g., grain size distribution, organic matter content, bulk density).
- Assess the rate of soil loss on vegetated sites.
- Expand revegetation monitoring to include the assessment of the relationship of plant cover and canopy structure on surface stability.
- Research revegetation cover and surface stability at similar sites in NWT, YT and elsewhere.
- Determine the types of emergent and submergent vegetatation that would facilitate aquatic ecosystems as part of pit lake littoral zones. Look for opportunities where plants used for pit lake bank and shoreline stabilization will also perform well as littoral habitat for fish.

Task 2. Plant Community Characteristics

- Quantitative field assessment of plant community characteristics and surface stability at reference tundra communities in the EKATI area.
- Research criteria (plant cover and surface soils) used to indicate stability in other reclamation projects.

Task 3. Development Rates

- Review results of ongoing revegetation studies at the Rock Pad Revegetation Study, the PDC, Fred's Channel and other sites with similar characteristics.
- Expand the scope of ongoing studies to include the assessment of surface physical characteristics of revegetated sites (terrestrial and aquatic habitats).
- Review relevant literature on revegetation of similar sites.

5.5.2 Conceptual Work Scopes (2014 and following)

- Continue to build on the existing work scope, to acquire long-term information on plant cover and community development and surface stability
- Add study sites as suitable sites become available, to expand the application and confidence with which information acquired can be applied to pit lake shoreline vegetation at EKATI.

5.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on vegetation cover and stability for pit lakes is linked to:

- Research on the establishment of plant communities in other mine components. In many cases site conditions, plant species present, and other community characteristics will be similar across mine components.
- Research on the use of native plants and establishment of plant communities for the pit lakes and other mine components.
- Research on Traditional Knowledge inclusion in reclamation planning for the EKATI mine components.

Based on the current LOM Plan the first open pit available for reclamation will be Pigeon Pit, in 2019. Vegetation research on pit lake edges will initially be conducted in the Panda Diversion Channel (PDC) and the Pigeon Diversion Channel. These two channels are ideal sites for research on vegetation cover and stability in this mine component, because their physical conditions are similar to those of pit lake edges. Learnings from the Pigeon pit lake reclamation will also be carried forward to other pit lakes as they are reclaimed and closed.

5.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-4e. Vegetation Cover and Surface Stability for Pit Lakes

Research Task #	Task	Project Tracking (*Reporting*, *Modeling*, *Field Work*, *Engineering Designs*)	Research Start	Research Finish
Short-term Research Tasks (within next 3 years)				
1	Plant Cover and Community Structure	Field work, literature review	2010	2014
2	Plant Community Stability Characteristics	Field work, literature review	2010	2014
3	Development Rates	Field work, literature review	2010	2014
Long-term Tasks (2014 and following)				
1-3	Continued monitoring of existing studies, add new sites	Field work, monitoring	2014	2018

5.8 COST

Total expected costs are $100,000 - $150,000.

5.9 REFERENCES

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6. Underground Water Quality and Quantity

6.1 UNCERTAINTY

Quality and volume of underground water associated with loads of chloride that will contribute to pit lake water quality.

6.2 RESEARCH OBJECTIVE

Each of the Panda, Koala North and Koala open pits are connected to underground mines which will be flooded along with the open pits at mine closure. The effects of underground geochemistry and connate water contributions is unknown at this time, but must be considered when modeling pit lakes water quality. The research of underground water quality and quantity will be completed as a separate research study because of the specific nature of the underground contribution, but will be used to assist the larger study on pit lake lakes water quality.

The objective of the research is to determine the ground water and salinity contributions from underground mines to pit lakes.

6.3 RESEARCH PLAN

6.3.1 Tasks Completed or Initiated

See 4.1 for more detailed description of the research.

1. Underground Water Quality Assessment

In October 2005, an assessment of mine water from the underground operations at EKATI was undertaken to assess the impacts of this water on the LLCF water quality. A field program was undertaken to quantify water volumes and contaminant loadings originating from the Koala North, Koala and Panda underground developments over a period of 14 consecutive days. In addition, all available historical data related to underground development and water quality were analyzed to identify patterns and trends in loadings of water quality parameters from the underground mines. The assessment is documented in Rescan (2006).

6.3.2 Short-term Tasks (to be started/continued in the next three years)

1. Underground Flow Measurements

Measurements of underground flows. This information will come from water being pumped to the surface, with consideration that the underground mine workings are hydraulically open to the overlying open pits.

2. Analysis of Underground Flow Measurements

Review and analyze data prior to input into pit lakes load balance model update.

3. Develop Conceptual Regional Groundwater Model

Develop conceptual groundwater regional model and evaluate expected groundwater behaviour during pit flooding.

6.4 FINDINGS OF RESEARCH COMPLETED

6.4.1 Research Summary Results

6.4.1.1 Underground Water Quality Assessment

The underground water quality assessment is documented in Rescan (2006). The historical flow records collected from September 2003 to the present show a trend of increasing flow rates of mine water from the underground operations with large temporary inflows of groundwater. The temporary inflows were caused by development of fracture zones with high hydraulic conductivity and inflowing surface water. Based on flow meter measurements recorded during the 14 day sampling program in October 2005, the average total flow rate of mine water from EKATI underground was estimated at 976 m^3/d. The available flow meter records did not provide information about what proportion of the total flow originated at Panda and Koala underground, respectively.

Predictions of future mine water flows from underground are associated with considerable uncertainty due to the difficulty in predicting local hydrological conductivities of the host rock and kimberlite that will be intercepted by future developments. Estimates made by Klohn Crippen in 2003 for the ultimate steady state flow rate of mine water were 10 L/s from Panda underground and 3 L/s from Koala underground. However, updated estimates produced in 2005 predicted a substantially higher flow rate from Koala underground. A future total steady state flow rate from the underground development of 20 L/s is considered a reasonable estimate of long-term flows.

Analysis of the main underground sump and drill-hole water chemistry confirms previous general findings, that the groundwater is saline (Na-Ca-Cl type) with increasing dissolved solids content with depth.

6.4.2 Application of Lessons Learned

The flow and quality estimates of underground water were predicted to provide the dominant source of chloride, sodium and calcium loadings to the LLCF. At closure, it is expected that groundwater from the underground will contribute loadings of these and other parameters to the ultimate pit lake water quality. The assessment documented in Rescan (2006) underlines the uncertainty in groundwater estimates, primarily in terms of flow estimates.

6.4.3 Data and Information Gaps

No data and information gaps have been identified at this time.

6.5 REMAINING SCOPE TO BE COMPLETED

6.5.1 Detailed Work Scopes (next three years)

Table 5.1-4f provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Underground Flow Measurements

On-going measurements of underground flows. This information will come from water being pumped to the surface.

Task 2. Analysis of Underground Flow Measurements

Review and analyze data that will contribute to development of groundwater conceptual model and for input into the pit lakes load balance model update.

Task 3. Develop Conceptual Regional Groundwater Model

Develop groundwater conceptual model and evaluate expected groundwater behaviour during pit flooding. Conceptual models developed for the 1995 EIS will be reviewed and updated.

6.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on water quality in the underground mines is linked to:

- Research on pit lake water quality in the Open Pit mine component.

Early research of the underground mine water quality began with water quality modeling for the LLCF, and with the Pit Lakes Studies in 2008. Research on the contribution of mine water will continue with a conceptual groundwater model in 2014. Panda and Koala pits will commence flooding in 2033.

6.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-4f. Water Quality – Underground Mines

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short-term Research Tasks (within next 3 years)				
1	Underground Flow Measurements	Internal data reports	2009	2012
2	Analysis of Underground Flow Measurements	Internal memo	2012	2012
3	Develop Conceptual Regional Groundwater Model	Report	2013	2014

6.8 COST

Total expected costs are $150,000 - $200,000.

6.9 REFERENCES

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7. Permafrost Growth in Waste Rock Storage Areas

7.1 UNCERTAINTY

What will be the permafrost state/extent in each of the Waste Rock Storage Areas (WRSA) at mine closure?

7.2 RESEARCH OBJECTIVE

The WRSA at EKATI have been designed to contain the rock excavated from the open pits, and will remain in place at the end of mining operations. Permafrost growth through the WRSA is a key component of chemical and physical stability within the piles. Water from precipitation and snowmelt seeps into the waste rock piles and freezes in place. The WRSA are also designed to encourage permafrost movement from the underlying tundra into the rock pile. Additional cooling is also expected to occur as a result of the material placement within and around the perimeters of the WRSA. A more detailed description of cooling processes and ice formation processes is described in detail in Section 4.3 of the ICRP. Specific descriptions of the current WRSA at EKATI are also covered in Section 5.4.3 of the ICRP. Measurements of the internal temperature of the Panda/koala WRSA indicate that a portion of the pile is currently colder than the natural permafrost. Over the long term the permafrost is expected to grow further into the pile, but the expected rates of growth and the extent of growth at mine closure is unknown. The research plan will use existing information and trends, to analytically estimate the spatial extent and condition of the permafrost at mine closure in each of the WRSA. Objectives of the research are to:

- Review and collate existing data on waste rock placement and ground temperature monitoring data,
- Conduct a geotechnical investigation and install additional instrumentation at target locations within the WRSA to assist with the understanding of structure and thermal conditions within the waste piles,
- Develop a calibrated finite element model to simulate the thermal regime of the WRSA, and
- Use the calibrated model to predict the thermal condition of the WRSA at mine closure,
- Update the water balance for the WRSA to determine when permafrost will reach maximum coverage.

7.3 RESEARCH PLAN

7.3.1 Tasks Completed or Initiated

1. WRSA Performance Evaluation

WRSA performance evaluation was completed by EBA in 2006 as part of the update of the ICRP. The evaluation summarized the available information regarding the thermal performance of the EKATI site WRSA. It also documented the information that has been provided to regulators regarding the operation of the various EKATI WRSA and provided recommendations for construction and operation of future WRSA at EKATI.

2. WRSA Thermal Modelling

Thermal modelling of waste rock piles was completed by EBA in 2006 as part of the update of the ICRP. The evaluation developed a model to predict long-term temperatures and permafrost stability in the waste rock piles at EKATI. The model considered convective cooling processes in the piles as well as climate warming with time.

3. Data Available

Thermal data available is summarized as follows.

1. Existing ground temperature data for Panda/Koala, Misery, and Fox WRSA.
   - Ten ground temperature cables have been installed in the Panda/Koala WRSA, and temperatures have been monitored since 1998.
   - Eight ground temperature cables have been installed in the Misery WRSA, and temperatures have been monitored there since 2000.
   - Three ground temperature cables have been installed in the Fox toe berms and monitoring has been conducted since 2002.
   - Three ground temperature cables have been installed in the Fox WRSA, and have been monitored since 2007.
2. Thermal data has been collected from test piles at Diavik Diamond Mine since 2004, some of this data is publicly available.
3. A waste rock dump analysis was completed by EBA in preparation for 1995 EIS. This analysis outlined a hypothesis to characterize the manner in which water was expected to flow through the materials and the rate at which permafrost was expected to aggrade into the waste rock piles.
4. Design plan for WRSA (including slope design for convective cooling) and toe berm was completed (to slow velocity of water seeping through pile). This information is outlined in the Waste Rock Management Plans as well as the most recent performance evaluation of WRSA by EBA in 2006.
5. Some information is available on variability in freezing different materials (Andersland and Anderson 1978; Andersland and Ladanyi 1994). Coarse rejects are typically deposited at higher moisture contents than waste rock. The high water contents mean that the latent heat that must be liberated to freeze the coarse rejects is orders of magnitude higher than in waste rock. Therefore, it takes considerably colder conditions to freeze the material as compared to waste rock.
6. Monthly surveys of waste dump piles have been carried out (toe and crest, state of surface, volumes and materials and locations of dumping areas, as well as locations of roads on dump piles).
7. Toe berm effectiveness was evaluated. Some discussion of this is outlined in the 2006 Performance Evaluation Report by EBA, and in the Toe Berm Effectiveness Evaluation completed by EBA in 2007.
8. Sable and Pigeon WRSA designs are included in the 2000 Sable, Pigeon and Beartooth Environmental Assessment.
9. Annual Landsat imagery exists since 2002.

7.3.2 Short-term Tasks (to be started/continued in the next three years)

See Section 7.5.1 for more detailed description of the research tasks.

4. Literature Review

Conduct a literature review to learn about experiences from other mining operations and other industries on the temperature regime within coarse porous media in permafrost areas.

5. Record of Waste Rock Deposition

Compile a record of waste rock deposition (materials, volume, location, and period). This requires analysis of available historical records.

6. Develop 3D Representation of the WRSA

Develop a three dimensional model that depicts the historical and projected future placement of material at the WRSA. The model should also incorporate the possible excavation and use of waste rock from the WRSA for future reclamation activities, such as capping the LLCF and any other activities requiring rock fill.

7. Installation, as necessary, of Ground Temperature Monitoring Cables

Identification and assessment, based on the geothermal data set, of candidate areas for additional instrumentation followed by installation, as necessary, of ground temperature cables at key locations within the waste rock piles to augment monitoring of the temperature regime and the variation of temperature against time.

8. Geotechnical Investigation and Instrumentation

Drill, investigate, and install instrumentation in the Panda/Koala/Beartooth WRSA to measure moisture/ice content and pore airspace conditions. As part of this task, the selected instrumentation will need to be evaluated before installation.

9. Instrumentation Monitoring

Monitor the instrumentation installed in Tasks 7 and 8 to determine trends in permafrost change within the WRSA. The field data will be used to calibrate and refine the thermal model, which will assist with predicting the permafrost condition at mine closure in each of the WRSA.

10. Thermal Modelling

Complete thermal analysis to model and predict the thermal conditions of the WRSA at mine closure.

7.3.3 Long-term Tasks (2014 and following)

See Section 7.5.2 for more detailed description of the research.

11. Review Updated Literature

Continue to track the results of current research on waste rock piles, especially at Diavik Diamond Mine.

12. Application of Current Literature Research

Apply current research findings to possibly enhance the final WRSA design.

13. Monitoring and Evaluation

Keep monitoring temperatures inside WRSA to confirm the adequacy of final design.

7.4 FINDINGS OF RESEARCH COMPLETED

7.4.1 Research Summary Results

7.4.1.1 WRSA Thermal Data

Thermal data results are summarized as follows.

Panda/Koala WRSA

The entire WRSA is in permafrost condition except for the seasonal thaw depth in the order of 4 to 6 m that is tending to decrease with time. Temperatures around the pile perimeter (around 200 m) are colder than those in the pile centre due to convective cooling at the pile perimeter. Temperatures in the centre of the pile are controlled by conduction similar to undisturbed terrain, and are getting colder with time.

Addition of materials around/on top of the pile created colder temperatures at depth, and reduced the amplitude of the season temperature fluctuations. This phenomenon was observed under the presence of toe berms and stockpiled overburden till.

Misery WRSA

The entire Misery WRSA is in a permafrost condition except for the seasonal thaw depth, which is quite variable in Misery WRSA reaching between 3 m to 21 m. The areas of the pile with shallower active layers perform similarly to Panda/Koala WRSA. The amplitudes of season fluctuations are decreasing with time. The foundation temperatures approach normal ground temperatures found at Misery, typically at -4ºC.

The thicker active layers are in locations with no typical terrain conditions such as near the outside slope or where the snow drifts. One of those locations is speculated not to freeze due to the presence of ponded water on the foundation before the pile was constructed. In this location, longer time is anticipated to overcome this originally warmer state.

Fox WRSA

Three ground temperature cables were installed within the Fox WRSA during October 2006. The results of the ground temperature readings indicated that some active temperature equilibration is still occurring within the pile; however, there is a general cooling trend with most of the measured temperatures still being above freezing.

Coarse Processed Kimberlite Storage Pile

Coarse processed kimberlite is not frozen but is getting colder with time. The seasonal thaw depth was found to be between 3.5 m to 4 m. Some material inside the pile reached slightly below 0ºC. Coarse processed kimberlite has considerably different characteristics than waste rock, the most notable being a much higher moisture content.

The slightly below zero temperatures inside the pile might not be indicative of a frozen condition due to possible pore salinity. A large amount of latent heat is also anticipated inside the pile due to high moisture content at deposition (the zero curtain temperature). Freezing is anticipated once the latent heat has been liberated. Freezing of the coarse processed kimberlite is anticipated, but it might take a decade or more to occur.

Convective cooling effects are not anticipated in the coarse kimberlite because of its well graded nature and the small size of the pore space.

7.4.1.2 Toe Berms

Panda and Bearclaw Toe Berms

The low-permeable cores of Panda and Bearclaw toe berms have remained frozen since construction. Temperatures fluctuate in Bearclaw toe berm between -1ºC and -14ºC (top of core), and between -4ºC to -8ºC (bottom of core). Temperatures lower than normal ground temperature (-5ºC) in the low-permeable core and the toe berm base indicate the presence of convective cooling provided by waste rock overlying the core.

The thickness of the active layer reduced with time to the order of 3 m and the amplitude of the seasonal temperature fluctuations has decreased slightly with time.

Fox Toe Berm

The low-permeable core of the berms stays in a frozen condition year round. The depth of seasonal thaw is between 3 m to 5 m (well within the waste rock cover). Temperatures in the east berm are colder than normal ground temperature at EKATI, which indicates convective cooling present in the overlying waste rock cover.

The foundation is in a permafrost condition, and the temperatures are becoming colder with time.

7.4.2 Application of Lessons Learned

Based on existing information, it appears that convective cooling achieves permafrost conditions more rapidly than conduction cooling. Convection cooling can be disrupted by the placement of fine layers to hinder the air flow within the waste rock material. Planning of the waste rock placement should be designed to promote convective cooling as a means of rapidly creating permafrost conditions within the WRSA.

7.4.3 Data and Information Gaps

No data and information gaps have been identified at this time.

7.5 REMAINING SCOPE TO BE COMPLETED

7.5.1 Detailed Work Scopes (next three years)

Table 5.1-4g provides an outline and schedule of tasks to be undertaken during the next three years.

Task 4. Literature Review

Conduct a literature review to learn about experiences from other mining operations and other industries on the temperature regime within coarse porous media in permafrost areas. For example, a test pile has been constructed at Diavik Diamond Mine and is monitored by the University of Alberta. This information will be a valuable comparative study since Diavik Diamond Mine has similar materials and climatic conditions.

Task 5. Record of Waste Rock Deposition

Develop a system whereby the record of both historical and future waste rock placement can be stored and retrieved. The system should:

- be designed for ease of use,
- contain sufficient detail (i.e., tonnage placed, location and elevation, material type, period, etc.),

- be flexible to enable new parameters to be added, and
- be sustainable without major data modifications for the balance of the mining operations.

Task 6. Develop 3D Representation of the WRSA

Develop three-dimensional representation of the historical placement of material within the WRSA.

The historical waste rock placement model should depict the historical and projected future placement of material at the WRSA. This should include tonnage placed, location and elevation, and material type, and should be time related. Ideally, this should be a 3D graphical representation of the development of the waste rock pile that will form a base model for future waste rock planning and scheduling. Pertinent parameters such as footprint topography and size, survey data, height, slope angles, will be included, as well as material thermal properties which should be colour-coded for easy reference for future analytical work. The model should also include the location and extent of a possible future quarry site for LLCF rock capping in the Panda/Koala/Beartooth WRSA. The quarry location is included as part of Engineering Study #7 Landfill Volumes, Location and Placement, in Appendix 5.1-5 of the ICRP.

Task 7. WRSA Water Balance

Develop specific water balance of WRSA. Regional water balances have been developed for the EKATI area during the Environmental Assessment. Specific water balances for WRSA have not been completed. This information will assist in understanding water inputs and freezing processes in the piles. The information from this task will also assist Research Plan #9, WRSA Seepage and Water Quality in Appendix 5.1-4.

Task 8. Installation of Ground Temperature Monitoring Cables

Install ground temperature cables at key locations within the waste rock piles to monitor the temperature regime and variation with time.

On the basis of the above tasks, the installation of ground temperature cables can be optimized to target areas of interest or concern, or areas requiring more detailed information. These locations must fully support and add relevant data to enhance the future thermal modelling.

Task 9. Geotechnical Investigation and Instrumentation

Drill, investigate and install instrumentation in the Panda/Koala/Beartooth WRSA to measure moisture/ice content and pore airspace conditions.

Prior to this investigation program, it will be necessary to ascertain and evaluate appropriate techniques to measure moisture/ice content and pore air space conditions within the waste rock coarse air space. Upon evaluation and satisfaction that the proposed techniques will provide the necessary measurements, the instrumentation should be installed at locations of interest or concern or areas requiring more detailed information. Again, these locations must fully support and add relevant data to enhance future thermal modelling.

Task 10. Instrumentation Monitoring

Monitor ground temperatures and moisture/ice instrumentation in the WRSA to determine trends in permafrost.

Task 11. Thermal Modelling

Based on the findings of the above tasks, use a finite element model to simulate the thermal regime of the WRSA. The investigation and monitoring data will be used to calibrate the thermal model against measured condition and thereafter assist the prediction of the thermal condition of the WRSA at mine closure.

7.5.2 Conceptual Work Scopes (2014 and following)

Table 5.1-4g provides an outline and schedule of tasks to be undertaken after 2014.

Task 12. Review Updated Literature

Continue tracking the results of current research on waste rock piles, especially at Diavik Diamond Mine.

Task 13. Application of Current Literature and Research

Apply current research findings to possibly enhance the final WRSA design.

Task 14. Monitoring and Evaluation

Continue monitoring temperatures inside WRSA to confirm the adequacy of final design.

7.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on the state/extent of permafrost in WRSA at mine closure in the WRSA mine component is linked to:

- Research of the potential instability of WRSA caused from degradation of permafrost and exposure of unstable materials during quarrying.

The growth and extent of permafrost growth in the Panda/Koala/Beartooth, Misery, and Fox WRSA have been measured through ground temperature cables since the footprint of these storage piles was established. This information is used to study how and over what time scale permafrost aggrades into these piles. Similar research will be conducted on the Sable and Pigeon WRSA when the footprint of the storage piles is in place, in approximately 2015.

Research on permafrost growth in all WRSA will continue through to the end of mining operations.

7.7 PROJECT TRACKING AND SCHEDULE

Table 5.4-1g. Permafrost Growth in WRSA

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short-term Research Tasks (within next 3 years)				
4	Literature review	Literature Review Report	2011	2011
5	Record of Waste Rock Deposition	Deposition Tracking Report	2011	2011
6	Develop 3D Representation of the WRSA	Deposition Plan and 3D Model	2011	2011

(continued)

Table 5.4-1g. Permafrost Growth in WRSA (completed)

Research Task #	Task	Project Tracking (*Reporting*, *Modeling*, *Field Work*, *Engineering Designs*)	Research Start	Research Finish
7	WRSA Water Balance	Water Balance Report	2012	2012
8	Installation of Ground Temperature Monitoring Cables	GTC installation in all WRSA	2012	2012
9	Geotechnical Investigation and Instrumentation	Fieldwork (Drilling Investigation and Instrument Installation)	2012	2012
10	Instrumentation Monitoring	Annual WRSA GTC summary (included as part of seepage evaluation)	2012	2017
11	Thermal Modelling	Report	2012	2013
Long-term Tasks (2014 and following)				
12	Review Updated Literature	Literature Review Report	2015	2015
13	Application of Current Literature Research	Model Update	2016	2016
14	Monitoring and Evaluation	Report	2018	2018

7.8 COST

Total expected costs are $1,200,000 - $1,500,000.

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8. WRSA Access Ramps

8.1 UNCERTAINTY

The design and location of ramps on WRSA that allows safe access and egress by people and wildlife.

8.2 RESEARCH OBJECTIVE

The WRSA final design will include a series of lifts and benches around the perimeter of the pile and flat surfaces across the tops of the piles. Ramps have been proposed for each of the WRSA that will allow wildlife and people a means of safely accessing the tops of the piles as well as a safe means of leaving the piles. Because the sides of the WRSA will have run-of-mine waste rock, varying in size from fine rock to large boulders, with slope angles on the sides of the lifts at 35-37°, BHP Billiton believes that ramps will be necessary to ensure there are safe areas for access and egress. This follows with the communities' concern for wildlife safety, the second most important reclamation concern for the communities, after water quality (see Figure 2.1-1A of the ICRP). To address the uncertainty of how ramps will be constructed, the objective of the research plan is to:

- Design and locate the appropriate number of access ramps on WRSA that will allow safe use by people and wildlife after mine closure.

8.3 RESEARCH PLAN

8.3.1 Tasks Completed or Initiated

No research has been completed at this time.

8.3.2 Short-term Tasks (to be started/continued in the next three years)

See Section 8.5.1 for more detailed description of the research tasks.

1. Consult with Communities on Ramp Design

Community input, particularly in the areas of Traditional Knowledge (TK) will assist in determining the location and number of WRSA ramps. Opportunities for collecting TK and bringing it into the research will be used throughout the research plan.

8.3.3 Long-term Tasks (2014 and following)

2. Construction Design Plan

Develop a construction design plan for ramps for each WRSA. Update the number and location of access ramps in each WRSA as each storage area nears final configuration and with the TK information collected in Task 1.

8.4 FINDINGS OF RESEARCH COMPLETED

8.4.1 Research Summary Results

No research has been completed at this time.

8.4.2 Application of Lessons Learned

No research has been completed at this time.

8.4.3 Data and Information Gaps

No data and information gaps have been identified at this time.

8.5 REMAINING SCOPE TO BE COMPLETED

8.5.1 Detailed Work Scopes (next three years)

Task 1. Consult with Communities on Ramp Design

Ramp designs will incorporate TK and will be defined based on consultation with local communities and their understanding of caribou migration pathways, and caribou safety. Currently a research plan is in place that specifically addresses how TK can be incorporated into reclamation planning, and the methods and approaches used to involve and encourage TK input from communities. This research is planned for 2010 and 2011. The findings will be used in 2012 and beyond for the WRSA ramps designs.

8.5.2 Conceptual Work Scopes (2014 and following)

Task 2. Construction Design Plan

Develop a construction design plan for ramps for each WRSA. Update the number and location of access ramps in each WRSA as each storage area nears final configuration, with input from TK, in Task 1. The number and location of the access ramps will be determined once the final planned profile of the WRSA is in place and will be dependent on modifications to the piles from quarry work required for capping of the LLCF, pit flooding infrastructure, as well as capping materials for landfills and landfarm. Access ramps used by haul traffic during operations will likely remain as long-term access ramps at mine closure. Additional ramps will be designed and constructed. Design plans will be included in the final closure plans for each WRSA mine component.

8.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on WRSA Access Ramps in the WRSA mine component is linked to:

- Research on WRSA stability after quarry work has been completed.
- Research on Traditional Knowledge inclusion in reclamation planning for the EKATI mine components.

The timing of research on access ramps will be during the construction of the WRSA, with more emphasis toward the end of the WRSA operations. Wildlife access to the WRSA will be deterred during operations because these sites will remain active with mining equipment activities. Currently all WRSA remain operational with expected completion of the current Panda/Koala/Beartooth WRSA in 2020, Fox in 2015 and Misery in 2018. Fox WRSA will be the first to be reclaimed, and therefore the research will initially focus on Fox, and the learnings subsequently passed onto successive WRSA.

8.7 PROJECT TRACKING AND SCHEDULE

Table 5.4-1h. WRSA Access Ramps

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short-term Research Tasks (within next 3 years)				
1	Consult with Communities on Ramp Design	Community Consultation (to be determined through the TK Research Plan)	2010	2014
Long-term Tasks (2014 and following)				
2	Construction Design Plan for Fox WRSA	Design Plan	2014	2014

8.8 COST

Total expected costs are $100,000 - $150,000.

8.9 REFERENCES

BHP-Dia Met. 1995. NWT Diamonds Project Environmental Impact Statement. Prepared for BHP Minerals Ltd. and Dia Met Inc. by Rescan Environmental Services Ltd.

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9. WRSA Seepage and Water Quality

9.1 UNCERTAINTY

Environmental effects of any WRSA seepage that exists post-closure.

9.2 RESEARCH OBJECTIVE

WRSA toe berms have been constructed around some areas of the waste rock piles to reduce flows towards the receiving environment. During mining operations most of the seepage from the waste rock storage areas report to approved containment facilities. Once the saturated core has reached it maximum elevation in the WRSA, runoff will flow through the active layer of granite and ultimately out of the pile. However, prior to developing a fully saturated core, multiple freshet and storm events will flush water through the active layer and into lower portions of the pile where it will freeze. No deleterious material is expected to be in the active layer once the saturated core reaches its maximum elevation. (Please refer to Section 5.4.4.7 in the ICRP for more discussion on waste rock water quality trends).

The research objective is to determine what the long-term seepage chemistry from WRSA will be post-closure, and the potential environmental risks of this seepage. The outcomes of the research will be used to develop mitigation strategies if necessary.

9.3 RESEARCH PLAN

9.3.1 Tasks Completed or Initiated

See Section 9.4.1 for more detailed description of the research.

1. Pre-mine Kinetic Tests

Pre-mine and supplemental geochemical characterization studies included kinetic testing of waste rock materials and processed kimberlite waste materials (CKR and FPK) in order to characterize the leaching behaviour of each rock type (NDM 1997; BHPB 2002; SRK 2003a, 2003b, 2003c).

2. Operational Seepage Monitoring

The seepage monitoring program results in seepage water quality and flow data for all WRSA. The seepage monitoring program was fully initiated at EKATI in 1999 and is currently conducted twice each year (freshet and fall), and reported annually in the Waste Rock and Waste Rock Storage Area Seepage Survey Report (e.g., SRK 2009).

3. Specific Studies of Coarse Kimberlite Reject

A study of the source of acidic conditions in ponded water down gradient of the Coarse Kimberlite Rejects Storage Area (CKRSA) was performed in 2002 (Day et al. 2003; SRK, 2003d).

4. ARD Classification of Kimberlite

Geochemical and mineralogical analyses were conducted on kimberlite samples to estimate carbonate composition and evaluate the use of analytically determined carbonate as a surrogate for neutralization potential of kimberlite (SRK 2007a).

5. Ion Exchange Capacity of Soils

A study was conducted to evaluate whether cation exchange between WRSA drainage and tundra soils could be responsible for the observed trends in pH and dissolved aluminum concentrations along the flow path between SEEP-018B and SEEP-019 (SRK 2007b).

6. On-site Kinetic Tests

On-site field kinetic tests were constructed to measure the field performance of potentially reactive wastes. Eleven on-site barrel tests were constructed in spring 2007. Leachate samples from the barrel tests are collected during the open water season and will continue throughout the operational mine life.

7. Water Quality Predictions

Predictions of long-term seepage quality were presented in pre-mine geochemical characterization reports (NDM 1997; SRK 2003a, 2003b, 2003c), and recently updated in the Geochemical Characterization and Metal Leaching (ML) Management Plan (SRK 2007c).

8. Toe Berm Performance

A review was conducted to evaluate the effectiveness of toe berms constructed at several WRSA to control seepage flows (SRK 2007d).

9. Ground Temperature Monitoring of WRSA

A ground temperature monitoring system is in place for Panda/Koala, Misery and Fox WRSA. Ground temperatures are measured a minimum of four times annually using ground temperature cables(GTCs) installed at various locations within the WRSA.

9.3.2 Short-term Tasks (to be started/continued in the next three years)

Short-term research tasks identified as part of this research are primarily the continuation of on-going monitoring and testing programs to assess seepage quality. This data will be used for operational management plans and closure planning.

1. Operational Seepage Monitoring

This monitoring program will continue as described in Section 9.3.1.

2. On-site Kinetic Tests

This research will continue as described in Section 9.3.1.

3. Water Quality Prediction

Predict post-closure seepage flows and water quality.

4. Risk Assessment

Determine the effects that seepage will have on the receiving environment (ecological risk assessment).

9.3.3 Long-term Tasks (2014 and following)

See Section 9.5.2 for more detailed description of the research tasks.

5. Mitigation Plan

Develop mitigation measures if required.

9.4 FINDINGS OF RESEARCH COMPLETED

9.4.1 Research Summary Results

9.4.1.1 Pre-mine Kinetic Tests

Pre-mine and supplemental geochemical characterization studies included kinetic testing with humidity cells and column tests to evaluate the leaching behaviour of waste materials and predict drainage quality (NDM 1997; BHP Billiton 2002; SRK 2003a, 2003b, 2003c). Kinetic testing of various waste rock materials indicated that most waste rock materials have low potential for acid generation under room temperature conditions, with low levels of leaching and neutral to alkaline pH. An exception to this was observed from two kinetic tests of Misery Pipe metasediments with elevated sulphur concentrations which generated acidic leachate, though oxidation rates were low and related to sulphur concentrations. Significant acidity and metal release from metasediments is expected to be a short-term effect, due to the relatively low sulphide contents (<0.2%). In additional, these materials have been managed to minimize this potential, and have not resulted in acidic seepage in the field to date.

Kinetic testing of kimberlite and kimberlite waste materials showed that these materials did not appear to have potential to generate acid. Sulphur and metal leaching (particularly nickel) from kimberlite materials occurred at a higher rate than for the waste rock; however, the leachate from kimberlites was also more alkaline than from waste rock due to the presence of greater quantities of carbonate.

9.4.1.2 Operational Seepage Monitoring

Seepage surveys of all constructed waste rock storage facilities and ore stockpiles are conducted twice a year (during spring freshet, and again in late summer or fall before freeze up), in accordance with the requirements of the Water Licence. Testing of seepage chemistry is designed to detect potential chemical changes that may be produced by the waste rock. Results of seepage monitoring are reported annually in Waste Rock and Waste Rock Storage Area Seepage Survey reports (e.g., SRK 2009).

The range of observed seepage water quality has been generally stable over the period of operational monitoring with seasonal and year-over-year variability and localized areas with minor elevations. Atypical results identified by routine seepage monitoring has led to several special studies (described below), as well as changes to operational management.

9.4.1.3 Specific Studies of Coarse Kimberlite Reject

Routine seepage monitoring downgradient of the Coarse Kimberlite Rejects Storage Area (CKRSA) identified acidic conditions in stagnant pools and in some flowing seeps, with pH values as low as pH 3 observed during 2001 and 2002. Investigations conducted in the summer of 2002 (Day et al. 2003; SRK 2003d) concluded that the acidic tundra soils were leaching iron from the overlying coarse kimberlite rejects (CKR) under reducing condition, and that oxidation of reduced iron in contact with the atmosphere at emergent seepage locations was responsible for the observed low pH conditions. Since 2002, deposition of granite waste rock around the margins of the CKRSA has eliminated all external dump toes consisting of CKR, and the pH of seepage downgradient of the CKRSA has improved, and is typically in the range of 4.7 to 7.

9.4.1.4 Kimberlite Neutralization Potential

Kimberlites at EKATI have high neutralization potential (NP) and are characterized as having negligible potential to generate ARD due to their high carbonate content. The carbonate content of a material can be determined from measurements of total inorganic carbon (TIC), but the analysis does not distinguish between calcium- and magnesium-bearing carbonates (e.g., calcite, dolomite, magnesite) and iron-and manganese bearing carbonate (e.g., siderite, ankerite), the latter of which do not contribute to the NP. A mineralogical analysis was therefore conducted in 2006 to determine if TIC analysis is a reasonable surrogate to carbonate NP (SRK 2007a).

Mineralogical analyses identified the dominant carbonate form in Fox Pit kimberlite samples to be calcite, while that of the Panda underground samples was dominantly dolomite with minor amounts of magnesite. No iron carbonates were found by XRD or microprobe.

The proportions of carbonate as calcium and magnesium compared to total carbonate were between 95% and 99%. Neutralization potentials determined from TIC therefore provide a good estimate of actual available NP from calcium and magnesium carbonates. It was therefore recommended that the current practice of calculating NP from TIC as a conservative measure of ARD potential could continue.

9.4.1.5 Ion Exchange Capacity of Soils

A study was conducted in fall 2006 to evaluate whether cation exchange between WRSA drainage and tundra soils could be responsible for the observed trends of decreasing pH and increasing dissolved aluminum concentrations along the flow path between SEEP-018B and SEEP-019 (SRK 2007b).

The findings of this study supported the cation exchange hypothesis by showing that the observed aluminum concentrations could be achieved by charge-equivalent exchange with dissolved calcium at the levels that appear to be occurring based on reductions of calcium load along the flowpath. Further, it appears that aluminum release could continue for a few decades, at ever-decreasing rates, which is expected to result in generally declining aluminum concentrations at SEEP-019 with time.

9.4.1.6 On-site Kinetic Tests

The on-site kinetic tests have not yet produced sufficient data to draw any interpretations. A summary of the tests will be provided in the Report on the 2010 Seepage Monitoring Program (March 2011).

9.4.1.7 Water Quality Predictions

Early predictions of long-term seepage quality were presented in pre-mine geochemical characterization reports (NDM 1997; SRK 2003a, 2003b, 2003c) based on a combination of laboratory kinetic testing results and available seepage water quality data. Most recently, an update of long-term seepage water quality was presented in the Geochemical Characterization and Metal Leaching (ML) Management Plan (SRK 2007c) based on current drainage chemistry from seepage monitoring stations around each storage facility.

Waste rock leachate quality is dependent on the actual minerals present and the mechanisms by which the minerals break down chemically to release metal ions to solution. Since weathering process occurring now are expected to continue and slowly diminish into the future, seepage water quality observed over the operational monitoring period constitutes the best available information on which to base estimates of future seepage water quality for neutral and alkaline drainage conditions. As such, median and 95th percentile values were used as estimates of ‘most probable’ and ‘reasonable worst case’ future water quality, respectively. In summary, long-term seepage quality is expected to be similar to current conditions, and would be expected to improve with time as leachable sources are depleted. Leachable sources exposed during reclamation by relocation of materials or by surface disturbances could be expected to be similar to those sources generated on an on-going basis during operations. Information from the water balance studies will also be incorporated, if necessary into this task to understand the timing of maximum permafrost coverage in the WRSA and how this might affect seepage water quality from the piles. Water balance information will be drawn from the research on permafrost development in the WRSA (Reclamation Research Plan #7, Appendix 5.1-4).

9.4.1.8 Toe Berm Performance

The performance of toe berms at EKATI was reviewed by EBA Engineering and SRK Consulting in 2007 (EBA 2007; SRK 2007d). Toe berms have been constructed around the Fox WRSA and at select locations around the Panda/Koala/Beartooth WRSA.

The assessment considered the geochemistry and measured flows at seepage monitoring stations before and after toe berm construction. However, the geochemical analysis provided limited useable data because measured changes in the geochemistry could be attributed to several factors not necessarily related to toe berm construction. Therefore the degree of effectiveness of the toe berms in limiting seepage of water from the WRSA could not be quantified. However, measured flows rates were reduced at several locations after toe berm construction, and this was substantiated by observations during construction that showed water impounding along the inside toe of some of the berms. The evaluation therefore suggests that toe berms are effective in reducing flow rates of water exiting the waste rock.

9.4.1.9 Ground Temperature Monitoring of WRSA

The following ground temperature monitoring is in place for Panda/Koala, Misery and Fox WRSAs: ten ground temperature cables (GTC) have been installed in the Panda/Koala/Beartooth WRSA and adjacent toe berms, and temperature has been monitored there since 1998; two GTC have been installed in the CKRSA, and temperatures have been monitored since 2001, although one GTC has been damaged and non-operational since 2005; eight GTC have been installed in the Misery WRSA, and temperature has been monitored there since 2000; three GTC have been installed in the Fox toe berms and monitoring has been conducted there since 2002; and three GTCs have been installed in the Fox WRSA, and have been monitored since 2007. Ground temperatures are measured a minimum of four times at the various locations within the WRSA, and the results are report annually in the Waste Rock and Waste Rock Storage Area Seepage Survey reports (e.g., SRK 2009).

In summary, results presented in the 2008 Waste Rock and Waste Rock Storage Area Seepage Survey Report (SRK 2009) indicates that the entire Panda/ Koala/ Beartooth WRSA and the Misery WRSA are in a permafrost condition with the exception of the surface active layer. The CKRSA however is believed to be unfrozen at its current temperature of slightly below 0°C. This is because the freezing point temperature of CKR is expected to be lower due to the higher salinity of porewaters. Freezing of the pile is anticipated, though it is expected to take a considerable amount of time due to high moisture content and the amount of latent heat that must be liberated before freezing will occur. Large portions of the Fox WRSA also continue to remain unfrozen, though it has continued to show an overall cooling trend and is expected to continue and culminate in freezing of the pile. Toe berms at all WRSA are in a permafrost state with the exception of the surface active layer.

9.4.2 Application of Lessons Learned

The results of on-going and completed studies have contributed to the understanding of mine waste geochemistry and processes associated with waste rock storage area seepage. This information will contribute to the prediction of the behaviour of these materials and facilities during and after closure. Several studies have also been applied to current management practices:

- Results of the Kimberlite Neutralization Potential study determined that TIC measurements provide a good estimate of actual available neutralizing potential (NP) from calcium and magnesium carbonates. As a result, the practice of calculating NP from TIC as a conservative measure of ARD potential was allowed to continue.
- The results of the specific studies of coarse kimberlite rejects have had important implications for management of wastes where soils have high natural acidity. Granite waste rock was deposited around the margins of the CKRSA to eliminate all external dump toes consisting of CKR. In addition, subsequent expansions of the CKRSA and all newly constructed waste rock storage facilities at all mine components were constructed with pre-laid granite pads, and operational management procedures are in place to limit the accidental disposal of kimberlite in the waste rock storage areas.
- The evaluation of the effectiveness of toe berms suggests that toe berms are effective in reducing flow rates of water exiting the waste rock, and that the use of toe berms would be effective as part of the waste management plan for future pit developments. As such, plans for the construction of the Sable Pit WRSA include construction of toe berms around its perimeter.

9.4.3 Data and Information Gaps

No data and information gaps have been identified for the research at this time.

9.5 REMAINING SCOPE TO BE COMPLETED

9.5.1 Detailed Work Scopes (next three years)

Table 5.1-4i provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Operational Seepage Monitoring

Seepage monitoring surveys measuring water chemistry and seepage flow rates will continue to be conducted at a minimum of twice per year, and reported annually in the Waste Rock and Waste Rock Storage Area Seepage Survey reports (e.g., SRK 2009).

Task 2. On-site Kinetic Tests

Leachate samples from the on-site barrel tests will continue to be collected during the open water season and will continue throughout the operational mine life. The results will add to the understanding of the leaching behaviour of specific waste materials under actual site conditions. A summary of the tests will be provided in the Report on the 2010 Seepage Monitoring Program (March 2011).

Task 3. Water Quality Prediction

Predict post-closure seepage flows and water quality. Historical and current seepage data will be used to estimate potential concentrations and flows of chemical constituents to the receiving environment.

Task 4. Risk Assessment

Determine the effects that seepage will have on the receiving environment (ecological risk assessment). The risk assessment will consider dilution of the seepage in the receiving environment and ecological receptors in the receiving environment.

9.5.2 Conceptual Work Scopes (2014 and following)

Table 5.1-4i provides an outline and schedule of conceptual tasks to be undertaken in 2014 and following.

Task 5. Mitigation Plan

Develop mitigation measures if required.

9.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on WRSA seepage and water quality in the waste rock storage area mine component is linked to operational seepage monitoring for WRSA. Operational monitoring will continue to be used while the WRSA are still active.

9.7 PROJECT TRACKING SCHEDULE

Table 5.4-1i. Waste Rock Seepage Quality

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short-term Research Tasks (within next 3 years)				
1	Operational Seepage Monitoring	Field work and reporting	On-going	2018
2	On-site Kinetic Tests	Field work and reporting	On-going	2018
3	Water Quality Prediction	Data review, analyses, modeling, reporting	2013	2013
4	Risk Assessment	Data review, analysis, and reporting	2013	2013
Long-term Tasks (2014 and following)				
5	Mitigation Plan	Information review and reporting	2014	2014

9.8 COST

Total expected costs are $200,000 - $300,000.

9.9 REFERENCES

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10. Establishment of Self-sustaining Plant Communities on Topsoil and Lake Sediment Storage Sites

10.1 UNCERTAINTY

The development of self-sustaining plant communities on the remaining topsoil and lake sediment/glacial till materials storage area after the material has been quarried for reclamation activities.

10.2 RESEARCH OBJECTIVE

Lake sediments (mixed with glacial till) were salvaged from the overburden materials of the Panda and Koala North open pits at the commencement of pit mining. These materials were stockpiled north of the Panda/Koala WRSA. Topsoil has been salvaged from the Koala, Fox and Misery sites and is stockpiled near each of these pits. Additional storage sites for lake sediments and topsoil will be created when the Sable and Pigeon pits are developed. The current volume of salvaged materials and storage locations are provided in Section 5.4 of the ICRP. Revegetation will be required at all of these locations after some or all of the stored material has been removed for surface reclamation across the minesite.

The research of vegetation growth on remnant topsoil and lake sediment storage sites is divided into two research plans. This research plan focuses on finding the plant species and identification of substrate materials that will affect the plant community composition. The second research plan (Vegetation Cover and Surface Stability on Topsoil and Lake Sediment Storage Sites) focuses on the expected percentage of cover that will be sufficient to maintain surface stability.

The research objective for the establishment of self-sustaining plant communities on topsoil and lake sediment storage sites is to determine what self-sustaining plant community type(s), can be established on sites where topsoil and lake sediment/glacial till was stored.

10.3 RESEARCH PLAN

10.3.1 Tasks Completed or Initiated

1. Tundra Plant Species

The task will be used to survey tundra plant species which have the potential for revegetating topsoil and lake sediment/glacial till storage areas. BHP Billiton has committed to using native regional plants for revegetation work at EKATI. Native plant research for topsoil and lake sediment areas includes identifying plants that would grow and sustain on a variety of soil conditions ranging in texture from the fine-grained lake sediment to coarse-grained granular glacial till materials. The survey of established and disturbed tundra plant communities within the EKATI mine area and the surrounding region has identified tundra species with potential for revegetating top soil and lake sediment/glacial till materials. Potential species will be assessed, additional species may require testing.

2. Materials Suitability.

Assess the suitability of topsoil and lake sediment/glacial till materials to support a self –sustaining plant cover. Greenhouse studies have been completed and field trials initiated to assess the ability to establish and maintain a self-sustaining plant cover of local tundra species on topsoil, lake sediment and glacial till. Continued monitoring of field trials is required.

3. Seed Collection, Storage and Propagation

A Standard Operating Procedure (SOP) has been developed that identifies seed sources and provides guidelines for collecting and processing seeds for use in revegetation. The SOP will be expanded as needed, to include updated species lists and related information.

4. Natural Colonization and Successional Trends

Assess natural colonization and successional trends. Continued monitoring of field trials is required to assess natural colonization and successional trends at existing study sites on topsoil and lake sediment/glacial till storage sites. Literature will also be reviewed to determine how natural colonization can be encouraged.

5. Weeds Monitoring

The presence of weeds at EKATI and at abandoned mines in the NWT has been assessed in the course of monitoring revegetation and rehabilitation. This practice will continue on topsoil, lake sediment/glacial till storage areas.

10.3.2 Short-term Tasks (to be started/continued in the next three years)

See Section 10.5.1 for more detailed description of the research.

1. Tundra Plant Species

This research on identifying tundra plant species with potential for revegetation topsoil and lake sediment/glacial till storage sites is already underway. The task is to build on previous work.

2. Materials Suitability

This assessment of the suitability of topsoil and lake sediment/glacial till materials to support a self-sustaining plant cover is already underway. The research will build on previous work.

3. Seed Collection, Storage and Propagation.

A Standard Operating Procedure (SOP) for seed sourcing, collecting and processing has been developed. This research will build on previous work and refinements will be made to the SOP as needed.

4. Natural Colonization and Successional Trends.

The task will include continued monitoring of field trials and the findings will build on previous work. A literature review will be completed to examine how natural colonization can be encouraged.

5. Weeds Monitoring

Weeds colonization monitoring is already underway. This research will build on previous work.

10.3.3 Long-term Tasks (2014 and following)

No additional long-term tasks are planned. Short-term tasks identified will be continued in the long-term, as required.

6. Revegetation Locations

Determine locations within the remaining topsoil and lake sediment storage sites where vegetation establishment will be needed.

10.4 FINDINGS OF RESEARCH COMPLETED

Determine locations within the remaining topsoil and lake sediment storage sites where vegetation establishment will be needed.

10.4.1 Research Summary Results

10.4.1.1 Tundra Plant Species

Summary of Findings

Ecological mapping and vegetation inventories for EKATI were completed early in project development (BHP Billiton 1995), followed by an inventory of soils and vegetation for the Misery Esker (Kidd 1999). A Traditional Knowledge perspective on biodiversity in the mine area was provided the Dogrib Treaty 11 (Dogrib 2000).

Ongoing revegetation studies at EKATI have identified potentially useful native species (Kidd 1996; Kidd and Rossow 1997, 1998; Kidd and Max 2000a; Martens 2005, 2008, 2009).

Greenhouse Study

- Native-grass cultivars did not perform well, probably because grasses generally require at least a modest level of nutrients.
- Growth of *Hedysarum mackenzii* was poor, possibly due to excessive soil moisture in some treatments as a result of greenhouse conditions.
- No cuttings of the evergreen shrubs *Loiseleuria procumbens* (alpine azalea) or *Arctostaphylos alpina* (bearberry) survived. Cuttings of *Salix planifolia* (diamondleaf willow) and *S. myrtillifolia* (blueberry willow) and sprigs of *Arctophila fulva* (pendant grass) fared better; they are adapted to fine-grained soils, and their larger size (and therefore greater water storage) allowed them to better tolerate high temperatures in the greenhouse.
- This study also presented data on the physical and chemical properties of the lake sediment, and trace metal concentrations in plant tissues. Note that some of the challenges to plant growth in this experiment were due to the greenhouse conditions, and might not apply in field trials.

Field Studies

- Revegetation studies were established on topsoil and lake sediment/glacial till stockpiles. Seed mixtures of native-grass cultivars and native shrubs and herbs were applied at several sites and a number of useful native grass cultivars and forb and shrub species were identified.
- Native plant species potentially useful for revegetation of various site types, including topsoil and lake sediment/glacial till storage sites include *Epilobium angustifolium* (fireweed), *E. latifolium*

(river beauty), and the legumes *Astragalus alpinus* (alpine milkvetch), *Hedysarum mackenzii*, (liquorice root), *Oxytropis deflexa* (deflexed oxytrope), and *O. maydelliana* (Maydell's oxytrope).

- The most successful native-grass cultivars on lake sediment/glacial till were Arctagrostis latifolia (tall Arctic grass), Calamagrostis canadensis (bluejoint), *Deschampsia ceaspitosa* (tufted hair grass), *Trisetum spicatum* (spike trisetum), *Festuca rubra* (Arctared fescue) and *Poa alpina* (alpine bluegrass).

Application of Lessons Learned

A number of promising tundra species and native-grass cultivars have been identified for revegetation of lake sediment/glacial till stockpiles.

Data and Information Gaps

- The need for additional species suitable for revegetation of lake sediment/glacial till materials.
- Cultivation methods and practices to enhance establishment of tundra species by means of direct seeding, use of containerized stock or planting into an existing grass cover.

Recommendations for Future Work

- Cultivation methods and practices that promote the establishment of tundra species by means of containerized stock or direct seeding.
- Review the list of promising species to determine whether additional species need to be added for successful revegetation of lake sediment/glacial till.

10.4.1.2 Materials Suitability

Revegetation trials were established on topsoil and lake sediment/glacial till stockpiles at Fox Portal and Fox Pit, Beartooth WRSA, Panda/Koala Stockpiles (Kidd and Max 2002; Martens 2007).

Summary of Findings

- The results of the Fox Portal study showed that, on lake sediment and esker sand, vascular plant cover in all plant cultivation treatments was typically less than 5% after five growing seasons. On topsoil, vascular plant cover was moderate in plots seeded with native-grass cultivars, but low in other treatments. Soil properties of both lake sediment and esker sand were generally unfavourable for plant growth. Grazing by caribou and hares significantly affected establishment and early growth of plants, especially native forbs, in the experimental plots. The study area was fenced after the third growing season, but forbs were slow to recover.
- Topsoil provided the most favourable conditions for plant growth in the comparative study with esker sand and lake sediment at the Fox Portal through eleven years of monitoring. Low organic content, low moisture holding capacity and low cation exchange capacity appear to be the main factors responsible for poor growth.
- Subsequent research indicates that the lake sediment used at Fox Portal is not representative of that at the Panda/Koala stockpiles.
- Stockpiles at Panda/Koala stockpiles are composed of a mixture of coarse morainal material and lake sediment, with a small percentage of granite waste rock. Soil fines, i.e., silt plus clay fractions vary, and range from approximately 30% to 60%. Organic carbon levels are low (<1%).
- The high fines content of lake sediment, generally a favourable characteristic in terms of soil moisture and nutrient holding capacity, is a physical limitation for plant establishment. The

surface of lake sediment (and glacial till) deposits tends to be hard and dry, impairing moisture penetration and providing few microsites for seed to gain a foothold.

- Chemical characterization of lake sediment and glacial till has not identified any concern with respect to plant toxicity. Plant nutrient content is low.
- The addition of fertilizer (16-16-16 NPK), applied at moderate levels (e.g., 150 kg/ha) will assist plant establishment.
- Total vascular plant cover on a stockpile (left as dumped) comprised largely of lake sediment, averaged 14% 6 years after the seeding. On a levelled stockpile comprised largely of glacial till, vascular plant cover averaged 15% after 4 years. Both areas had been seeded with a mixture of native-grass cultivars and forbs and fertilized.
- Total vascular plant cover on topsoil stockpiles, two year following treatment with seed and fertilizer, was 12% at Fox and 15% at Beartooth. Seeded grasses provided most of the second year cover. The Beartooth stockpile was left in an as dumped condition. Seedling establishment on the upper slopes of the dump piles was good. Numerous microsites, created by the presence of rocks and gravel and a soft, friable surface enhanced seedling establishment. Species establishing from root stocks included *Betula glandulosa* (dwarf birch), *Calamagrostis canadensis* (bluejoint), *Cerastium arvense* (chickweed), *Epilobium* spp. (fireweed), *Ledum decumbens* (Labrador tea) and *Vaccinium uliginosum* (bilberry).

Application of Lessons Learned

- Lake sediment and glacial till materials in the Panda/Koala stockpiles appear to be suitable for plant establishment.
- The addition of fertilizer (16-16-16 NPK), applied at moderate levels (e.g., 150 kg/ha) will assist plant establishment.
- Where lake sediment and glacial till materials are to remain in stockpiles, revegetation results indicate that these materials should be left as dumped to improve soil moisture infiltration and plant establishment, and the diversity of the plant community that develops.
- Where stockpiles have been levelled, surfaces should be roughened, e.g., deep ripped, to relieve compaction, improve moisture penetration and storage, and provide favourable microsites for plant establishment.
- Survival of the original plant cover is greatly increased when topsoil stockpiles are left as dumped and not levelled.

Data and Information Gaps

- Suitability of lake sediment and glacial till stockpiles resulting from future mine development.
- Requirement for nutrient input to sustain or enhance plant cover development in the long-term.

Recommendations for Future Work

- Continued monitoring of plant cover at existing stockpile sites.
- Chemical and physical characterization of material in new lake sediment/glacial till stockpiles to assess suitability of material for plant growth.
- Nutrient requirements to sustain plant growth in the long-term.

10.4.1.3 Seed Collection, Storage and Propagation

Research Results

A Standard Operating Procedure (SOP) has been developed to identify seed sources and provide guidelines for collecting and processing seeds for use in reclamation (BHP Billiton 2004; Martens 2003, 2005).

The SOP provides information on locations, collection techniques and recommended harvesting dates for seed of several shrub, forb and graminoid species that have been found to be useful for reclamation at EKATI. Species listed include:

- *Arctostaphylos rubra, A. alpina* (bearberry)
- *Betula glandulosa* (dwarf birch),
- *Carex aquatilis* (water sedge)
- *Dryas integrifolia* (white dryad)
- *Empetrum nigrum* (crowberry)
- *Epilobium angustifolium, E. latifolium* (fireweed)
- *Eriophorum vaginatum* (cotton grass)
- *Hedysarum mackenzii* (Liquorice root)
- *Oxytropis deflexa* (reflexed locoweed), *O. maydelliana* (Maydell's oxytrope), **O. hudsonica* (Hudsons locoweed)
- *Vaccinium uliginosum* (bilberry)

Seed of tundra plants was collected between 2000 and 2004, cleaned and stored in a deep freeze at the EKATI Minesite. Germination tests conducted in 2008 indicated that the viability of all three *Oxytropis* spp. remained high (in excess of 90%, with scarification) after 4 to 8 years of storage. Viability of dwarf birch and fireweed seed, collected in 2004, remained at 55% and 69%, respectively.

Application of Lessons Learned

- A number of promising plant species for revegetation of lake sediment/glacial till have been identified through previous studies.
- Storage conditions optimum for legume seed may not be optimum for seeds with a thin seed coat, such as those from dwarf birch and fireweed.
- A commercial nursery was retained to develop methods and procedures for the large-scale production of containerized seedling stock.

Data and Information Gaps

- Review the existing information sources, including the SOP, to determine whether sources of seeds and/or live plant materials have been identified for all desired species. If needed, research additional collection sites.
- Species that can be readily established by direct seeding and species that are best established with containerized stock.
- Optimum time when seed should be collected.

- Collection methods:
  - by hand or machine assisted.
  - specialized methods for certain species.
- Estimated volumes of seed required by species.
- Storage conditions for each species to retain seed viability.
- Out-planting regime to minimize mortality.

Recommendations for Future Work

- Build on and expand the existing Seed Collection SOP to include potential useful species for lake sediment/glacial till storage areas, and address missing information.

10.4.1.4 Natural Colonization and Successional Trends

- Work closely with Coast to Coast Nursery in the development of methods and practices that will minimize out-planting mortality, including practices such as forced senescence and planting dormant stock.

Research Results

At this early stage in site reclamation, natural colonization is limited to early colonizers, such as *Betula glandulosa*, (dwarf birch), *Epilobiuim* spp. (fireweed), *Empetrum nigrum* (crowberry), and graminoid species such as *Calamagrostis canadensis* (bluejoint), *Eriophorum* spp. (cotton grass) and *Carex* spp. (sedges) in moist sites. Cover remains sparse (Martens 2005, 2007, 2009).

Application of Lessons Learned

- Native-grass cultivars and fertilizer, at low rates of application, promote surface stability and assist natural colonization.
- Natural colonization remains sparse.

Data and Information Gaps

- Methods to accelerate natural colonization
- Changes in plant community composition and structure with time.
- Chemical and physical characteristics of lake sediment/glacial till in future stockpiles

Recommendations for Future Work

- Determine site condition requirements for the target tundra species.
- Identify methods to assist establishment of tundra species in topsoil and lake sediment/glacial till.
- Continue monitoring successional trends at existing stockpile study sites.
- Review successional trends on similar sites in the NWT and YT and elsewhere.

10.4.1.5 Weeds Monitoring

Research Results

The presence of weeds at EKATI has been assessed periodically in the course of conducting rehabilitation monitoring. As of 2007, the only invasive weed recorded at EKATI is *Hordeum jubatum* (foxtail barley), which is limited to the area around the airport.

At the Giant Mine, near Yellowknife, extensive colonization by *H. jubatum* was noted in 2001 (Kidd and Max 2001). The only other non-native species present was *Equisetum pratense* (meadow horsetail). Non-native weed species recorded at the Rae Mine included *H. jubatum*, *Phalaris arundinacea* (reed canarygrass), *Taraxacum* spp. (dandelion) and *Polygonum* spp. (knotweed). At the Discovery Mine, weed species recorded included *H. jubatum*, *E. pratense*, and *Erigeron* sp. (fleabane). Martens (2007) assessed natural colonization at several disturbed sites in the region, but did not report the presence of any weedy species.

Application of Lessons Learned

Although the EKATI mine is remote, opportunity still exits for weeds to establish at the mine site – through natural vectors, via the winter road, or as contaminants in seed of native grasses grown on agricultural lands.

Data and Information Gaps

None.

Recommendations for Future Work

- Continue to watch for weeds when monitoring revegetation success and moving about on the mine site.
- Take appropriate action if weeds are found
- Request Certificate of Analysis for every seed lot prior to purchase to ensure that no problem weeds are included. Refuse contaminated seed lots or request that they be cleaned again and sampled again for weeds. Note: many weeds common in agricultural fields will be killed by the harsh winters at EKATI (Hardy BBT 1986).

10.5 REMAINING SCOPE TO BE COMPLETED

10.5.1 Detailed Work Scopes (next three years)

Table 5.1-4j provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Tundra Plant Species

- Review the list of promising species to determine whether additional species need to be added for successful revegetation of lake sediment/glacial till. Surveys could include the plant communities established on disturbed sites.
- Research cultivation methods and practices to enhance species establishment, as required.

Task 2. Materials Suitability

- Monitor plant cover at existing stockpile sites at Panda/Koala, Beartooth, Fox and Misery Pits, to characterize the development of long-term plant cover.
- Determine chemical and physical properties of lake sediment/glacial till materials in new storage piles at Sable, Pigeon and Misery Pits and assess revegetation suitability.
- Research nutrient requirements to support a self-sustaining plant cover on storage sites.

Task 3. Seed Collection, Storage and Propagation

Develop a program that will provide suitable native stock for revegetation of all mine components that require revegetation, including topsoil and lake sediment storage areas. Because native seed production is generally low and infrequent, seed collection and development of suitable methods and procedures must start early in the research program. In 2010-2013 the research will build on previous studies, by including seed collection, storage and propagation work specific to those plants already identified as candidates for the establishment of an early protective cover, and for a long-term succession cover on lake sediment/glacial till.

Sub-tasks to be undertaken:

a) Select Species

This will include species known to do well plus others identified in the assessment trials outlined above in Section 10.5.1.

b) Seed Collection

1. Seed Needs. Determine estimated quantity of seed of the target species required for revegetation research and reclamation of storage sites remaining after site reclamation is complete. Seed requirements and storage viability will determine species collection priorities and quantities collected for future use.
2. Collection Sites. Identify accessible stands of selected species, where seed or other plant materials can be collected. Several locations (three or four) for each species will be selected to avoid intensive collection from the same area year after year. This may require the addition of two or three sites for those species already addressed in the SOP. Sites will be GPS referenced and marked on a collection site map.
3. Seed Harvesting. Research the use of handheld equipment to increase efficiency of seed collection.
4. Collection Schedule. Through germination testing, determine the phenology of seed ripening and visual cues to identify mature seed.
5. Seed Storage. Test various storage methods to maximize seed survival and germination. Research to date has shown that legume viability is maintained at a high level, after eight years of storage in a deep freeze. Small seeds with a thin seed coat, such as fireweed and dwarf birch may require different conditions to maintained viability.

c) Plant Propagation

Research into direct seeding and growing containerized seedling stock in the greenhouse for later planting will be continued. Research into the large-scale propagation of tundra species as containerized stock began in 2008. Coast to Coast nurseries, in Smokey Lake Alberta, are currently rearing six tundra species [*Betula glandulosa (*dwarf birch), *Vaccinium uliginosum* (bog bilberry), *Oxytropis deflexa* (reflexed locoweed), *Epilobium angustifolium & E. latifolia* (fireweed), *Empetrum nigrum* (crowberry) and *Hedysarum mackenzii* (Liquorice root)] for out-planting in the Rock Pad Reclamation Study in 2009 and 2010 (Martens 2009). These species all have promise for revegetation of topsoil and lake sediment/glacial till. On-going research on the rearing of seedlings and development of practices to increase survival of out-planted seedlings will be directly applicable to revegetation of the storage sites. Other species with potential for revegetation of storage areas will be added to the Coast to Coast seedling propagation program and the on-site field testing program.

Task 4. Natural Colonization and Successional Trends

- Research plant colonization and community succession on comparable habitats in NWT and YT. Integral to this research will be the characterization, to the extent possible, of the expected plant community and the successional changes that might occur over time.
- Research methods to assist establishment to tundra species on topsoil and lake sediment/glacial till materials.
- Field assessment of natural colonization of existing study sites on topsoil and lake sediment/glacial till stockpiles, and sites with similar characteristics.

Task 5. Weeds Monitoring

Continue to monitor reclamation sites within the EKATI mine area for the presence of introduced weeds. Determine whether weed control is needed, and develop a plan if appropriate.

10.5.2 Conceptual Work Scopes (2014 and following)

Task 6. Revegetation Locations

Determine locations within the remaining topsoil and lake sediment storage sites where vegetation establishment will be needed. This information will be obtained by reviewing maps and final schematics of the mine area, in order to determine site characteristics after all infrastructure development and removal is complete. This research will involve analysis of moisture regimes, substrate types, and areas of instability where cover vegetation will be needed. In addition, determine the specific erosion risks at each site. If hydraulic erosion is a concern, determine whether erosion control structures or geotextiles need to be in place prior to or in place of revegetation efforts. Research will include assessment of surface flow patterns, severity of flood events, and sensitivity of substrate to erosion.

10.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on the use of native plants and establishment of self-sustaining plant communities in topsoil and lake sediment storage areas is linked to:

- Research on the establishment of self-sustaining plant communities in other mine components. In many cases site conditions, plant species present, and other community characteristics will be similar across mine components.
- Research on vegetation percent (%) cover and surface stability for the topsoil and lake sediment storage sites, and other mine components.
- Research on Traditional Knowledge inclusion in reclamation planning for the EKATI mine components.

Additional research will continue throughout mining operations until all required materials have been used and these sites are no longer subject to operations disturbance.

10.7 PROJECT TRACKING AND SCHEDULE

Table 5.4-1j. Sustainable Plant Communities on Topsoil and Lake Sediment Storage Sites.

Research Task #	Task	Project Tracking (*Reporting*, *Modeling*, *Field Work*, *Engineering Designs*)	Research Start	Research Finish
Short-term Research Tasks (within next 3 years)				
1	Tundra Plant Species	Field Assessments and Reporting	2010	2014
2	Materials Suitability	Field Assessments, Monitoring	2010	2014
3	Seed Collection, Storage and Propagation	Field work, nursery research (germination tests), monitoring.	2010	2014
4	Natural Colonization and Plant Succession Trends	Literature review, field assessments.	2010	2014
5	Weeds Monitoring	Ongoing monitoring, adaptive management (if required)	2010	On going
Long-term Tasks (2014 and following)				
6	Revegetation Locations	Desktop Evaluation	2014	2018

10.8 COST

Total expected costs are $100,000 - $150,000.

10.9 REFERENCES

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11. Vegetation Cover and Surface Stability on Topsoil and Lake Sediment Storage Sites

11.1 UNCERTAINTY

Plant cover required for long-term surface stabilization of sites in the topsoil and lake sediment/glacial till storage sites to prevent erosion.

11.2 RESEARCH OBJECTIVE

Lake sediments (mixed with glacial till) were salvaged from the overburden materials of the Panda and Koala North open pits at the commencement of pit mining. These materials were stockpiled north of the Panda/Koala WRSA. Topsoil has been salvaged from the Koala, Fox and Misery sites and is stockpiled near each of these pits. Additional storage sites for lake sediments and topsoil will be created when the Sable and Pigeon pits are developed. The current volume of salvaged materials and storage locations are provided in Section 5.4 of the ICRP. Revegetation will be required at all of these locations after some or all of the stored material has been removed for surface reclamation across the minesite.

The research of vegetation growth on remnant topsoil and lake sediment storage sites is divided into two research plans. This research plan focuses on the expected percentage of cover that will be sufficient to maintain surface stability. The second research plan (Establishment of Self-sustaining Plant Communities on Topsoil and Lake Sediment Storage Sites) focuses on plant species and identification of substrate materials that will affect the plant community composition.

The research objective for the establishment of the vegetation cover and surface stability topsoil and lake sediment storage sites is to determine what percentage (%) of vegetation cover will be needed to effectively provide surface stability on former topsoil and lake sediment/glacial till storage sites, once the material has been removed for use in reclamation, and to the meet closure objective.

11.3 RESEARCH PLAN

Research has begun on the development of plant cover on topsoil and lake sediment/glacial till storage sites at EKATI. This research plan will build on existing revegetation studies and expand the scope to include the assessment of the physical characteristics. Revegetation studies on the Panda/Koala lake sediment/glacial till stockpiles, the Rock Pad Revegetation Study and at the Fox Portal will be utilized. Additional relevant data may be obtained from the vegetated topsoil stockpiles at Fox, Beartooth, Misery and Koala (vegetation covers have been established at these sites to maintain surface stability until this material is removed and used for future reclamation work). In addition, the relevant literature on revegetation of similar sites will be reviewed.

11.3.1 Tasks Completed or Initiated

Information is available on the establishment of plant cover on lake sediment/glacial till stockpiles and topsoil stockpiles, however no work has been initiated or completed on the relationship between plant cover and surface stability of these materials.

11.3.2 Short-term Tasks (to be started/continued in the next three years)

To determine what percentage of vegetation cover will be needed to effectively provide surface stability on topsoil and lake sediment/glacial till stockpiles, research will cover the following tasks:

1. Plant Cover and Canopy Structure

This task will determine the levels of plant cover and canopy structure needed to provide surface stability on vegetated sites. The information will be obtained in part by monitoring the results of the revegetation studies established on lake sediment/glacial till and topsoil materials at EKATI, and the review of relevant literature on revegetation of similar sites.

2. Plant Community Stability Characteristics

Determine plant community characteristics needed to indicate stability, and how they can be assessed. This research will include quantitative descriptions of reference tundra communities in the EKATI area, as well as a review of criteria that have been used to indicate stability in other northern reclamation projects.

3. Development Rates

Assess rates of development of plant cover and community structure with time. This information will be obtained primarily by monitoring the results of ongoing revegetation studies at EKATI, particularly the studies already established at the Panda/Koala lake sediment/glacial till stockpiles, Fox Portal, topsoil stockpile sites and the Rock Pad Revegetation Study. Research at these sites will be expanded in scope to include the assessment of physical characteristics of the surfaces to be revegtated. In addition, the relevant literature on revegetation of similar sites will be reviewed.

11.3.3 Long-term Tasks (2014 and following)

Short-term tasks identified in Section 11.3.2, above, will continue in 2013 and following. Because plant cover and community development is a slow process in the Low Arctic tundra, existing studies will be monitored to track long-term changes in plant cover and surface stability. Additional study sites may be added, to provide information on the dynamics of early plant cover and surface stability on newly disturbed sites with suitable site characteristics, at a time when disturbed sites are most vulnerable to erosion.

11.4 FINDINGS OF RESEARCH COMPLETED

11.4.1 Plant Cover and Community Structure

Research on the development of plant cover on topsoil and lake sediment/glacial till has begun at several storage and research sites at EKATI. Native-grass cultivars were seeded in test plots on lake sediment at the Fox Portal. Several seed mixes composed of native-grass cultivars, native forbs, and native shrubs were applied to the glacial till/lake sediment stockpile associated with the Panda/Koala WRSA in 2002. At Airstrip Lake, revegetation test plots on lake sediment were seeded with native-grass cultivars in 2004, and legumes were added in 2005.

11.4.1.1 Research Summary Results

- At Fox Portal, mean total live cover of vascular plants on topsoil after five growing seasons in plots seeded with native grass cultivars (without added rocks), was 24.3%, and consisted almost entirely of the seeded grasses. After 11 years, total vascular plant cover had declined somewhat to 16.9% (Martens 2007).
- In lake sediment test plots seeded with native-grass cultivars (without added rocks) at Fox Portal, mean total live cover of vascular plants after five growing seasons was 2.3% (down from 4.7% after one growing season), and consisted almost entirely of the seeded grasses (Kidd and Max 2000b). At the Panda/Koala WRSA, the lake sediment plots seeded with native-grass cultivars had the highest cover (23 to 28%) in 2006. Only trace cover was found in plots seeded with legumes (forbs); plots seeded with the forb *Epilobium angustifolium* and two native shrubs had no cover of these species. In the Airstrip Lake test plots, cover values in 2006 ranged from 14 to 18%, somewhat lower than in 2005 (Martens 2007). Legumes seeded in test plots in 2005 were not yet evident in 2006.
- On the Panda/Koala lake sediment/glacial till stockpile site, total vascular plant cover averaged 15% after six years, on a stockpile comprised largely of lake sediment (left as dumped), and 14% after four years, on a levelled stockpile comprised largely of glacial till.
- On the Misery topsoil stockpile, mean cover of native-grass cultivars after 3 growing seasons ranged from 15 to 28% (Martens 2005). On the Fox and Beartooth topsoil stockpiles; cover after two growing seasons ranged from 10 to 27% (Martens 2007).
- Early colonizers, *Epilobium* spp. (fireweed), and seeded legumes provided only sparse cover after eleven years at Fox Portal. A number of native species had established from rootstocks on the Beartooth topsoil stockpile (left as dumped) and provided only sparse cover two years after placement.
- The high fines content of lake sediment, generally a favourable characteristic in terms of soil moisture and nutrient hold capacity is a physical limitation for plant establishment. The surface of lake sediment (and glacial till) deposits tends to be hard and dry, impairing moisture penetration and providing few microsites for seed to gain a foothold (Martens 2008).

11.4.1.2 Application of Lessons Learned

- Native-grass cultivars can be successfully established on lake sediment/glacial till.
- Poor physical characteristics of lake sediment and glacial till will slow the rate of plant colonization and community development.
- Surface erosion was observed to be a minor factor in the establishment of plant cover on storage sites.

11.4.1.3 Data and Information Gaps

- Levels of plant cover, canopy height, etc. needed to stabilize the surface of lake sediment/ glacial till and former topsoil storage sites, taking into consideration such factors as substrate and slope angle, and the importance of root biomass.
- Characteristics of adjacent and/or predisturbance tundra plant communities, to assist in developing criteria for a stable post-reclamation community.
- Longer-term data on plant community development in the study plots at the Fox Portal, revegetated lake sediment/glacial till and topsoil storage piles, Airstrip Lake, the Rock Pad Revegetation Study and other sites with similar characteristics.

11.4.1.4 Recommendations for Future Work

- Build on plant cover assessment work at revegetated stockpiles and other relevant sites with similar characteristics.
- Add additional study sites as disturbed areas with suitable site characteristics become available.

11.5 REMAINING SCOPE TO BE COMPLETED

11.5.1 Detailed Work Scopes (next three years)

Table 5.1-4k provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Plant Cover and Canopy Structure

- Monitor and assess the relationship between vegetation cover/canopy structure and surface stability at lake sediment/glacial till and topsoil stockpiles, and the Rock Pad Revegetation Study.
- Assess the physical characteristics of sites to be revegetated (e.g., grain size distribution, organic matter content, bulk density).
- Assess the rate of soil loss on vegetated sites.
- Expand revegetation monitoring to include the assessment of the relationship of plant cover and canopy structure on surface stability.
- Research revegetation cover and surface stability at similar sites in NWT, YT and elsewhere.

Task 2. Plant Community Stability Characteristics

- Quantitative field assessment of reference tundra communities in the EKATI area.
- Research criteria (plant cover and surface soils) that have been used to indicate stability in other reclamation projects.

Task 3. Development Rates

- Review and assess the rates of development of plant cover and other community characteristics over time, on revegetated lake sediment/glacial till and topsoil stockpile sites, the Rock Pad Revegetation Study and sites with similar characteristics.
- Expand the scope of ongoing studies to include the assessment of surface physical characteristics of sites to be revegetated (terrestrial and aquatic habitats).
- Review relevant literature on revegetation of similar sites.

11.5.2 Conceptual Work Scopes (2014 and following)

Task 4. Ongoing Monitoring

- Continue to build on the existing work scope, to acquire long-term information on plant cover and community development and surface stability.
- Add study sites as suitable sites become available, to expand the application and confidence with which information acquired can be applied to lake sediment/glacial till stockpile sites and what remains of topsoil stockpile sites at EKATI.

11.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on vegetation cover and stability lake sediment/glacial till and topsoil storage sites is linked to:

- Research on the use of native plants and development of self-sustaining plant communities, for topsoil and lake sediment storage sites and other mine components.
- Research on vegetation cover and surface stability for other mine components. In many cases site conditions, plant species present, and other community characteristics will be similar across mine components.
- Research on Traditional Knowledge inclusion in reclamation planning for the EKATI mine components.

11.7 PROJECT TRACKING AND SCHEDULE

Table 5.4-1k. Stabilization of Lake Sediment/Glacial Till and Topsoil Stockpile Sites

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short-term Research Tasks (within next 3 years)				
1	Plant Cover and Community Structure	Field work, literature review	2010	2014
2	Plant Community Stability Characteristics	Field work, literature review	2010	2014
3	Development Rates	Field work, literature review	2010	2014
Long-term Tasks (2014 and following)				
4	Ongoing Monitoring of Existing Studies, Add New Sites	Field work, monitoring	2014	2018

11.8 COST

Total expected costs are $100,000 - $150,000.

11.9 REFERENCES

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12. Long-term LLCF Water Quality

12.1 UNCERTAINTY

The water quality of the LLCF and its discharge after closure.

12.2 RESEARCH OBJECTIVE

The closure plan for the LLCF is for settling ponds in each of Cells A, B and C to collect surface runoff from the rock and vegetation cover in each of these cells. The intermediate dikes will become water level control structures. They will be permanent features in the new landscape that control water elevation in the residual ponds and allow surface water to decant from one pond to the next within the basin. The Outlet Dam will be decommissioned and breached at closure and surface flow to Leslie Lake will be restored. The drainage system for the LLCF at closure is shown in Figure 5.5-5 of the ICRP, and LLCF water management is described in Section 5.5.5.6 of the ICRP. Early studies for water quality at closure were completed for the ICRP and are discussed in Section 7.6 of the document. Predictions from water quality research will be important in refining the final closure plan for the facility. These predictions will be based on the deposition plan, kimberlite processing and any changes to the water quality during operations.

The objective of the research plan is to predict the long-term LLCF water quality after closure using numerical modeling tools and best current estimates of source terms and the LOM Plan.

12.3 RESEARCH PLAN

12.3.1 Tasks Completed or Initiated

See Section 12.4.1 for more detailed description of the research.

1. Operational LLCF Water Quality Model

A water quality model has been developed for the operation of the LLCF (Rescan 2008a, 2008b).

2. Operational LLCF Monitoring Data

Operational monitoring data of LLCF water quality and physical structure (Rescan 2008c, 2007a). Water quality and flow data for key contributing operational sources to LLCF (Rescan 2008a, 2008b).

3. Conceptual LLCF Water Quality Model for Post-closure Phase

A conceptual water quality model for LLCF post-closure has been developed based on the operational model (partially completes Tasks 1, 2, and 3).

4. Research on Effects of Processed Kimberlite Effluent on Water Chemistry and Biology

Research on the effects of processed kimberlite effluent and minewater on water chemistry of the LLCF and potential aquatic effects.

12.3.2 Short-term Tasks (to be started/continued in the next three years)

See Section 12.5.1 for more detailed description of the research tasks.

1. Develop LLCF Closure Water Quality Model

Develop numerical water quality model based on operational LLCF model, to predict water quality after closure.

12.3.3 Long-term Tasks (2014 and following)

See Section 12.5.2 for more detailed description of the research tasks.

2. Estimate the Contribution to the LLCF Water of Salts Expelled from PK Pore Water

Estimate the contribution to the LLCF water of salts expelled from processed kimberlite pore water as pore spaces freeze, until the long-term stable frozen conditions in the LLCF processed kimberlite are reached. Assess the possibility that the chemistry of expelled pore water may evolve during the expulsion timeframe.

3. Update Closure Water Quality Model

Update the water closure quality model as new information becomes available through the mine operations period, and post-closure.

12.4 FINDINGS OF RESEARCH COMPLETED

12.4.1 Research Summary Results

12.4.1.1 Operational LLCF Water Quality Model

An LLCF water quality model is documented in Rescan (2008a, 2008b) as a water quality management tool for the LLCF. The model was developed using the software GoldSim 9.0. Version 1.0 of the model was developed by Rescan Environmental Services (Rescan) in 2005 (Rescan 2008a). The updated model, Version 2.0, supersedes all previous versions of the water quality model and will be used in future applications (Rescan 2008b).

The results of the calibration run using chloride confirmed that Version 2.0 of the water quality model is suitable for use as a predictive tool for the LLCF. The model was run as a life-of-mine Monte Carlo simulation using current best estimates of key input parameters.

The predictions made by the water quality model are based on many assumptions, primarily those of future loadings to the LLCF. Because these inputs are associated with considerable inherent uncertainties (e.g., underground mine water flow rates), the model predictions are likewise associated with uncertainty. Therefore, modeling predictions should not be taken at face value but should be considered to be a best estimate that is based on the information that is currently available.

12.4.1.2 Operational LLCF Monitoring Data

There is an on-going LLCF monitoring program that tracks the water quality and physical structure of the LLCF water column (Rescan 2007a). These data continue to be collected to improve numerical modeling estimates and to refine the conceptual water quality model of the LLCF. The LLCF monitoring has shown cells D and E are seasonally temperature stratified until late September or early October. There is a strong seasonal signal in the concentration of most water quality variables, with concentrations increasing under ice primarily because of ice exclusion of solutes.

12.4.1.3 LLCF Water Quality Model for Post-closure Phase

A conceptual water quality model for LLCF post-closure has been developed for the LLCF post-closure phase. Numerical model development was undertaken to simulate the evolution of water quality within Cell E of the LLCF and Leslie Lake after mine closure. The modeling work is based on the existing water quality prediction model of the LLCF, updated to consider the post-closure period (Model version: LLCF closure v1.0).

To simulate post-closure conditions the modeling work considers chemical loadings to the LLCF from natural runoff, leaching from the waste rock cap covering exposed processed kimberlite beaches and seepage through the processed kimberlite beaches. Scenarios also considered seepage through Dike C and additional loadings from seepage water from submerged processed kimberlite.

A model sensitivity analysis has been undertaken to identify key model parameters of which the following were identified:

- climatic conditions;
- flow paths through and / or over Dike C;
- hydraulic conductivity for seepage flow through the processed kimberlite beaches;
- water management of excess water in Cell E; and
- chemical loadings associated with leaching from waste rock and seepage through the processed kimberlite beaches.

Modeling results showed that even for conservative conditions (i.e., assuming parameter concentrations in Cell E are equal to Water License levels at closure and high end parameter values); the model predicted that all parameters covered by the Water License would be below CCME guideline values by 2040 and most by 2035. Dilution of all parameters is predicted to be between 2 and 6 times after 5 years following the end of operations and 6 to 0 after 10 years. The model predicts a rapid decrease in concentrations within the LLCF following the end of operations and water quality within the facility meeting CCME guideline values for all parameters after 10 to 20 years, even if worst case initial conditions are considered.

The model runs are limited by the assumptions made of future loadings entering the facility. There is uncertainty associated with all the parameters considered in the model. However, the results of the sensitivity analysis indicated where this uncertainty has the greatest impact on model results. The model inputs that have some degree of uncertainty and that can have an impact of the water quality predictions are:

- leach rates associated with the rock cap planned for LLCF reclamation;
- seepage loadings from the processed kimberlite solids; and
- seepage rates through Dike C to provide a better understanding of flow paths after.

The modeling work is providing information to guide future monitoring efforts to improve the planning and execution of LLCF reclamation.

12.4.2 Research on Effects of Processed Kimberlite Effluent on Water Chemistry and Biology

12.4.2.1 Processed Kimberlite Effluent Toxicity Characteristics

Research on the effects of processed kimberlite effluent on the water chemistry and zooplankton of the LLCF (Crocquet de Rosemond 2002; Rescan 2004). This research investigated the toxicity of processed kimberlite effluent on the freshwater zooplankter *Ceriodaphnia dubia*, a commonly used laboratory test organism. Acute (48 hour) and chronic (7 day) toxicity bioassays were conducted using supernatant and filtrate of the final process effluent. Neither the supernatant nor the filtrate, at 100% strength, were acutely toxic to the test organism. Chronic toxicity studies indicated that growth, reproduction and eventually survival were adversely affected by the undiluted effluent supernatant and filtrate. Chronic bioassays using serial dilution showed that effects on survival occurred at an effluent filtrate concentration of approximately 50% and that effects to reproduction occurred at effluent filtrate concentrations lower than 25%.

Toxicity Identification Evaluation (TIE) undertaken by de Rosemond and Liber (2004) using Ethylenediaminetetraacetic acid (EDTA) as a chellator failed to reduce toxicity of 100% and 50% processed EKATI processed kimberlite effluent to *C. dubia*, indicating toxicity may not be caused by certain cationic metals. EDTA, sodium thiosulfate, aeration, and solid phase extraction with C-18 manipulations failed to reduce processed kimberlite effluent toxicity. Toxicity was reduced significantly by pH adjustments to pH 3 or 11 followed by filtration. Toxicity testing with *C. dubia* determined that the cationic DADMAC polymer had a 48-h median lethal concentration (LC50) of 0.32 mg/L and 7-d median effective concentration (EC50) of 0.014 mg/L. The anionic PAM polymer had a 48-h LC50 of 218 mg/L. Based on a weight-of-evidence approach, using the data obtained from the TIE, the polymer toxicity experiments, the estimated concentration of the cationic polymer in the kimberlite effluent, and the behaviour of kimberlite minerals in pH-adjusted solutions, the authors concluded that the cationic DADMAC polymer was the toxic component of this diamond mine processed kimberlite effluent.

12.4.2.2 Polymer (Flocculent) Toxicity Studies

A study undertaken for BHP Billiton evaluated the use of the cationic coagulant, Magnafloc 368 in association with the anionic flocculant Magnafloc 156 (Rescan 2004). Magnafloc 368 (MF368) is a cationic coagulant used by EKATI in conjunction with the anionic flocculant Magnafloc 156 (MF156) to accelerate sedimentation-removal of fines from processed kimberlite effluent. A previous study by Crocquet de Rosemond (2002) deduced that MF368 could be causing observed toxicity of processed kimberlite effluent supernatant to *Ceriodaphnia dubia*, raising concerns regarding the use of MF368 at EKATI. However, a key uncertainty in this research was the inability to confirm that significant residual concentrations of MF368 were present in PKE, due to the lack of an analytical method for this chemical.

Testing and analysis was undertaken to investigate if MF368 was present in processed kimberlite effluent at concentrations potentially harmful to aquatic life. Testing was conducted on the following samples:

- Samples A and B – laboratory-synthesized processed kimberlite effluent analogues prepared through a process designed to mimic processing at EKATI with known addition rates of MF368 (30 g/t and 9 g/t, respectively).
- Sample C – a positive “control” sample prepared by spiking Grizzly Lake water with a known quantity (0.4 mg/L) of MF368.
- Processed kimberlite effluent – actual processed kimberlite effluent collected at EKATI on December 8, 2004.

All samples were submitted for the following tests in early January, 2004:

- Analysis of water quality including total metals, nutrients and physical parameters.
- MF368 analysis using a bromophenol blue colourimetric test which was under development at the time.
- *Ceriodaphnia* 7-d Three-brood Survival and Reproduction Test (with hardness adjustment to ~90 mg/L $CaCO_3$ for Sample C).
- *Selenastrum capricornutum* 72-h Growth Inhibition Test.

The results of the water quality analysis did not identify large differences between Samples A and B, and processed kimberlite effluent. The determined residual MF368 concentrations were highest in Samples A and B (0.10-0.12 mg/L), followed by Sample C (0.05 mg/L) and processed kimberlite effluent (0.04 mg/L).

None of the test samples were toxic to S. *capricornutum* suggesting that residual MF368 concentrations in processed kimberlite effluent do not pose a risk to freshwater algae species even under the scenarios of higher residual concentrations represented by Samples A and B.

Processed kimberlite effluent did not cause mortality or reproductive effects in *Ceriodaphnia* at 100% supernatant. This result indicates that under current operating conditions at EKATI, it is possible to maintain residual MF368 concentrations at levels below those which are toxic to freshwater algae, zooplankton. The toxicity information provided in the Material Safety Data Sheet for MF368 indicates that fish exhibit equal or lower sensitivity to MF368 than zooplankton and algae and are therefore unlikely to be affected by MF368 in processed kimberlite effluent under operating conditions.

Samples A and B were moderately toxic to *Ceriodaphnia*, causing mortality at 100% supernatant and decreased reproduction at 50% and 100% supernatant. The no observed effect concentration (NOEC) was 25% indicating that dilution of supernatant by 4-fold reduced toxicity to zero.

Sample C did not cause mortality in *Ceriodaphnia* but caused some reproductive impairment which was also observed in Grizzly Lake water and was likely attributable to organism response to a change in water conditions. Total metals and ammonia concentrations in test samples were either below known toxicity thresholds, or could not be correlated with the *Ceriodaphnia* results suggesting that metals and ammonia were unlikely to be the cause of observed toxicity to *Ceriodaphnia*. In contrast, the *Ceriodaphnia* results were generally correlated with the determined MF368 concentrations suggesting a link between residual MF368 and potential processed kimberlite effluent toxicity, but that the current residual concentration in PKE was below the toxicity threshold.

Based on these results, it was not possible to rule out MF368 as the potential cause of processed kimberlite effluent toxicity observed by Crocquet de Rosemond (2002). A potential explanation for the different results in this study is that the average MF368 dosage rates were higher in 1999/2000, when Crocquet de Rosemond collected processed kimberlite effluent samples (35 g/t for “Typical” Panda and 90 g/t for “Fox-like” Panda), than under plant conditions in 2004 (4-30 g/t).

The Rescan (2004) study generally concluded that under the 2004 operating conditions, zooplankton and algae were unlikely to be affected by the use of these coagulants and flocculants.

A laboratory experiment reported by Liber et al. (2005) used lake trout fry (*Salvelinus namaycush*) exposed to two wastewater treatment polymers, one anionic (MagnaFloc 156) and one cationic (MagnaFloc 368; Ciba Speciality Chemical), to determine if these chemicals that are used and discharged by mining operations in Canada’s North pose a significant hazard to juvenile fishes. The cationic polymer was substantially more toxic to lake trout fry than the anionic polymer, with 96-hour LC50 estimates of 2.08 and >600 mg/L, respectively. Separate 30-d exposure experiments yielded no observed and lowest observed effect concentrations, respectively, of 0.25 and 0.5 mg/L for MagnaFloc 368, and 75 and 150 mg/L for MagnaFloc 156. In both cases, behavioural responses, especially startle response, were the most sensitive test endpoints. Histopathological assessment revealed that gill pathology appeared within a few days of exposure to both polymers, apparently as a result of localized hypoxia. Acute (4 day) effects included cloudy swelling of epithelial cells, increased gill vascularization, and thickening and shortening of the gill lamella. Chronic (30 day) polymer exposure produced only slightly greater pathological effects than acute exposure, with comparable responses observed only at >1.0 mg/L MagnaFloc 368 and 150 mg/L MagnaFloc 156, suggesting that the fish displayed some level of both behavioural and physiological adaptation to the respiratory stress imposed by the two polymers.

12.4.2.3 Nitrate Toxicity Studies

A study undertaken for BHP Billiton by McGurk et al. (2006) investigated the potential toxicity of nitrate, which is found in the processed kimberlite effluent at EKATI. The nitrate originates from residuals of the blasting agent (ANFO). The acute and chronic toxicity of the nitrate ion (NO_3^-) to the embryos, alevins, and swim-up fry of lake trout (*Salvelinus namaycush*) and lake whitefish (*Coregonus clupeaformis*) were tested in laboratory aquaria. The acute (96 hour) median lethal concentration (LC50) for swim-up fry was 1,121 mg NO_3-N/L for lake trout and 1,903 mg NO_3-N/L for lake whitefish. The chronic (~130 to 150-day) LC50s for embryos to swim-up fry were 190 and 64 mg NO_3-N/L, respectively. Sublethal effects on developmental timing and fry body size were observed at concentrations of 6.25 and 25 mg NO_3-N/L, respectively, in the chronic tests. The authors conclude that these results confirm that the Canadian nitrate water-quality guideline of 2.9 mg NO_3-N/L, which was derived from chronic tests on a temperate-zone amphibian, is applicable to the early life stages of two species of Arctic fish. However, it does not support use of the guideline for acute exposures during early life stages of salmonid fish or for acute or chronic exposures to adult fish, which are relatively insensitive to nitrate. Using this study and others, Environment Canada is currently developing updated guidance of nitrate for the protection of freshwater aquatic organisms.

12.4.2.4 Chloride Toxicity Studies

A study undertaken for BHP Billiton by Rescan (2008) investigated potential toxicity of chloride, which is found in the processed kimberlite effluent at EKATI. Chloride originates from conate groundwater that is pumped to the process plant and LLCF. Prior to 2006, guideline derivations and risk assessments for chloride used acute toxicity tests to determine a suitable short-term exposure guideline, which was divided by an acute-to-chronic ratio (ACR) to estimate a long-term exposure guideline. This approach was taken due to the paucity of chronic toxicity data available for chloride. As a result, these guidelines were dependent on the accuracy of the ACR value employed. The ACR of 7.59, derived by the United States Environmental Protection Agency (US EPA), was used in a number of cases. Since 2006, new toxicological data has allowed the ACR to be re-calculated. In 2007, Rescan and the Iowa Department of Natural Resources (DNR) independently calculated ACRs of 3.63 and 3.99, respectively (Rescan 2007b). These ACRs are considered more scientifically defensible than the previous ACR.

Notwithstanding, it is preferable to calculate long-term exposure guidelines directly on the basis of chronic toxicity test results, rather than using an ACR. With new chronic toxicological data obtained for EKATI, a long-term, site-specific guideline was derived. To reduce uncertainty with respect to sensitivity of resident species, toxicity testing with a resident cladoceran *(Daphnia middendorfiana)*, was conducted under environmental conditions similar to those at EKATI (i.e., photoperiod and temperature). The results of this testing were supportive of use of data for *D. magna* and *Ceriodaphnia.dubia*, respectively, as appropriate surrogates for resident species of cladocerans tested at a colder temperature.

To determine if water hardness should be incorporated into the WQO as an exposure and toxicity modifying factor (ETMF), 7-day *C. dubia* survival and reproduction tests were conducted across a range of water hardness from 10 to 320 mg/L $CaCO_3$. A decrease in the toxicity of chloride was observed with increasing hardness across the range of 10 to 160 mg/L hardness. Above a hardness of 160 mg/L, an additional reduction in toxicity was not as apparent.

Using the species sensitivity distribution (SSD) Rescan (2008) established a chloride WQO of 325 mg/L at a hardness of 80 mg/L. Based on the relationship between water hardness and chloride toxicity demonstrated with *C. dubia*, a WQO for water hardness levels between10 and 160 mg/L was calculated as:

$$\text{WQO} = 124 \times \ln(\text{hardness}) - 218$$

The data summarized in Rescan (2008) contribute substantially to the understanding of the toxicological characteristics of chloride. Although this project was designed to establish data for a site-specific WQO, the data presented here are applicable at sites across Canada and may provide a suitable basis for a Canadian Water Quality Criterion for this element.

12.4.3 Application of Lessons Learned

The results of on-going and completed studies have contributed to the understanding of potential issues and data gaps related to making long-term post-closure predictions of water quality for the LLCF and downstream lakes. A model sensitivity analysis was undertaken to identify key model parameters of which the following were identified:

- climatic conditions;
- flow paths through and/or over Dike C;
- hydraulic conductivity for seepage flow through the processed kimberlite beaches;
- water management of excess water in Cell E; and
- chemical loadings associated with leaching from waste rock and seepage through the processed kimberlite beaches.

The effects of effluent discharge characteristics to the downstream aquatic environment are also of key importance in evaluating the results of water quality predictions for closure. Based on results of operational water quality modeling, certain water quality parameters such as nitrate and chloride have been researched and this work will be applied to the closure modeling.

12.4.4 Data and Information Gaps

The following real or potential data gaps were identified making predictions of post-closure LLCF water quality:

- Pore water is incorporated into the conceptual post-closure water quality model as a source term (see Rescan 2007c), however, more detailed work is required to determine the importance of pore water expulsion to the quality of water in the LLCF post-closure.
- The influence of kimberlite weathering is not presently included in the post-closure conceptual water quality model for the LLCF, and additional work is required to evaluate the relative importance of this phenomenon on LLCF water quality post-closure.
- In the conceptual post-closure water quality model, the extra fine processed kimberlite (EFPK) and fine processed kimberlite (FPK) are not considered separately. At this time, there is no indication that parameter loadings associated with the EFPK or FPK are likely to be of concern during operation or closure of the LLCF. However, the post-closure water quality model needs to be updated to reflect any new information regarding the long-term behaviour of EFPK that may be identified through related reclamation research projects.

12.5 REMAINING SCOPE TO BE COMPLETED

12.5.1 Detailed Work Scopes (next three years)

Table 5.1-4l provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Develop LLCF Closure Water Quality Model

Develop numerical water quality model based on the operational LLCF model, to predict water quality after closure. The approach has been developed using an operational model and will be applied to make post-closure predictions. All model runs will start in 2020, when mine operations are expected to cease, and continue to 2040.

The key components of the modeling study are:

- Application of GoldSim model of LLCF to consider Closure Plan options,
- Modeling work to be based on Option 3aM of the MAA analysis, or more current Wastewater and Processed Kimberlite Management Plan,
- Model to operate on a monthly timestep and to simulate water quality for up to 20 years post closure,
- Impact of hydrological variability to be simulated for each scenario,
- Water quality predictions to be provided for the outlet of Cell E of the LLCF.

Task 2. Estimate the Contribution of Salts Expelled from PK Pore Water

Estimate the contribution to the LLCF water of salts expelled from processed kimberlite pore water as pore spaces freeze, until the long-term stable frozen conditions in the LLCF processed kimberlite are reached. Assess the possibility that the chemistry of expelled pore water may evolve during the expulsion timeframe. Information on pore water chemistry will be incorporated from the study on pore water concentrations which is part of the Permafrost Growth on LLCF Reclamation Research Plan #13 (Appendix 5.1-4).

12.5.2 Conceptual Work Scopes (2014 and following)

Table 5.1-4l provides an outline and schedule of tasks to be undertaken in 2014 and following.

Task 3. Update Closure Water Quality Model

Update the closure water quality model as new information comes available through the mine operations period, and post-closure.

12.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on long-term water quality LLCF is linked to:

- Research on the stabilization of EFPK in the LLCF to ensure no negative impacts on water quality.
- Research on the permafrost conditions in the LLCF at mine closure.
- Research on weathering characteristics of processed kimberlite.

Water quality modeling for the LLCF is conducted during mining operations. Predictive water quality modeling for closure will be conducted alongside operational modeling, with an update on closure predictions near the end of mining operations.

12.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-4l. Long-term LLCF Water Quality

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short-term Research Tasks (within next 3 years)				
1	Develop LLCF Closure Water Quality Model at Closure	Report	2008	2012
2	Estimate the Contribution of Salts Expelled from PK Pore Water	Report	2013	2013
Long-term Tasks (2014 and following)				
3	Update Closure Water Quality Model	Updated model report	2010	2017

12.8 COST

Total expected costs are $150,000 - $250,000.

12.9 REFERENCES

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13. Permafrost Growth in the LLCF

13.1 UNCERTAINTY

13.1.1 Research Question

How will permafrost develop through the LLCF and how will porewater and ground pressures be dissipated?

13.2 RESEARCH OBJECTIVE

Permafrost is expected to aggrade into the processed kimberlite at the LLCF after mine closure. The permafrost table above the lake level prior to processed kimberlite deposition roughly paralleled the ground surface and extended under the lake for a distance corresponding to the depth of water that froze to the lake bottom. Processed kimberlite placement will eventually shift the permafrost table and talik from it's original location. The talik will remain in those areas of the LLCF where a pond overlies the processed kimberlite. The permafrost table will eventually extend under the new pond limits for a distance corresponding to the depth of water that freezes annually to the pond bottom. Permafrost aggradation within the deposited processed kimberlite will occur via two scenarios. Where processed kimberlite is placed over what was originally exposed tundra (outside the original lake shore), permafrost aggradation will occur from above and below the processed kimberlite, as shown in Figure 5.5-7 of the ICRP. Where processed kimberlite is placed over a former talik area, permafrost aggradation will occur from the top downward.

The objective of this research is to predict how permafrost will grow through the LLCF and what corresponding processes are likely to take place for porewater expulsion and dissipation of ground pressures.

13.3 RESEARCH PLAN

13.3.1 Tasks Completed or Initiated

No research has been completed at this time. However data and information currently available that will assist the research work is listed below.

1. Geotechnical Investigations

Two separate geotechnical investigations have been completed at the LLCF and included drilling the deposited processed kimberlite during the winters of 2001/2002 and 2004/2005 (EBA 2002, 2006).

- Five boreholes were drilled in Cell B during the 2001/2002 investigation which found the upper 4 to 6 metres of processed kimberlite to be in a frozen condition with underlying unfrozen processed kimberlite material with occasional zones of additional frozen material and lenses of ground ice.
- During the 2004/2005 investigation four boreholes were drilled in both Cell B and Cell C. The Cell B boreholes that were located within the subaerial beach zone showed frozen processed kimberlite to a depth of approximately 9 m with a thin mantle of unfrozen processed kimberlite overlying original ground. Boreholes that were located within the cell water body showed unfrozen processed kimberlite for the full deposition profile. The Cell C boreholes that were located within the subaerial beach zone showed frozen processed kimberlite to a depth of approximately 7 m, with one borehole showing intermittently frozen material. Below 7 m the material was unfrozen to original ground. Again, boreholes that were located within the cell water body showed unfrozen processed kimberlite for the full deposition profile.

2. Mass Measurements for Processed Kimberlite

The mass of processed kimberlite that comes from each kimberlite pipe is recorded as part of the Process Plant operations. This, together with the LLCF spigot discharge locations, will enable a 3D surface model to be developed showing the approximate location and volume of discharged processed kimberlite.

3. Processed Kimberlite Characterization

A processed kimberlite characterization study was completed by EBA in June 1998 and further work on the deposited processed kimberlite (though not reported) was completed by EBA during 2005. This work included moisture content determination, particle size analysis, large strain consolidation testing, and frost heave testing.

4. Thermal Monitoring

Ground temperatures from within the LLCF have been collected since 2002; however, several ground temperature cables have been destroyed due to subsequent processed kimberlite placement in the LLCF. Temperature data has been collected from the north end of Cell B, north of Dike B, and for a brief period in Cell C.

5. Hydrology and Meteorology

Baseline and operational water balance. Pumping records are maintained by BHP Billiton to track all water which leaves the LLCF. An operations water balance was updated in 2007. Several years of meteorological data has been collected as part of the AEMP for the EKATI mine site.

6. Other Sites - Illisarvik

Early literature review has identified permafrost growth results for Lake Illisarvik, a small lake on northwest Richards Island. In 1978, the lake was drained in an experiment to study the aggradation of permafrost into the sub-lake talik. Over 50 papers have been published reporting observations at Illisarvik, on topics such as the rate of permafrost growth, expulsion of porewater, solute rejection during freezing, frost heave of the lake bottom, and growth of ice wedges in the lake-bottom sediments. Currently, aspects of long-term behaviour during freeze-back are being reported. Reclamation planning and monitoring reports are also available for the Nanisivik Mine in Nunavut that document predictive modelling and monitoring of permafrost formation in the mine tailings, including potential for cryogenic concentration, porewater expulsion, pingo formation, frost heaving, and surface deformations.

7. Other Sites – Kubaka Gold Mine

In 2002, EBA conducted a geotechnical site investigation of the Kubaka gold mine tailings in the Northeast Siberia. This involved drilling, logging and sampling of seven boreholes at the south end of the tailings pond, and installation of instrumentation to monitor the tailings conditions. Two boreholes were drilled through a significant thickness of tailings, penetrating the underlying overburden and approximately 2 m into the competent bedrock to reveal a vertical structure of the deposited tailings. The boreholes encountered a sequence of frozen and unfrozen tailings underlain by frozen overburden at a depth ranging from 30.8 m to 34.2 m. The frozen and unfrozen layers had variable ground ice/water content with discrete lenses of ground ice present. An intrapermafrost aquifer with high dissolved solids content was encountered near the base of the tailings interval.

13.3.2 Short-term Tasks (to be started/continued in the next three years)

See Section 13.5.1 for more detailed description of the research tasks.

1. Processed Kimberlite Deposition History

Develop a tabulated historical record of the processed kimberlite deposition in the LLCF.

2. Future Processed Kimberlite Deposition Planning

Review the updated processed kimberlite deposition planning for the remaining life of the mine.

3. Review of the Existing Geotechnical Information

Detailed review of existing geotechnical/permafrost information from boreholes drilled within the LLCF.

4. Characterization of the Processed Kimberlite

Assess the physical properties and mineralogy of the processed kimberlite.

5. Literature Review

Complete a literature review of permafrost growth at similar sites in northern environments.

6. Assessment of the Existing Ground Temperature Cable Locations

Assess existing ground temperature cable locations in the LLCF.

7. Porewater Concentration Study

Conduct in situ porewater concentration measurements and verify them with lab testing.

8. Geotechnical Investigation at the LLCF

Identify geotechnical borehole locations within the LLCF to obtain additional information required for Tasks 4 and 6. Complete a geotechnical investigation to establish the existing conditions and vertical structure of the deposited processed kimberlite.

9. Consolidation and Freeze Concentration Testing Study

Complete consolidation (settling) tests and freeze concentration tests on high water content tailings at a geotechnical laboratory.

13.3.3 Long-term Tasks (2014 and following)

See Section 13.5.2 for more detailed description of the research.

10. Thermal Modelling

Develop a thermal model to predict the development of permafrost growth in the LLCF and to predict the likely mechanisms for porewater expulsion and dissipation of ground pressures.

11. Ground Temperature Monitoring in the LLCF

Monitor ground temperatures in the LLCF to determine extent and trends of permafrost growth in the LLCF.

13.4 FINDINGS OF RESEARCH COMPLETED

13.4.1 Research Summary Results

No research has been completed at this time.

13.4.2 Application of Lessons Learned

No research has been completed at this time.

13.4.3 Data and Information Gaps

No data and information gaps have been identified at this time.

13.5 REMAINING SCOPE TO BE COMPLETED

13.5.1 Detailed Work Scopes (next three years)

Table 5.1-4m provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Processed Kimberlite Deposition History

Develop a tabulated historical record of the processed kimberlite deposition in the LLCF. This should include discharge (spigot) location, discharge period, kimberlite source as a percentage split, discharge tonnage and solids content. In addition, this task should include historical water levels for all the active deposition cells. The tabulated data will be combined and used to develop a 3D model of the processed kimberlite discharge history within the LLCF. This model will be supplemented with information obtained from historical investigation data and the proposed investigation detailed in Task 8.

Task 2. Future Processed Kimberlite Deposition Planning

Review the updated processed kimberlite deposition planning for the remaining life of the mine. (The deposition plan for the LLCF is being updated through 2009 and 2010.) Incorporate this information into the 3D model described in Task 1 above to develop a full mine life processed kimberlite deposition plan.

Task 3. Review of the Existing Geotechnical Information

Review the existing geotechnical/permafrost information for boreholes drilled within the LLCF to estimate the existing conditions and vertical structure of the deposited processed kimberlite.

Task 4. Characterization of the Processed Kimberlite

Assess the physical properties and mineralogy of the processed kimberlite. The mineralogy of the processed kimberlite has been assessed in previous studies. This data will be reviewed under this task and the requirement for additional testing and sampling identified. Physical properties and mineralogy of the processed kimberlite is required to assess thermal properties of the material and develop the thermal model. Properties of the processed kimberlite may vary spatially within the LLCF, depending on the kimberlitic source.

Task 5. Literature Review

Complete a literature review of permafrost growth and porewater expulsion at similar sites in northern environments. Possible sites to include may be those areas researched by MacKay and Burns in Lake Illisarvik, reclamation monitoring at the Nanisivik mine tailings area, and the Kubaka Gold Mine tailings facility in the Northeast Siberia.

This review may not be directly related to processed kimberlite material, however, there maybe information and results contained within this literature review that could assist with the modelling and prediction of permafrost aggregation within the LLCF. In addition, review of case study data can focus and direct research tasks as well as build on the lessons learned from field experiences.

Task 6. Assessment of the Existing Ground Temperature Cable Locations

Assess existing ground temperature cable locations in the LLCF. Some ground temperature cables have been installed in the LLCF during previous investigations; however, additional data is required to calibrate thermal models and monitor long-term permafrost development. The current locations of the ground temperature cables in the LLCF and the collected ground temperature data will be reviewed and potential locations for additional ground temperature cables identified. Because of the continued operations in the facility and the likelihood of damage or destruction placement of ground temperature cables will have to be synchronized with the deposition plan.

Task 7. Porewater Concentration Study

Conduct in situ porewater concentration measurements and verify them with lab testing. In situ measurements as well as confirmatory sampling would be completed as part of the winter drilling program discussed in Task 8. Measurements such as conductivity or downhole geophysics will be evaluated for their applicability to this research. In situ measurements and samples would be collected through the entire deposition depth of processed kimberlite.

Porewater chemistry affects the freezing process in the processed kimberlite and the quantity of unfrozen porewater in the permafrost. The study will assist in understanding the impact of freezing on porewater chemistry, and how porewater expulsion plays a role in the porewater chemistry of the processed kimberlite, which will affect changes in the freezing process.

Task 8. Geotechnical Investigation at the LLCF

A geotechnical investigation will be completed in the LLCF will be completed to provide additional information to that compiled under Tasks 4 and 6. The purpose of the investigation would be to:

- Obtain additional stratigraphy information, as identified in Task 4, to establish the existing conditions and vertical structure of the processed kimberlite and foundation soils.
- Install instrumentation as identified in Task 5. This would likely include ground temperature cables and instrumentation to monitor in situ porewater characteristics.
- Collect samples through the entire deposition depth. This would include both soil samples to characterize the subsurface soils, and porewater samples for use in the porewater concentration study (Task 7).

The investigation would be completed as a winter drilling program. Boreholes would be advanced from the surface of the frozen processed kimberlite beaches, through the entire tailings interval, the underlying overburden, and at least two metres into competent bedrock. The precise number and location of the boreholes would be dictated by the requirements identified in previous tasks; however, in general the locations would be set in an attempt to bracket the typical range of deposited materials ranging from fine to coarse processed.

Samples of frozen processed kimberlite will be drilled and sampled using a CRREL barrel; unfrozen material may be sampled using either a piston or Shelby tube sampler. Alternative sample methods will be evaluated as part of this task, to ensure that samples can be obtained through the entire soil column.

Processed kimberlite and porewater samples will be used to evaluate the processed kimberlite consistency and consolidation characteristics, gradation and mineralogy, permafrost parameters (such as types of cryogenic structures, occurrence of ground ice bodies, volumetric and gravimetric ice content), porewater chemistry, and in situ and future porewater pressure in the deposited tailings.

The obtained information will be incorporated into the 3D model described in Task 1 above.

Task 9. Consolidation and Freeze Concentration Testing Study

Complete consolidation (settling) tests and freeze concentration tests on high water content tailings at a geotechnical laboratory. (Extra fine processed kimberlite requires significant time to consolidate and settle out of suspension. An understanding of the process and the timing required to do so is required to model permafrost growth).

The testing will involve a large strain consolidation test on high water content tailings using step loading method. The objective of the test is to determine the one-dimensional consolidation properties of high water content (low solids content) tailings. The one-dimensional consolidation properties that will be determined are the volume change versus effective stress (coefficient of volume change or compressibility) and the coefficient of consolidation.

The freeze concentration test will evaluate expulsion of the soluble solids from a lift of freshly deposited tailings when freezing, and determine the potential occurrence of layers and lenses of unfrozen tailings (cryopegs) within the frozen tailings interval due to the higher dissolved solids content of the porewater. Testing will be completed on a range of particle sizes, reflecting local variations in the processed kimberlite particle sizes within the LLCF.

13.5.2 Long-term Tasks (2014 and following)

Table 5.1-4m provides an outline and schedule of tasks to be undertaken after 2014.

Task 10. Thermal Modelling

Develop a thermal model to predict the development of permafrost growth in the LLCF.

Task 11. Ground Temperature Monitoring in the LLCF

Monitor ground temperatures in the LLCF to determine extent and trends of permafrost growth in the LLCF which will enable further calibration of the thermal model developed in Task 9.

13.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on permafrost growth in the LLCF is linked to:

- LLCF water quality research, particularly porewater chemistry which affects unfrozen porewater concentrations.
- Research on projected volumes of EFPK in the LLCF, and the behaviour of those materials post-closure.

Research on permafrost growth in the LLCF began at the conceptual design stage for the LLCF processed kimberlite deposition in the 1995 EIS, followed by a processed kimberlite characterization study in 1998. Additional studies followed in 2002 and 2005 with information from ground temperature cables. Access and the use of stable monitoring sites to study the growth of permafrost in the LLCF will be questionable until the surface of the facility is consolidated and trafficable. Currently, most of the facility remains active and will remain active until approximately 2013 when the northern end of Cell B will be accessible for research work. However, opportunities may arise to place ground temperature cables to monitor permafrost aggradation that will continue during active discharge to the facility. BHP Billiton will review the field work requirements and will seek opportunities to install equipment in the LLCF through 2010 and 2011.

13.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-4m. Permafrost Growth on LLCF – PKCA

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short-term Research Tasks (within next 3 years)				
1	Processed Kimberlite Deposition History	3D model	2011	2011
2	Future Processed Kimberlite Deposition Planning	3D model	2011	2011
3	Review of the Existing Geotechnical Information	Report	2011	2011
4	Characterization of the Processed Kimberlite	Report	2011	2011
5	Literature Review	Literature Review Report	2011	2011
6	Assessment of the Existing Ground Temperature Cable Locations	Report	2012	2012
7	Porewater Concentration Study	Report	2012	2012
8	Geotechnical Investigation at the LLCF	Report/Test Data	2013	2013
9	Consolidation and Freeze Concentration Testing Study	Test Data	2013	2013
Long-term Tasks (2014 and following)				
10	Thermal Modelling	Evaluation Report	2014	2014
11	Ground Temperature Monitoring	Inspection report	2013	2017

13.8 COST

Total expected costs are $1,200,000 to $1,500,000.

13.9 REFERENCES

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14. Stabilization of EFPK in the LLCF

14.1 UNCERTAINTY

The stabilization of extra fine processed kimberlite (EFPK) in the LLCF to ensure no negative impacts on water quality and aquatic habitat.

14.2 RESEARCH OBJECTIVE

The purpose of this research is to investigate methods for in situ stabilization of the EKPF within the LLCF. At closure, Outlet Dam will be breached and surface water flow through the LLCF will be allowed to discharge to the receiving environment. EFPK in the LLCF must be stabilized so that it remains within the LLCF and does not migrate outside the facility and impact downstream water quality.

The research can be broadly categorized into three tasks: characterize the EFPK, develop stabilization options, and conduct field trials.

EFPK characterization is intended to develop an understanding of the expected behaviour of the EFPK in the LLCF. Initial tasks will include the following:

- Physical characterization of the EFPK (e.g., particle size distribution, clay types, solids content, consolidation characteristics, permeability and strength characteristics); and
- Evaluation of the spatial extent of EFPK (e.g., volume, thickness, density profile, location and area), based on the LOM Plan and projected deposition in the LLCF.

- With and understanding of the EFPK material properties and spatial extent, specific research projects will be undertaken to evaluate potential stabilization options. These include:Evaluate possible, practical and economic methods to increase the settling rate of the EFPK solids, and
- Evaluate both sub-aerial and sub-aqueous EFPK stabilization measures to maintain containment of the EFPK within the LLCF.
- The final task will be the completion of field trials to evaluate stabilization measures developed as part of this research.

In situ stabilization, through accelerated consolidation, physical covers or other means is the preferred option for EFPK containment. However, if in situ methods prove unsuccessful then other management strategies, including other storage options, for the EFPK will be considered. Another management strategy for EFPK is the backfill of processed kimberlite into an open pit. The uncertainty around this method is addressed in Research Engineering Study # 5.

14.3 RESEARCH PLAN

14.3.1 Tasks Completed or Initiated

See Section 14.4.0 for more detailed description of the research.

1. Evaluation of kimberlite characteristics

Characterization study for Panda and Fox kimberlite pipes included clay types, settling characteristics, particle size and geochemistry. This work was completed by EBA in 1998.

2. Plumb line surveys

Plumb line surveys were undertaken during the summers of 2005 and 2008 to assess the profile of EFPK within the LLCF. The 2005 survey was completed in Cell B and Cell C. The 2008 survey was completed in Cell C.

3. Cone Penetration Testing

Cone penetration testing was completed in the summer of 2010, in Cell C. A total of 11 test locations were completed along the length of Cell C, providing a density of profile of the fine processed kimberlite and EFPK in the cell.

4. LiDAR surveys

A LiDAR topographic survey of the LLCF was completed in 2008. This survey will be used as a base line for ongoing processed kimberlite deposition management and also for long-term closure planning. A subsequent LiDAR survey was completed in 2010, allowing for an accurate evaluation deposition volumes.

14.3.2 Short-term Tasks (to be started/continued in the next three years)

See Section 14.5.1 for more detailed description of the research tasks.

Short-term research tasks identified as part of this research are primarily related to assessing the in situ properties of the EFPK in the LLCF and the time-dependent behaviour of the material. This data will be used for operational management plans and closure planning.

1. Plumb Line Surveys

Complete plumb line surveys as needed to evaluate the EFPK settled density profile and compare successive surveys to quantify the EFPK volume change.

2. Evaluate EFPK Sampling Methods

Review, research and evaluate potential improvements in the sampling methods for the EFPK. Currently, it is difficult to obtain a full depth representative sample of the low-density EFPK deposit with minimal disturbance, and to sample this material while the facility is in active operations.

3. Consolidation and Settling Tests

Complete a sampling program of the EFPK in Cells A and C, and submit these samples for laboratory testing to evaluate the physical and consolidation characteristics of the material.

Initiate a column sedimentation test to further evaluate free settling and consolidation behaviour of the EFPK. This test will enable the time-dependent behaviour of the EFPK to be evaluated and will provide a baseline controlled test against which field measurements can be compared.

4. Evaluate Accelerated EFPK Settling Methods

Evaluate practical and economic methods to increase the settling rate of the EFPK solids.

5. Estimate Closure Distribution of EFPK

Estimate the final locations, volumes, and properties of EFPK within each of the LLCF containment cells, based on the results of investigation data and laboratory testing.

6. Evaluate EFPK Stabilization Measures

Evaluate measures required to stabilize the EFPK. These may include a water cap, sand or rip-rap cover; however, other options will be considered. This task will consist of a geotechnical evaluation and literature review, which will be used to design future field trials (Task 8). Stabilization alternatives will be evaluated based on the physical properties of the EKATI EFPK and the expected distribution. It will incorporate the LLCF water balance from the Reclamation Research Plan on LLCF water quality and quantity at closure (Appendix 5.1-4), and other related studies.

14.3.3 Long-term Tasks (2014 and following)

See Section 14.5.2 for more detailed description of the research.

7. Model long-term EFPK distribution.

Update long-term solids modeling to estimate EFPK distribution over time.

8. Field Trials to Evaluate EFPK Stabilization Measures.

A field trial program will be implemented to evaluate the EFPK stabilization measures developed in Task 6.

14.4 FINDINGS OF RESEARCH COMPLETED

14.4.1 Research Summary Results

The mass of processed kimberlite that comes from each kimberlite pipe is recorded as part of Process Plant operations. This data allows for the processed kimberlite source within various portions of the LLCF to be roughly identified.

The total volume of processed kimberlite pumped to the LLCF since operations startup is also recorded as part of the Process Plant operations. This includes total solids and treated sewage effluent, and mine water (reported in the Environmental Agreement and Water Licenses Annual Reports).

Settling tests were completed on Fox ore (BHP Billiton 2006). Initial investigation results indicated that processing of this ore may result in an increased EFPK percentage with an increased percentage of smectite clays and therefore require different reagent and flocculent additions, including chloride to achieve desirable settling characteristics for processing.

A plumb line survey was completed in 2005. The survey was conducted by measuring the depth of penetration of a lead plumb ball (SG of 11.4) and a glycol plumb bottle (SG of 1.1) to estimate the distribution of the EFPK in Cells B and C. The survey demonstrated that the majority of EFPK has very low shear strength and behaves essentially like a 'heavy' liquid flowing to fill the lower pond zone. EFPK was found to exist in very low solids content (less than 10% solids by weight) above the elevation of the glycol plumb depth. The maximum glycol plumb depths ranged from 6 to 13 m.

A second plumb line survey was completed in 2008. The data from this survey is currently in review.

In 2008, a LiDAR topographic survey of the LLCF was completed. This provided a high resolution topographic survey of the current LLCF conditions and will form the basis of ongoing processed kimberlite deposition planning. A second LiDAR survey was completed in 2010, and is being used to evaluate deposition rates in the LLCF and develop an ongoing depositional plan.

A series of cone penetrometer tests were completed in 2010 in Cell C. The results show a relatively low volume of EFPK in the cell. The precise reason for this is unknown, but it may be attributable to an increased chloride content in the cell water or sub aerial deposition.

14.4.2 Application of Lessons Learned

Operational data and studies were used to estimate the quantity of EFPK in the LLCF at closure and develop an operational plan for processed kimberlite deposition in the LLCF.

During deposition, processed kimberlite is naturally separated into coarser-grained fine processed kimberlite (FPK) and EFPK in the LLCF. The FPK (mainly sand-sized) settles first to form well defined sub-aerial and sub-aqueous beaches. This material accounts for 88% by mass of the processed kimberlite discharged into the LLCF. The EFPK (mainly silt and clay-sized) that does not settle on beaches is carried into the ponds and settles as an undulating, low-density mass. EFPK constitutes an estimated 12% by mass and 35% by volume of the processed kimberlite discharged into the LLCF. The EFPK is expected to accumulate and ultimately restrict flow through the dikes.

A 2004/2005 operations assessment of the LLCF outlined Option 3aM as the preferred operational outline for the LLCF. The objectives of this option, including a drawing of the final LLCF deposition model, are found in the 2007 Waste Water Processed Kimberlite Management Plan (WPKMP) and discussed in Section 5.5.

Option 3aM describes the use of permanent ponds in the containment cells at mine close. Spillway structures in dikes will act as water level control structures for the upstream ponds. This option suggested the use of a water cap to provide containment for the EFPK at closure.

Water cap depths were estimated for the LLCF in the 2007 WPKMP. The final EFPK surface elevation in Cell C assumed for volume calculations is 456 m based on a final dike crest elevation of 459 m with an allowance for freshet rise and freeboard. This would allow for an approximate 1 to 1.5 m seasonal rise. In Cell D the EFPK final elevation is predicted at 437 m, with the final pond elevation at 454 m.

14.4.3 Data and Information Gaps

The following data gaps were identified in evaluating the EFPK in the LLCF.

- Updated EFPK volumes from Plumb Line surveys. Periodic field sampling will be required to ensure alignment with the Deposition Plan and to provide update for closure planning.
- Understanding of EFPK performance with time observed in Cell C, and the difference between the EFPK deposit properties for previous ores (in Cell C) with that for Fox dominated ore in Cell A.
- Updated deposition model based on actual deposition performance.
- Understanding of ability to place physical covers to augment water covers in zones where water covers alone could be inadequate.
- Water balance modeling and verification of final water surface elevations in containment cells post closure.

14.5 REMAINING SCOPE TO BE COMPLETED

14.5.1 Detailed Work Scopes (next three years)

Table 5.1-4n provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Plumb Line Surveys

Conduct periodic plumb line surveys as needed to estimate the settled deposit density profile. This information will provide a snapshot of the processed kimberlite and EFPK settling profiles on the beach areas and within the ponded areas, and will assist with modeling of future EFPK settlement.

Surveys will be completed in cells that have EFPK deposits (Cells A, B and C). Similar to previous surveys, the penetration depth of plumb bobs with known specific gravities will be measured at various locations in the LLCF. The coordinates of each survey location will be recorded to enable future measurements to be taken at the same location. Surveys will be completed in summer when the cells can be accessed by boat. Survey frequency will be dictated by the findings.

Data obtained from the survey will enable the density of the EFPK to be monitored and allow the change in density over time to be evaluated.

Task 2. Evaluate EFPK Sampling Methods

Various sampling methods and current industry practice will be reviewed to assess a safe and suitable method of sampling EFPK in the LLCF. The selected method will become a standard and will be employed in the sampling program discussed in Section 14.5.1.

This task will be completed early in the research program.

Task 3. Consolidation and Settling Tests

Sample the EFPK column in both old EFPK deposit areas in Cell C and in new EFPK deposit areas in Cell A to gain an understanding of settling and consolidation characteristics. The sampling program will be developed based on the results of the Task 2 research.

Recovered samples will be tested to evaluate their physical properties and variability between different locations in the LLCF. Testing may include particle size analysis, porewater chemistry, x-ray diffraction, specific gravity and Atterberg limits.

Once the testing is complete, the data will be compared against previously completed work.

Column sedimentation testing of processed kimberlite will also be completed as part of this task. This testing will evaluate time-dependent behaviour on a bulk processed kimberlite sample. Testing of a larger sample is intended to reduce scaling errors associated with extrapolating small bench scale tests to a macro environment such as the LLCF.

The proposed testing will estimate settling rates, density and shear strength gain with time. This will provide a benchmark to compare the results of plumb line surveys to and provide input into evaluating the potential for physical covers to stabilize the EFPK at closure.

Task 4. Evaluate Accelerated EFPK Settling Methods

Review and evaluate practical and economic methods to increase the settling rate of the EFPK in the LLCF (i.e., adding flocculants and/or coagulants). The first stage of this task will be a review of current and previous process plant practices and their relative effectiveness. This work will also include research into alternate methods or industry practice that may provide improved settling rates. This work will be completed ahead of laboratory testing (Task 3).

The second stage of this task will be an evaluation of processing methods through laboratory testing likely completed jointly with Task 3. The precise nature of the testing will be determined at the time.

Task 5. Estimate Closure Distribution of EFPK

Data from the 2008 LiDAR and plumb line surveys is being used to update the short-term sequencing of processed kimberlite deposition in accordance with the approved WPKMP.

This task of the reclamation research plan will use the updated deposition plan to refine the anticipated processed kimberlite profile in each containment cell at the end of mining operations. It will provide an estimation of final locations and volumes of EFPK in the LLCF.

Task 6. Evaluate EFPK Stabilization Measures

A geotechnical evaluation will be completed to assess and evaluate EFPK stabilization options. Broad tasks associated with the evaluation will include:

- Literature review – A review of existing literature relating to tailings stabilization will be undertaken. As part of this review, the existing practices at other diamond mine site will be reviewed, as well as other industries where low strength tailings are generated. The use of water caps and their applicability will also be explored as part of this task. Physical covers such as sand or sand/riprap will also be considered.

- Compile existing EFPK data – Data obtained from the LLCF investigations and laboratory test data will compiled and reviewed. Expected long-term behavior will also be extrapolated from the known data. This information will feed directly into the evaluation of suitable stabilization measures.
- Develop EFPK deposition model – A preliminary deposition model will be developed based on the existing data. This model will be reviewed and updated (as noted in Task 7) as new information becomes available.
- Evaluate stabilization options – Stabilization options identified in the literature review and previous EKATI planning documents will be reviewed and evaluated. The suitability of each option will be evaluated based on the expected long-term EFPK properties (i.e., long-term shear strength or aerial extent may preclude some cover options from being pursued). Viable options will be recommended for subsequent field trials.

The evaluation will draw on the LLCF water balance from the Reclamation Research Plan on LLCF water quality and quantity at closure (Appendix 5.1-4), and other related studies. The results of this research task will be used to assess the need for and, if necessary, design a field trial program (Task 8).

Should the results from this task identify the potential that EFPK stabilization methods will not provide an acceptable closure for the LLCF, BHP Billiton will, through risk assessment, review alternate options for EFPK storage.

14.5.2 Conceptual Work Scopes (2014 and following)

Table 5.1-4n provides an outline and schedule of conceptual tasks to be undertaken in 2012 and following.

Task 7. Model EFPK Distribution at Closure

Update the model for post closure performance of the LLCF to evaluate distribution and movement of EFPK in the LLCF.

Task 8. Field Trials to Evaluate EFPK Stabilization Measures

A field trial program will be implemented to evaluate the EFPK stabilization measures developed in Task 6. The timing and location of the field trials will depend on the processed kimberlite deposition plan for the LLCF.

14.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on the stabilization of EFPK in the LLCF to ensure no negative impacts on water quality and aquatic habitat is linked to:

- Engineering studies on the expected behaviour of processed kimberlite and/or EFPK stored in open pits.
- Research on the long-term water quality and water balance of the LLCF and its discharge after closure.

EFPK research is conducted as part of the ongoing operations of the LLCF and updates to the Wastewater and Processed Kimberlite Management Plan. Results from the operations work will be incorporated into the EFPK Research Plan for mine closure. Results from EFPK behaviour will also assist with research on processed kimberlite backfill of open pits, if an open pit becomes available in future updates of the LOM Plan.

14.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-4n. Stabilization of EFPK in the LLCF - PKCA

Research Task #	Task	Project Tracking (*Reporting*, *Modeling*, *Field Work*, *Engineering Designs*)	Research Start	Research Finish
Short-term Research Tasks (within next 3 years)				
1	Plum Line Surveys	Field work and reporting	2009	Ongoing
2	Evaluate EFPK Sampling Methods	Field work and literature review	2011	2012
3	Consolidation and Settling Tests	Field work and laboratory testing,	2012	2012
		Construction of settling column and ongoing monitoring	2012	Ongoing
4	Evaluate Accelerated EFPK Settling Methods	Literature review, laboratory testing	2011	2011
5	Estimate Closure Distribution of EFPK	LiDAR and Plumb Line Survey data review, update Deposition Plan	2009	2012
6	Evaluate EFPK Stabilization Measures	Literature review and desktop evaluation	2012	2013
Long-term Tasks (2014 and following)				
7	Model EFPK Distribution at Closure	Modeling	2014	2016
8	Field Trials to Evaluate EFPK Stabilization Measures	Field work	2014	On going

14.8 COST

Total expected costs are $1,000,000 to $1,500,000

14.9 REFERENCES

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15. Metals Bioaccumulation

15.1 UNCERTAINTY

The understanding of safety for wildlife that directly ingest processed kimberlite soils and vegetation growing on processed kimberlite, as well as humans that consume wildlife that graze on LLCF vegetation.

15.2 RESEARCH OBJECTIVE

The ICRP proposes a combination rock and vegetation cover on the LLCF at mine closure. Vegetation field trials have been completed for species and soil amendments between 2000 and 2007. The research results indicated that a vegetation cover can be established directly into processed kimberlite. The associated risk of a vegetation cover over processed kimberlite is the accumulation of metals in the plants which will be grazed by wildlife, and subsequently consumed by humans. Direct ingestion of processed kimberlite by animals at the LLCF also has a potential risk for wildlife. A preliminary assessment has been conducted on the risks associated with wildlife that may frequent the LLCF (Rescan 2006), however, further work is planned regarding these risks post-closure with inputs from additional vegetation field studies, and monitoring of wildlife grazing impacts to vegetation planned for a LLCF Reclamation Pilot Study commencing in approximately 2013.

The research objective is to identify and quantify the potential risks to wildlife ingesting metals from processed kimberlite from the LLCF post-closure, and any associated risks to humans consuming this wildlife.

15.3 RESEARCH PLAN

15.3.1 Tasks Completed or Initiated

See Section 15.4.1 for more detailed description of the research.

1. *Baseline Vegetation Data*

   Baseline information on naturally occurring tundra vegetation species is important to evaluate potential candidate species to be used for site reclamation. This information is documented in Rescan (1995).

2. *Assessment of Metals in Vegetation at EKATI*

   An initial assessment of types of vegetation that will grow in the LLCF was undertaken using research plots in Cell B of the LLCF (Martens 2001, 2002, 2003, 2004). Using plants grown in these LLCF field trials, trace metal accumulation in plant tissue was measured in the species growing on the processed kimberlite (Martens 2004). The information provides a basis for evaluating the potential suitability of various options for vegetating the LLCF post-closure.

3. *Wildlife and Human Health Risk Assessment*

   A wildlife and human health risk assessment was undertaken by Golder (2004) and updated by Rescan (2006). These studies estimated the type of vegetation that is consumed by grazers that frequent the LLCF area and the length of time spent grazing. The risk assessments were then conducted to evaluate metals uptake by grazers on the LLCF and of humans consuming these animals.

15.3.2 Short-term Tasks (to be started/continued in the next three years)

There are no research activities planned for the next three years.

15.3.3 Long-term Tasks (2014 and following)

Table 5.1-4o provides an outline and schedule of tasks to be undertaken in 2013 and following.

1. *Complete Pilot Study Addressing Assumptions of Risk Assessment*

   Complete a Pilot Study using plots on exposed processed kimberlite on the LLCF that addresses key assumptions made in the Risk Assessment (Rescan 2006).

2. *Update Wildlife and Human Health Risk Assessment*

   The wildlife and human health risk assessment (Rescan 2006) will be updated once information from the reclamation Pilot Study comes available.

15.4 FINDINGS OF RESEARCH COMPLETED

15.4.1 Research Summary Results

15.4.1.1 Baseline Vegetation Data

Baseline information on naturally occurring tundra vegetation species is important to evaluate potential candidate species to be used for site reclamation. The ecological mapping study was completed in the summer of 1994 and included field sampling, classification and mapping of 11 tundra ecosystem units. The information is documented in Rescan (1995).

15.4.1.2 Assessment of Metals in Vegetation at EKATI

An initial assessment of type of vegetation that will grow in the LLCF was undertaken using research plots in Cell B of the LLCF (Martens 2001, 2002, 2003, 2004). Using plants grown in these LLCF field trials, trace metal accumulation in plant tissue was measured in the species growing on the processed kimberlite (Martens 2004). Elevated levels of trace metals that exceeded the U.S. National Academy of Sciences recommended dietary intake of cattle, sheep or rabbits, were found in plant tissues of the key LLCF reclamation species (dwarf birch, fireweed, reflexed locoweed, alkali grass) growing in processed kimberlite. The findings recommended that a risk assessment be completed that considered the following:

- Residence time of the primary grazers in the mine area and on the LLCF,
- Forage preference of the primary grazers,
- Trace metals concentrations in plants growing in native soils and processed kimberlite,
- The effects of seasonal stage of plant growth on tissue metal concentrations, i.e., collecting samples in mid-growing season rather than at the end of the growing season,
- Potential trace mentals bioaccumulation and biomagnifications in resident grazers (sik-sik and Arctic hare) and their predators.

15.4.1.3 Wildlife and Human Health Risk Assessment

In support of the LLCF reclamation research, a wildlife and human health risk assessment of the potential risks to wildlife and human receptors exposed to metals from the LLCF was conducted by Golder Associates Ltd. in 2004 (Golder 2004). The risk assessment was based on a future scenario where the LLCF would be vegetated, rather than fully capped with waste rock. The study concluded that risks to wildlife and human health were acceptable. However, the Government of the Northwest Territories (GNWT) and the Independent Environmental Monitoring Agency (IEMA) had concerns regarding key assumptions in the risk assessment. The risk assessment was updated to address the GNWT and IEMA concerns (Rescan 2006).

The objectives of the updated risk assessment were to identify and assess the metals which could pose a potential risk to wildlife grazing on vegetation at the LLCF, and to humans that consumed the wildlife that grazed on the LLCF. Concerns raised by the GNWT and IEMA were incorporated into the assessment.

Potential risks to wildlife receptors were evaluated by comparing the estimated daily intake of the metals for each wildlife receptor to toxicity benchmark values. Caribou, grizzly bear, muskox, wolf, wolverine, hare, ptarmigan and Canada goose were evaluated with regards to their exposure to aluminum, barium, chromium, cobalt, magnesium, manganese, molybdenum, nickel, selenium and strontium at the LLCF. Caribou were evaluated under two soil ingestion scenarios: normal soil ingestion and elevated soil ingestion. Acceptable risks were predicted for wildlife receptors at the individual and population level from exposure to all metals evaluated except aluminum and magnesium. Aluminum and magnesium were not evaluated in the original risk assessment. Assumptions made throughout the risk assessment process were conservative and likely caused potential risks to be overestimated.

Potential impacts to humans were evaluated by comparing the estimated daily intake of each metal to toxicity reference values. All metals in the wildlife risk assessment were included in the human health risk assessment. Selected human receptors were adults (ages 20+ years old) and toddlers (6 months to 4 years old). The exposure pathway evaluated was ingestion of caribou (using both soil ingestion scenarios) and goose meat from animals that have taken up metals from the LLCF. The risk assessment indicated acceptable risks from the human consumption of Canada geese and caribou for all metals evaluated except nickel. Potential unacceptable risks from nickel were predicted for both the toddler and adult under the scenario of exposure to caribou with an elevated soil ingestion rate. It is likely that the concentrations in meat tissue were over predicted based on the assumptions made regarding the diets of caribou.

The potential risks predicted were based on a future scenario in which the LLCF is vegetated. Because this land use scenario does not yet exist, several conservative assumptions had to be made in order to predict the amount of exposure that each of the receptors may receive. These assumptions included:

- The LLCF will be suitable habitat for the selected wildlife receptors (once it is revegetated).
- The receptors will have full access to the LLCF (once it is revegetated).
- The LLCF will provide adequate vegetation for the receptors daily dietary requirements (i.e., all vegetation is palatable and preferred).
- Receptors will feed solely in the LLCF, ranging from five months to all year, with the exception of the wolf receptor where it was assumed that they would only spend a total of eight days per year at the site.
- All metals evaluated are 100% bio-available to all wildlife and human receptors evaluated.

15.4.2 Application of Lessons Learned

In the Tier 1 wildlife and human health risk assessment (Rescan 2006), conservative assumptions were made which likely overestimated the risk predictions. If the risk assessment had been found acceptable, based on the conservative assumptions, then no further evaluation would likely be required. Because potential risks were predicted, the conservative assumptions that are considered the “drivers” of the predicted risk require further evaluation in the form of a Tier 2 risk assessment. However, because the land use scenario under which the risk assessment was based does not exist at this time, re-evaluating the conservative assumptions may not increase the certainty in the risk assessment.

The planned LLCF Reclamation Pilot Study in 2013 will comprise a large unfenced area at the upper end of Cell B of the LLCF. This project will proceed once processed kimberlite deposition has been completed in an appropriate area. During this Pilot Study, it may be possible to re-evaluate some of the assumptions in this assessment because the Pilot Study will more closely represent the future-vegetated scenario of the LLCF post closure. The scale and accessibility to wildlife of the Pilot Study area will be of relevance to the risk assessment.

15.4.3 Data and Information Gaps

The following data gaps were identified in evaluating metals bioaccumulation:

- Address the assumptions (and remaining unknowns) in the Wildlife and Human Health Risk Assessment (Rescan 2006);
- Determine the plant species that will grow on the LLCF, and what the successional path of those species will be;
- Understand which plants are hyperaccumulators and what metals they accumulate; and
- Assess metals accumulation in plant roots (to date only assessment of metals in leaves and stems).

15.5 REMAINING SCOPE TO BE COMPLETED

15.5.1 Detailed Work Scopes (next three years)

There are no planned research activities for the next three years.

15.5.2 Conceptual Work Scopes (2014 and following)

Table 5.1-4o provides an outline and schedule of tasks to be undertaken in 2014 and following.

Task 1. Complete Pilot Study Addressing Assumptions of Risk Assessment

A Pilot Study will be undertaken to addresses key assumptions made in the Risk Assessment (Rescan 2006). The Pilot Study will be designed to assess:

- The palatibility of vegetation growing on the LLCF;
- Grazing/residence times by animals on the LLCF; and
- Bioavailability of metals in plant tissue to wildlife and human receptors.

Using information from the original field trials (Martens 2001, 2002, 2003, 2004) an area of up to approximately 60 ha in area of the north end of LLCF Cell B will be planted with vegetation known to grow on processed kimberlite. The area will not be fenced to allow observations to be made of wildlife feeding on the vegetation. The Pilot Study is expected to run for approximately five years, however, the exact length of time is dependent on other aspects of the pilot study (i.e., constructability, physical stability, plant growth, LOM plan).

Task 2. Update Wildlife and Human Health Risk Assessment

Based on the information collected from the Pilot Study the wildlife and human health risk assessment will be updated. The methods for the risk assessment will follow those from Rescan (2006) with any new additional regulatory guidance on ecological and human health risk assessment methodology.

15.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on metals bioaccumulation in the LLCF is linked to:

- Research on the grazing impacts to vegetation on LLCF, and cover sustainability.
- Research on the plant cover required for long-term surface stabilization of processed kimberlite in the LLCF, to prevent erosion and maintain stream water quality downstream of the LLCF.
- Research on Traditional Knowledge inclusion in reclamation planning for the EKATI mine components.

The research on metals bioaccumulation will need to be completed prior to a decision on the final vegetation cover for the LLCF. Initial studies were completed with the first field vegetation research between 2000 and 2005. The next round of research will be conducted when the top section of the Cell B is ready to test vegetation growth in a pilot study, in approximately 2013.

15.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-4o. Metals Bioaccumulation

Research Task #	Task	Project Tracking (Reporting, Modeling, Field Work, Engineering Designs)	Research Start	Research Finish
Long-term Tasks (2014 and following)				
1	Complete Pilot Study Addressing Assumptions of Risk Assessment	Report	2014	2018
2	Update Wildlife and Human Health Risk Assessment	Report	2015	2015

15.8 COST

Total expected costs are $300,000 - $500,000.

15.9 REFERENCES

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16. Establishment of Self-sustaining Plant Communities in the LLCF

16.1 UNCERTAINTY

The development of self-sustaining plant communities within the Processed Kimberlite Containment Areas (PKCA) mine component (i.e., on the Long Lake Containment Facility [LLCF]) that are compatible with the surrounding tundra environment.

16.2 RESEARCH OBJECTIVE

To determine what self-sustaining plant community type(s) can be established on the LLCF. This research will be used to develop methods for using native vegetation, both planted and naturally colonizing, to enhance surface stability within the PKCA mine component.

16.3 RESEARCH PLAN

Early research on processed kimberlite began with greenhouse studies in 1999. These were followed by field studies within fenced research plots on Cell B of the LLCF. After the operations review of the LLCF and a new deposition plan in 2005, the research plots were covered by processed kimberlite in 2008. The updated deposition plan shows that processed kimberlite deposition will be active in all cells (B, A and C) until approximately 2013, when a section of the north end of Cell B will no longer require processed kimberlite.

A revegetation pilot study at the north end of Cell B will commence in approximately 2013 and will address a combination of operational and research questions, including vegetation establishment without fenced enclosures. Pilot studies on vegetation will continue at the north end of Cell B through 2019, when kimberlite deposition will be completed in the LLCF. The findings from the pilot study will be applied to the remainder of the facility at that time.

16.3.1 Tasks Completed or Initiated

See Sections 16.4.1 through 16.4.6 for more detailed description of the research.

1. Assessment of the suitability of processed kimberlite as a revegetation substrate

This task was used as the initial assessment of whether vegetation could be grown directly in kimberlite, and what types of soil amendments and fertilizers would be necessary to assist with maintenance and sustainability.

2. Identification of locations within the LLCF suitable for revegetation.

Field studies have indicated that vegetation can be used to enhance surface stability in the Water Interface Zone and the Central Zone of the LLCF.

3. Survey of tundra plant species with potential for revegetating the LLCF

BHP Billiton has committed to using native regional plants for revegetation work at EKATI. Native plant research on the LLCF includes identifying plants that would grow and sustain on processed kimberlite (serpentine soil), as well as finding sufficient quantities of native plants (including native cultivars) which could be propagated to reclaim the LLCF surface. The survey of established and disturbed tundra communities within the EKATI mine area and the surrounding region has identified tundra species with potential for revegetating selected areas of the LLCF. Additional species need to be tested.

4. Seed collection, storage and propagation

A Standard Operating Procedure (SOP) has been developed that identifies seed sources and provides guidelines for collecting and processing seeds for use in revegetation. The SOP will be expanded as needed, to include updated species lists and related information.

5. Assessment of natural colonization and successional trends

Natural colonization of the LLCF has been documented in the course of revegetation research. Successional trends were investigated at other mine sites in the NWT. Additional studies will focus on natural colonization and succession on tailings impoundments in the NWT and methods to encourage and assist plant establishment.

6. Assessment of weeds at EKATI

The presence of weeds at EKATI and at abandoned mines in NWT has been assessed in the course of monitoring revegetation and rehabilitation. This practice will continue.

16.3.2 Short-term Tasks (to be started/continued in the next three years)

See Section 16.5.1 for more detailed description of the research.

1. Assess revegetation suitability of additional tundra species

This research will build on previous work.

2. Seed collection, storage and propagation

This research will build on previous work.

3. Natural colonization and plant succession on the LLCF

This research will build on previous work and will also consider plant community development in response to site factors including weathering of processed kimberlite.

4. Weeds monitoring

This research will build on previous work.

5. Pilot vegetation study planning

Information acquired from the above tasks will provide basic information for the planning and design of the Pilot Revegetation Study, to be established in Cell B of the LLCF in 2013.

6. Closure objectives for LLCF plant communities

Determine what closure objectives and associated closure criteria can be used to indicate that LLCF plant communities have reached a satisfactory level of resilience to natural and man-made perturbations, evidencing that the community will eventually reach a stable, self-sustaining state.

7. Stability of LLCF plant communities

This research will look at the LLCF plant community characteristics needed to indicate stability, and how they can be assessed using trend analysis.

16.3.3 Long-term Tasks (2014 and following)

See Section 16.5.2 for more detailed description of the research.

8. Pilot revegetation study

Learnings from the establishment of the Pilot Revegetation Study, using operational equipment, and the assessment of results will be key in identifying the practices and procedures for the successful reclamation of the LLCF.

16.4 FINDINGS OF RESEARCH COMPLETED

16.4.1 Assessment of the Suitability of Processed Kimberlite as a Revegetation Substrate

16.4.1.1 Research Summary Results

Greenhouse Trials

A greenhouse trial of plant growth and establishment on kimberlite was conducted in 1999 (Kidd and Max 2000b). Plant materials tested included cuttings of *Salix planifolia* (diamond leaf willow), sprigs of *Arctophila fulva* (pendant grass), a seed mix of native-grass cultivars and seed of *Hedysarum mackenzii* (liquorice root).

All the plants tested were able to survive in kimberlite for a limited period, but the study concluded that long-term survival was less likely, due to low levels of nutrients and organic matter, the potential for compaction, and possible moisture stress due to limited water holding capacity.

Additional research on methods for establishing vegetation cover on kimberlite was conducted as part of a Master of Science research project at the University of Alberta (Reid and Naeth 2001, 2002). This study focused on the use of various soil amendments to improve the ability of kimberlite to sustain plant growth.

Field Trials

The establishment and persistence of native-grass cultivars were assessed in field test plots on processed kimberlite, located within the Central deposition zone of Cell B of the LLCF (Martens 2000, 2001, 2003, 2005). Seedlings of five native tundra species were, in 2002-2003, transplanted into kimberlite in test plots stabilized with native-grass cultivars (Martens 2005). The species tested included *Betula glandulosa* (dwarf birch), *Dryas integrifolia* (white dryad), *Epilobium angustifolium* (fireweed), *O.deflexa* (reflexed locoweed) and *H. mackenzii* (liquorice root). Revegetation studies initiated in the Water Interface zone in 2002 had to be abandoned when the water level in Cell B was permanently raised.

In 2003, a study was initiated to test the effectiveness of revegetation treatments for stabilizing a channel that had developed in Cell B, within the LLCF (Martens 2003). Treatments applied included seeding native-grass cultivars, planting seedlings of native sedges and willow cuttings.

Research results indicated that:

- Vegetation can be successfully established and plant cover maintained when planted directly into processed kimberlite (Martens 2005, 2007).
- The native-grass cultivars tested are capable of maintaining a plant cover in the Central Zone of the LLCF without the use of soil amendments.
- Vegetation established readily in the Water Interface Zone. Prior to the permanent elevation of the water level in Cell B (and the forced abandonment of the study), seeded native-grass cultivars were well established, transplanted sods of *Calamagrostis canadensis* (bluejoint reedgrass) and *Carex aquatilis* (water sedge) thrived, and willow cuttings had sprouted leaves and branches (Martens 2002).
- Amendment of processed kimberlite with peat or lake sediment improved plant growth during the second and third gr owing seasons but showed no effect in subsequent years (Martens 2005, 2007).
- Survival of tundra plant seedlings transplanted onto kimberlite was poor. Mortality was attributed primarily to burial of seedlings by windblown kimberlite, which was trapped by the grass canopy in the test plots (Martens 2005).
- The presence of a diverse soil microflora and nodulation of legume roots growing in processed kimberlite are positive indicators of soil development, and important factors in the development of a self-sustaining plant cover on processed kimberlite (Martens 2005).
- The concentration of soil salts varied somewhat from year to year, but remained at moderate levels (EC 4.5 dS/m 6.3 dS/m), without an apparent affect on growth of the native grass cultivars or the natural colonization of dwarf birch (Martens 2005, 2007).
- Soil organic carbon and available nutrients (NPK) remained relatively stable during the eight years of the study.
- Serpentine soils that typically develop on kimberlite deposits are usually deficient in plant available calcium. The addition of several forms of calcium in the greenhouse and field studies produced no growth response, at the outset or after five years of study, suggesting that plant uptake of calcium is not a concern in the long-term revegetation of the LLCF, and requires no further study.
- Grass cover in vegetated treatment plots, high in the years following initial establishment, declined to levels that averaged between 10 % and 15 %. Dead (litter) plant cover increased steadily over the years with the annual additions from aboveground plant production.
- Native-grass cultivars rooted to a maximum depth of 90 cm, where soil moisture was readily available. Root density was greatest in the upper 25 cm.
- Establishment of native plants from seed (other than native-grass cultivars) proved unsuccessful due to unfavourable site conditions (dry surface soil and wind erosion) and lead to the testing of

containerized stock, i.e., seedling plugs, and the identification of this as the most reliable method of establishing native plants in processed kimberlite.

- The accumulation of litter created favourable site conditions for colonization by dwarf birch in the sixth growing season.
- Research plots, fenced to prevent grazing by primary graziers (caribou and arctic hare), did not attract primary grazers when the fence was removed during the final season before the plots were covered with processed kimberlite. Native-grass cultivar plots, not protected from grazing from the time of seeding, persisted despite four years of grazing. The plants, however, were short and provided little cover or protection from wind erosion.

16.4.1.2 Application of Lessons Learned

Application of lessons learned during eight years of revegetation research in processed kimberlite:

- The surface of the LLCF should be roto-tilled to provide a homogeneous (physically and chemically) soil material, and a good seedbed.
- Drill seeding, as opposed to broadcast seeding, is preferred in the Central zone to enhance seedling establishment. Broadcast seeding is advised in the Water Interface zone because of poor trafficability and the presence of favourable moisture conditions.
- The tailings surface should be revegetated as soon as possible after final elevation is reached to control salt accumulation at the surface.
- When revegetating the LLCF under operational conditions, entire expanses of the LLCF, e.g., the area from one jetty to the next jetty should be revegetated at the same time, to reduce the potential of wind erosion and deposition in the revegetated area. If this in not possible, the areas adjacent should be stabilized temporarily, using physical control measures such as spray on erosion control material or “snow” fences, or by the seeding of annual species, until permanent revegetation is possible.
- The use of erosion control netting to assist the establishment of seed that is broadcast seeded is not recommended because the netting accumulated windblown kimberlite and restricted the establishment of seedlings.
- Maintenance fertilizer will be required for a period of time, to develop a self-sustaining plant cover.
- Sewage sludge could be used as a source of soil nutrients, if a practical method of application can be developed.
- Tundra seedlings were planted into established grass cover in spring; all suffered transplanting shock to variable degrees despite being hardened off.
- The use of conventional erosion control blankets, such as “Jute Soil Saver” in conjunction with the application of seed and fertilizer and rooted seedlings, does not provide adequate protection from water erosion in areas of concentrated flow.

16.4.1.3 Data and Information Gaps

- Operational equipment, methods and procedures to successfully establish a primary erosion-controlling cover of native-grass cultivars on the LLCF.
- The effect of primary grazers on revegetation success without permanent fencing.

- Temporary measures that may be required to protect the primary vegetation cover from grazing during the establishment phase.
- Long-term fertilizer requirement to maintain a stable vegetated surface.
- Methods and procedures to successfully establish native species in an erosion-controlling grass cover, by means of direct seeding or planting, and by natural colonization.
- Successional trends and characteristics of plant community that will develop on processed kimberlite in the long-term.

16.4.1.4 Recommendations for Future Work

Establishment of a Pilot Revegetation Study on the LLCF designed to provide missing information.

16.4.2 Identification of Locations within the LLCF Suitable for Revegetation

16.4.2.1 Research Results

Field studies indicated that vegetation could be used to enhance surface stability in the Water Interface Zone and the Central Zone of the LLCF (Section 5.5.5.2).

Natural colonization of the LLCF by *Puccinellia borealis* (alkali grass) began approximately in 2002, and by 2007 it occupied much of the Central Zone of Cell B (Martens 2007). The upper limit of colonization in 2007 roughly outlined the lower limit of the Upper Zone of processed kimberlite deposition. The largest processed kimberlite particles are deposited in this zone at the point of processed kimberlite discharge, resulting in a coarse-textured, rapidly drained substrate with low moisture holding capacity. These upper slopes of the LLCF are to be reclaimed with a rock cover, as outlined in Sections 5.5.5.2 and 5.5.5.3 because it is unlikely that plant cover can be sustained given the characteristics of the processed kimberlite in this area.

16.4.2.2 Application of Lessons Learned

The pattern of colonization of Cell B suggests that rock cover should extend approximately 100 to 300 m from the point of discharge with the lower limit taking on an undulating outline as it follows the semi-circular pattern created by successive discharge points located along the edge of the cell.

No vegetation is planned for the Upper Zone, where conditions are not expected to be conducive to sustained plant growth.

16.4.2.3 Data and Information Gaps

Identification of the location of the upper and lower boundary of Central Zone.

16.4.2.4 Recommendations for Future Work

Develop methodology, based upon physical characteristics of processed kimberlite, to determine the location of the upper and lower boundary of the Central Zone.

16.4.3 Survey of Tundra Plant Species with Potential for Revegetating the LLCF

16.4.3.1 Research Results

Ecological mapping and vegetation inventories for EKATI were completed early in project development (BHP Billiton 1995), followed by an inventory of soils and vegetation for the Misery Esker (Kidd 1999). A Traditional Knowledge perspective on biodiversity in the mine area was provided by the Dogrib Treaty

11 (Dogrib 2000). Ongoing revegetation studies at EKATI have identified potentially useful native species (Kidd 1996; Kidd and Rossow 1997, 1998; Kidd and Max 2000a; Martens 2005).

In 1999, seed of several legume species was sown in a field plot at EKATI, along the Old Camp Road, and along the banks of the Panda Diversion Channel, with the intention of establishing collection areas. Species included were *Hedysarum mackenzii* (liquorice root), *Oxytropis deflexa* (deflexed oxytrope) and *Astragalus eucosmus* (elegant milkvetch) (Kidd and Max 2000a). Seed of several graminoid species was collected from wetland stands for testing of viability and germination (Kidd and Max 2000a). Species tested were *Eriophorum angustifolium* (tall cottongrass), *Carex aquatilis* (water sedge), *Arctagrostis latifolia* (polargrass), *Calamagrostis purpurascens* (bluejoint) and *Arctophila fulva* (pendant grass).

Native plant species (other than native-grass cultivars) with proven ability to establish within the Central Zone of the LLCF include *Epilobium angustifolium* & *E. latifolium* (fireweed), *Betula glandulosa* (dwarf birch), *Dryas integrifolia* (white dryad) and the legumes *Hedysarum mackenzii*, *Oxytropis deflexa*, *O. maydelliana* (Maydell's oxytrope) and *O. hudsonica*. Species adapted to the Water Interface Zone include *Salix planifolia* (diamond leaf willow), *Eriophorum* spp. (cotton grass), *Carex aquatilis* (water sedge).

The grass *Puccinellia borealis* (alkaligrass) naturally colonized the study plots on the LLCF, and appeared well adapted to growth on processed kimberlite within the Central deposition zone (Martens 2005).

Festuca rubra (Arctared fescue), *Deschampsia ceaspitosa* (Nortran tufted hairgrass), *Poa alpina* (Gruening and Glacier alpine bluegrass), *Agropyron violaceum* (Violet wheatgrass) and *Festuca ovina* (sheep fescue) are the best suited of the native grass cultivars tested to maintain a grass cover on processed kimberlite. Norcoast Bering hairgrass, also successful, will not be utilized as it accumulates trace metals and is not native to the area (Martens 2005)

16.4.3.2 Application of Lessons Learned

Species tested to date appear indifferent to growth in processed kimberlite, i.e., none exhibited symptoms of stress when growing in processed kimberlite. Seedling mortality was related primarily to burial by wind-blown kimberlite.

16.4.3.3 Data and Information Gaps

- Identify additional tundra species adapted to growth in processed kimberlite.
- Cultural methods and practices to enhance establishment of tundra species by means of direct seeding or planting into an existing grass cover.

16.4.3.4 Recommendations for Future Work

- Research into additional species suited to growth in processed kimberlite.
- Research cultural methods and practices that promote establishment of tundra species by means of containerized stock or direct seeding.

16.4.4 Seed Collection, Storage and Propagation

16.4.4.1 Research Results

A Standard Operating Procedure (SOP) has been developed to identify seed sources and provide guidelines for collecting and processing seeds for use in reclamation (BHP Billiton 2004; Martens 2003, 2005).

The SOP provides information on locations, collection techniques and recommended harvesting dates for seed of several shrub, forb and graminoid species that have been found to be useful for reclamation at EKATI. Species listed include:

- *Arctostaphylos rubra, A. alpina* (bearberry)
- **Betula glandulosa* (dwarf birch),
- **Carex aquatilis* (water sedge)
- **Dryas integrifolia* (white dryad)
- **Empetrum nigrum* (crowberry)
- **Epilobium angustifolium, E. latifolium* (fireweed)
- **Eriophorum vaginatum* (cotton grass)
- **Hedysarum mackenzii* (Liquorice root)
- **Oxytropis deflexa* (reflexed locoweed), *O. maydelliana* (Maydell's oxytrope), **O. hudsonica* (Hudsons locoweed)
- **Vaccinium uliginosum* (bilberry)

Seed of tundra plants used in the LLCF research was collected between 2000 and 2004, cleaned and stored in a deep freeze at the EKATI Minesite. Germination tests conducted in 2008 indicated that the viability of all three *Oxytropis* spp. remained high (in excess of 90%, with scarification) after 4 to 8 years of storage. Viability of dwarf birch and fireweed seed, collected in 2004, remained at 55% and 69%, respectively.

Establishment of tundra plants by direct seeding produced poor results, leading to the production of rooted seedlings for out planting as one- to two-year old stock. Because little information on commercial production of native tundra seedling plugs is available, ecological profiles of potential revegetation species, including available information on propagation was prepared for potential revegetation species, and provided to the nursery undertaking seedling production.

The small quantities of seedlings required for the LLCF revegetation research were produced by specialty nurseries in Calgary and shipped to EKATI by airfreight. Coast to Coast Reforestation Inc, located in Smokey Lake, AB, began work on producing seedlings for out-planting in the Rock Pad Revegetation Study established at EKATI in 2008. The species marked with an asterisk have, or are currently being grown as seedling plugs (i.e., containerized stock).

16.4.4.2 Application of Lessons Learned

- Seed production within any one species varies from year to year and between sites within the same year. Not every year is a good seed year.
- Additional species need to be tested for suitability for growth in processed kimberlite.
- Storage conditions optimum for legume seed may not be optimum for seeds with a thin seed coat, such as those from dwarf birch and fireweed.
- A commercial nursery was retained to develop methods and procedures for the large-scale production of containerized seedling stock that will be required for LLCF revegetation.

16.4.4.3 Data and Information Gaps

- o Location of collection sites of tundra species to be added to the revegetation research study.
- o Additional collection sites of existing SOP species.
- o Optimum time when seed should be collected.
- o Collection methods:
  - – by hand or machine assisted.
  - – specialized methods for certain species.
- o Estimated volumes of seed required by species
- o Storage conditions for each species to retain seed viability.
- o Out-planting regime to minimize mortality.

16.4.4.4 Recommendations for Future Work

- o Build on and expand the existing Seed Collection SOP and address missing information.
- o Work closely with Coast to Coast Nursery in the development of methods and practices that will minimize out-planting mortality, including practices such as forced senescence and planting dormant stock.

16.4.5 Assessment of Natural Colonization and Successional Trends

16.4.5.1 Research Results

Natural colonization on the LLCF has been observed in the course of conducting other fieldwork. The grass *Puccinellia borealis* (alkaligrass) naturally colonized the study plots on the LLCF, and appeared well adapted to growth on processed kimberlite within the Central deposition zone (Martens 2005). Several kilograms of seed were collected and discussions with commercial seed producers are currently underway.

Betula glandulosa (dwarf birch) naturally colonized the LLCF reclamation research plots seven years after establishment (Martens 2007). The accumulated grass litter provided site conditions suitable for establishment of seedlings. Dwarf birch is a prolific seed producer (when seed is produced), the seed is small, light in weight, and with its winged appendage, well designed for transport by wind across large distances, especially during winter when surfaces are covered with snow.

Natural colonization was also investigated at several other mine sites in NWT, but results were not reported for specific mine components (Kidd and Max 2001; Martens 2007).

16.4.5.2 Application of Lessons Learned

- o Tundra species will colonize the LLCF when the particular conditions required by the species are provided. For a primary colonizer such as *Puccinellia borealis*, a bare surface is suitable; for dwarf birch, a primary colonizer given the right site conditions, appears to require a well-developed litter cover to establish on the LLCF.
- o Species that are prolific producers of light weight, highly mobile seed, are likely to be among the first to colonize the LLCF.
- o Natural colonization will likely be accelerated by assisting in the establishment of species that produce seed of lower mobility.

16.4.5.3 Data and Information Gaps

- LLCF site conditions that enhance conditions for colonization by tundra species.
- Methods to accelerate natural colonization.
- Changes in the plant community composition and structure with time.

16.4.5.4 Recommendation for Future Work

- Research site conditions requirements for the target tundra species.
- Research methods to assist establishment of tundra species, especially those with lower seed mobility, including the construction of islands of planted species and direct seeding in the Water-interface Zone.
- Research successional trends in low arctic ecosystems and disturbed sites with similar characteristics to processed kimberlite.
- Assess natural colonization of abandoned tailings impoundments and similar sites in the NWT and YT.

16.4.6 Assessment of Weeds at EKATI

16.4.6.1 Research Results

The presence of weeds at EKATI has been assessed periodically in the course of conducting rehabilitation monitoring. As of 2007, the only invasive weed recorded at EKATI is *Hordeum jubatum* (foxtail barley), which is limited to the area around the airport.

At the Giant Mine, near Yellowknife, extensive colonization by *H. jubatum* was noted in 2001 (Kidd and Max 2001). The only other non-native species present was *Equisetum pratense* (meadow horsetail). Non-native weed species recorded at the Rae Mine included *H. jubatum*, *Phalaris arundinacea* (reed canarygrass), *Taraxacum* spp. (dandelion) and *Polygonum* spp. (knotweed). At the Discovery Mine, weed species recorded included *H. jubatum*, *E. pratense*, and *Erigeron* sp. (fleabane). Martens (2007) assessed natural colonization at several disturbed sites in the region, but did not report the presence of any weedy species.

16.4.6.2 Application of Lessons Learned

Although the EKATI mine is remote, opportunity still exits for weeds to establish at the mine site – through natural vectors, via the winter road, or as contaminants in seed of native grasses grown on agricultural lands.

16.4.6.3 Data and Information Gaps

None

16.4.6.4 Recommendations for Future Work

- Continue to watch for weeds when monitoring revegetation success and moving about on the mine site.
- Take appropriate action if weeds are found
- Request Certificate of Analysis for every seed lot prior to purchase to ensure that no problem weeds are included. Refuse contaminated seed lots or request that they be cleaned again and

sampled again for weeds. Note: many weeds common in agricultural fields will be killed by the harsh winters at EKATI (Hardy BBT 1986).

16.5 REMAINING SCOPE TO BE COMPLETED

16.5.1 Detailed Work Scopes (next three years)

Table 5.1-4p provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Assess revegetation suitability of additional tundra species

Research to date has identified a limited number of tundra species that are adapted to processed kimberlite. Additional potential species will be identified and tested, based upon their presence in local plant communities, their ecological profiles (site preference and tolerances), and available information of growth in kimberlitic soils. *Serpentine And Its Vegetation, A Multidisciplinary Approach* by R.R. Brooks, Ph.D., will be a key source of information.

Potential species include, but are not limited to: *Empetrum nigrum* (crowberry), *Arctostaphylos alpina* (bearberry), *Vaccinium uliginosum* (bilberry), *Arctophila fulva, Carex bigelowii*. Field (if a suitable location can be found on the LLCF) and/or greenhouse trials of plant establishment and growth on processed kimberlite will be established and monitored. See also Task 3, below.

Task 2. Seed Collection, Storage and Propagation

The immediate purpose of this program is to provide seed and suitable stock for the Pilot Revegetation Study, expected to begin in 2013. The ultimate purpose is to develop a program that will provide suitable native stock for revegetation of the remainder of the LLCF. Because native seed production is generally low and infrequent, seed collection and development of suitable methods and procedures must start early in the research program. In 2009-2012 the research will build on previous studies, by including seed collection, storage and propagation work specific to those plants already identified as candidates for the establishment of an early protective cover, and for a long-term succession cover.

Sub-tasks to be undertaken:

a) Select Species

This will include species known to do well plus others identified in the assessment trials outlined above in Task 1.

b) Seed Collection

1. Seed Needs. Determine estimated quantity of seed of the target species required for LLCF revegetation research and the Pilot Revegetation Study. Seed requirements and storage viability will determine species collection priorities and quantities collected for future use.
2. Collection Sites. Identify accessible stands of selected species, where seed or other plant materials can be collected. Several locations (3 or 4) for each species will be selected to avoid intensive collection from the same area year after year. This may require the addition of two or three sites for those species already addressed in the SOP. Sites will be GPS referenced and marked on a collection site map.

3. Seed Harvesting. Research the use of handheld equipment to increase efficiency of seed collection.
4. Collection Schedule. Through germination testing, determine the phenology of seed ripening and visual cues to identify mature seed.
5. Seed Storage. Test various storage methods to maximize seed survival and germination. Research to date has shown that legume viability is maintained at a high level, after eight years of storage in a deep freeze. Small seeds with a thin seed coat, such as fireweed and dwarf birch may require different conditions to maintained viability.

c) Plant Propagation

Research into direct seeding and growing containerized seedling stock in the greenhouse for later planting will be continued. Research into the large-scale propagation of tundra species as containerized stock began in 2008. Coast to Coast nurseries, in Smokey Lake Alberta, are currently rearing six tundra species [*Betula glandulosa* (dwarf birch), *Vaccinium uliginosum* (bog bilberry), *Oxytropis deflexa* (reflexed locoweed), *Epilobium angustifolium & E. latifolia* (fireweed), *Empetrum nigrum* (crowberry) and *Hedysarum mackenzii* (Liquorice root)] for out-planting in the Rock Pad Reclamation Study in 2009 and 2010 (Martens 2009). Research into the rearing of seedlings and development of practices to increase survival of out-planted seedlings will be directly applicable to revegetation of the LLCF. Other species with potential for processed kimberlite revegetation will be added to the Coast to Coast seedling propagation program and the on-site field testing program.

Direct seeding will, because of poor trafficability, be the preferred method of plant establishment in the Water Interface Zone. Direct seeding trials with species likely to be adapted to site conditions found in this zone, such as *Salix planifolia, Carex bigelowii, Eriophorum vaginatum,* will be initiated on site.

Task 3. Natural Colonization and Plant Succession on the LLCF

Natural colonization of *Betula glandulosa* and *Puccinellia borealis* was recorded during monitoring of revegetation studies on the LLCF (Martens 2005). Research during the next three years will include, but not be limited to:

- Review of literature on plant colonization community succession on disturbed lands, including information available from local mines (i.e., NWT and YT).
- Field assessment of natural colonization of abandoned tailings containments in the NWT and YT. Operations with tailings of comparable chemical and physical properties will be targeted.
- The utilization of *Puccinellia borealis* in the primary revegetation regime in an efficient and useful manner.
- The effectiveness of islands of planted tundra vegetation as centres of seed dispersion.

Integral to this research will be the characterization, to the extent possible, of the expected plant community and the successional changes that might occur over time. The effects of the anticipated changes in chemical and physical properties of processed kimberlite resulting from long-term weathering (see Appendix 5.1-5, Plan #11) will also be considered.

Task 4. Weeds Monitoring

Continue to monitor reclamation sites within the EKATI mine area for the presence of introduced weeds. Determine whether weed control is needed, and develop a plan if appropriate.

Task 5. Pilot Vegetation Study Planning

The vegetation pilot study is planned to commence in 2013. Prior to this research will include the outline of specific equipment and material needs, types and volumes (E.gs, site preparation and seeding equipment, plants/seeds amendment materials). Vegetation study planning will also incorporate and work in conjunction with planning of other LLCF pilot studies which will be completed in the same location (north end of Cell B) at the same time as the vegetation studies.

Task 6. Closure Objectives for LLCF Plant Communities

Determine what closure objectives and associated closure criteria can be used to indicate that LLCF plant communities have reached a satisfactory level of resilience to natural and man-made perturbations, evidencing that the community will eventually reach a stable, self-sustaining state. The research will include a literature review of current studies. The work will be closely associated with the types of plant species that can grow on the LLCF, continuing on with the field research which started in 2000 and will continue with the Pilot Vegetation Study.

Task 7. Stability of LLCF Plant Communities

This research will look at the LLCF plant community characteristics needed to indicate stability, and how they can be assessed using trend analysis. The research will include a literature review on the types of community characteristics that indicate stability, as well as field trials as part of the Pilot Vegetation Study.

16.5.2 Conceptual Work Scopes (2014 and following)

Task 8. Pilot Vegetation Study

The Pilot Vegetation Study will involve field studies of plant establishment, growth and persistence on the LLCF, established with operational equipment at the north end of the containment area. The study will incorporate the use of waste rock in the Upper Zone, and revegetation of the Central and Water Interface zones of the LLCF.

Studies will be monitored periodically to assess plant community development over the long term. The research will assess:

- Equipment and methods for site preparation, seeding and planting.
- Influence of grazing on vegetation establishment and erosion control.
- Construction and effectiveness of islands of planted tundra species.
- Vegetation establishment on the LLCF under the influence of assisted and natural colonization.
- Maintenance fertilizer requirements.
- Changes to the geochemical makeup of the processed kimberlite from weathering and wildlife grazing (see Appendix 5.1-4 Research Plan #18 and Appendix 5.1-5 Engineering Study #11).
- Changes in soil organic carbon and plant nutrients.

- Drainage and erosion control.
- Location of the upper and lower limit of the Central Zone.

For research into design of internal drainage channels, see Appendix 5.1-5 Engineering Study #9.

Findings from the Pilot Revegetation Study will be used in the development of final reclamation plans for the LLCF.

16.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on the use of native plants and establishment of self-sustaining plant communities in the PKCA mine component is linked to:

- Research on the establishment of self-sustaining plant communities in other mine components. In many cases site conditions, plant species present, and other community characteristics will be similar across mine components.
- Research on vegetation percent (%) cover and surface stability for the PKCA mine component and other mine components.
- Research on Traditional Knowledge inclusion in reclamation planning for the EKATI mine components.
- Research on the weathering of processed kimberlite.
- Research on the bioaccumulation of metals in grazers using the LLCF.
- Research on the design of internal drainage channels.

Reclamation field research on the LLCF will continue until approximately 2013 when a pilot vegetation study is planned for the northern end of Cell B. BHP Billiton will continue to seek opportunities to continue field work and initiate the pilot study if the Deposition Plan for the LLCF allows the opportunity for an area to be available for research and the site is safe for field work activities.

16.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-4p. Stabilization of EFPK in the LLCF - PKCA

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short-term Research Tasks (within next 3 years)				
1	Assess Revegetation Suitability of Additional Tundra Species	Field work, nursery studies, monitoring	2009	2012
2	Seed Collection, Storage and Propagation	Field work, nursery research (germination tests), monitoring.	2009	2012
3	Natural Colonization and Plant Succession on the LLCF	Literature review, field assessments, pilot study.	2009	2012
4	Weeds Monitoring	Ongoing monitoring, adaptive management (if required)	2009	On going

(continued)

Table 5.1-4p. Stabilization of EFPK in the LLCF - PKCA (continued)

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
5	Pilot Revegetation Study Planning	Planning and Design	2011	2012
6	Closure Objectives for LLCF Plant Communities	Literature review, field assessment, pilot study.	2011	2016
7	Stability of LLCF Plant Communities	Literature review, field assessment, pilot study	2011	2016
Long-term Tasks (2014 and following)				
8	Pilot Revegetation Study	Field work, monitoring.	2014	2018

16.8 COST

Total expected costs, for the period 2009 to 2012, are $300,000 - $400,000.

16.9 REFERENCES

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17. Vegetation Cover and Surface Stability on the LLCF

17.1 UNCERTAINTY

Plant cover required for long-term surface stabilization of processed kimberlite surface.

17.2 RESEARCH OBJECTIVE

The reclamation plan for the LLCF is for a combination rock and vegetation cover over processed kimberlite. Three cover zones are included in the preliminary design. The Upper Zone will have a 100% rock cover; the Central Zone will be a combination of rock and vegetation; and the Water Interface Zone would have a rock over soft, finer-texture processed kimberlite (Refer to Section 5.5.5.2 and Figure 5.5.6 of the ICRP.) The Central Zone will have rock bands with approximately 50 to 100 m spacing in between which vegetation will be established on processed kimberlite. The vegetation plan for these areas is covered in Section 5.5.5.3 of the ICRP.

Vegetation research planning for the LLCF is divided into two research plans. This research plan focuses on the expected percentage of cover that will effectively maintain surface stability. The second research plan (Establishment of Self-sustaining Plant Communities) focuses on plant species and identification of substrate materials that will affect the plant community composition on the LLCF.

The research objective for the establishment of the vegetation cover and surface stability topsoil and lake sediment storage sites is to determine what percentage of vegetation cover will be needed to effectively provide surface stability on the processed kimberlite in the LLCF.

17.3 RESEARCH PLAN

17.3.1 Tasks Completed or Initiated

Early research on processed kimberlite began with greenhouse studies in 1999. These were followed by field studies within fenced research plots on Cell B of the LLCF. After the operations review of the LLCF and a new deposition plan in 2005, the research plots were covered by processed kimberlite in 2008. The updated deposition plan shows that processed kimberlite deposition will be active in all cells (B, A and C) until approximately 2013, when a section of the north end of Cell B will no longer require processed kimberlite.

A Vegetation Pilot Study at the north end of Cell B will commence in approximately 2013 and will address a combination of operational and research questions, including vegetation establishment without fenced enclosures. Pilot studies on vegetation will continue at the north end of Cell B through 2019, when kimberlite deposition will be completed in the LLCF. The findings from the pilot study will be applied to the remainder of the facility at that time.

Research completed at Cell B determined that vegetation could be grown directly on processed kimberlite; however, no work has been initiated or completed on the relationship between plant cover and surface stability on these materials.

17.3.2 Short-term Tasks (to be started/continued in the next three years)

To determine what percentage of vegetation cover will be needed to effectively provide surface stability, research on processed kimberlite will determine:

1. Plant Cover and Canopy Structure

Assess the relationship between levels of plant cover and the stability of the surface of the LLCF will be a primary objective of the Pilot Vegetation Study expected to start in 2013. In the next three years research will focus on the review of relevant literature on revegetation and surface stability of similar sites at EKATI and elsewhere.

2. Plant Community Stability Characteristics

Determine plant community characteristics needed to indicate stability and how they can be assessed. This research will include quantitative descriptions of reference tundra communities in the EKATI area, as well as a review of criteria that have been used to indicate stability of similar sites in other reclamation projects with similar characteristics.

3. Development Rates

Assess rates of development of plant cover and community structure with time. Vegetation research at Cell B provided information on the development of plant cover and community structure during an eight year period following revegetation. In addition, the relevant literature on revegetation of similar sites will be reviewed.

4. Pilot Vegetation Study Preparation

Design elements of the study related to the assessment of surface stability and plant community characteristics.

17.3.3 Long-term Tasks (2014 and following)

5. Pilot Vegetation Study

Design and establishment of a Vegetation Pilot Study at the north end of Cell B in approximately 2013.

17.4 FINDINGS OF RESEARCH COMPLETED

17.4.1 Development Rates

17.4.1.1 Research Summary Results

- The native-grass cultivars tested are capable of maintaining a plant cover in the Central Zone of the LLCF (Martens 2005).
- The grass *Puccinellia borealis* (alkaligrass) naturally colonized the study plots on the LLCF, and appeared well adapted to growth on processed kimberlite within the Water Interface and Central Zone (Martens 2005).
- *Betula glandulosa* (dwarf birch) naturally colonized the LLCF reclamation research plots seven years after establishment (Martens 2007). The accumulated grass litter provided site conditions suitable for establishment of seedlings.
- Natural colonization was also investigated at several other mine sites in NWT, but results were not reported for specific mine components (Kidd and Max 2001; Martens 2007).

17.4.1.2 Application of Lessons Learned

- Tundra species will colonize the LLCF when the particular conditions required by the species are provided. For a primary colonizer such as *Puccinellia borealis*, a bare surface is suitable; for dwarf birch, a primary colonizer given the right site conditions, appears to require a well-developed litter cover to establish on the LLCF.
- Species that are prolific producers of light weight, highly mobile seed, are likely to be among the first to colonize the LLCF.
- Natural colonization will likely be accelerated by assisting in the establishment of species that produce seed of lower mobility.

17.4.1.3 Data and Information Gaps

- Levels of plant cover, canopy height, etc. needed to stabilize the surface of the LLCF, taking into consideration such factors as slope angle and the importance of root biomass.
- Characteristics of adjacent and/or predisturbance tundra plant communities on similar sites, to assist in developing criteria for a stable post-reclamation community.
- Longer-term data on plant community development on processed kimberlite or at other sites with similar characteristics.

17.4.1.4 Recommendations for Future Work

Research development of plant cover and community structure on sites with similar characteristics as processed kimberlite.

17.5 REMAINING SCOPE TO BE COMPLETED

17.5.1 Detailed Work Scopes (next three years)

Table 5.1-4q provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Plant Cover and Canopy Structure

- Research the relationship between level of plant cover and surface stability on sites with similar characteristics to the LLCF.
- Research the relationship between surface stability and plant cover and canopy structure.

Task 2. Plant Community Stability Characteristics

- Research plant community characteristics needed to indicate stability.
- Research criteria (plant cover and surface soils) that have been used to indicate stability on other projects with similar site conditions.
- Research methods used to assess surface stability.

Task 3. Development Rates

Research the rate of development of plant cover and other community characteristics over time, on sites with similar characteristics. Build on findings from the completed LLCF vegetation research.

Task 4. Pilot Vegetation Study Preparation

Design elements of the study related to the assessment of surface stability and plant community characteristics.

17.5.2 Conceptual Work Scopes (2014 and following)

Task 5. Pilot Vegetation Study

The Pilot Vegetation Study will involve field studies of plant establishment, growth and persistence on the LLCF.

Studies will be monitored periodically to assess:

- Development of plant cover and community structure.
- Surface stability in relation to plant cover and community structure.

17.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on vegetation cover and stability in the LLCF is linked to:

- Research on the establishment of self-sustaining plant communities in the LLCF, and other mine components.
- Research on vegetation cover and surface stability for other mine components. In many cases site conditions, plant species present, and other community characteristics will be similar across mine components.
- Research on processed kimberlite weathering.

- Research on metals bioaccumulation.
- Research on the construction of stable internal drainage channels in the LLCF.
- Research on the final LLCF cover design that is safe for human and wildlife use.
- Research on Traditional Knowledge inclusion in reclamation planning for the EKATI mine components.

17.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-4q. Vegetation Cover and Surface Stabilization on the LLCF.

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short-term Research Tasks (within next 3 years)				
1	Plant Cover and Canopy Structure	Field work, literature review	2010	2012
2	Plant Community Stability Characteristics	Field work, literature review	2010	2012
3	Development Rates	Field work, literature review	2010	2012
4	Pilot Vegetation Study Preparation	Study Design	2010	2012
Long-term Tasks (2014 and following)				
5	Pilot Vegetation Study	Field work, monitoring.	2014	2018

17.8 COST

Total expected costs are $100,000 - $150,000.

17.9 REFERENCES

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18. Grazing Impacts on LLCF Vegetation

18.1 UNCERTAINTY

Grazing effects on LLCF vegetation cover sustainability.

18.2 RESEARCH OBJECTIVE

The reclamation plan for the LLCF is for a combination rock and vegetation cover over processed kimberlite. Three cover zones are included in the preliminary design. The Upper Zone will have a 100% rock cover; the Central Zone will be a combination of rock and vegetation; and the Water Interface Zone would have a rock over soft, finer-texture processed kimberlite (Refer to Section 5.5.5.2 and Figure 5.5.6 of the ICRP). The Central Zone will have rock bands with approximately 50 to 100 m spacing in between which vegetation will be established on processed kimberlite. The vegetation plan for these areas is covered in Section 5.5.5.3 of the ICRP.

Previous vegetation research on the LLCF was completed within fenced enclosures, where the impacts of grazing were not assessed. This research is important in understanding the types of plants preferred by wildlife, and how grazing will impact long-term sustainability of plant growth.

The focus of the research will be a pilot study at the LLCF with the research objective to determine the type of vegetation that can be established on the LLCF that will minimize grazing effects, and still provide sufficient plant cover to stabilize the processed kimberlite surface.

18.3 RESEARCH PLAN

18.3.1 Tasks Completed or Initiated

Research completed at Cell B of the LLCF determined that vegetation could be grown directly on processed kimberlite. Observations on grazing impacts were made during this research; however, no dedicated research has been initiated or completed on the grazing impacts on LLCF vegetation.

Field revegetation studies on the LLCF were conducted within fenced research plots on Cell B of the LLCF. After the operations review of the LLCF and a new deposition plan in 2005, the research plots were covered by processed kimberlite in 2008. The updated deposition plan shows that processed kimberlite deposition will be active in all cells (B, A and C) until approximately 2013, when a section of the north end of Cell B will no longer require processed kimberlite.

A Vegetation Pilot Study at the north end of Cell B will commence in approximately 2013 and will address a combination of operational and research questions, including vegetation establishment without fenced enclosures. The findings from the pilot study will be applied to the remainder of the facility at that time.

18.3.2 Short-term Tasks (to be started/continued in the next three years)

1. Literature Review.

A literature review will be conducted to identify plant species that can undergo grazing by caribou and hare, and provide sustainable, erosion controlling cover on the Central Zone of the LLCF. Research will also draw on Traditional Knowledge and Aboriginal elders and hunters to assess caribou and grazing preferences.

18.3.3 Long-term Tasks (2014 and following)

The northern portion of Cell B of the LLCF (approximately 60 ha) has been identified for a pilot vegetation study for various reclamation operations on processed kimberlite, commencing in approximately 2013. The pilot study will include field studies identified in Tasks 2 to 4 below to assess the effects of grazing on LLCF vegetation.

2. Grazing Preference Study

Conduct field studies to assess grazing preference by major grazers (caribou and hare) for vegetation species and using control methods.

3. Assess Grazing Impacts

Evaluate whether a self-sustainable vegetation cover can be maintained and whether this cover is capable of maintaining a stable soil surface. Research may involve the assessment of methods to control grazing during the vegetation establishment phase.

4. Botanical Composition Study

Describe the anticipated botanical composition of the LLCF vegetation cover, based upon identified grazing effects, and provide revegetation specifications and management guidelines.

18.4 FINDINGS OF RESEARCH COMPLETED

18.4.1 Assessment of Grazing Preference

Research has been initiated on the grazing preference by caribou for revegetation species. Two studies were conducted to observe grazing effects on revegetation species used to establish a primary plant cover on the LLCF.

- Native-grass cultivars were seeded in several small (5m x 5m) plots adjacent to the fenced revegetation study plots on Cell B and monitored for growth and utilization by major grazers (Martens 2001).
- The perimeter fence of one of the Cell B LLCF revegetation research plots was removed in early summer 2007 prior to the re-deposition of processed kimberlite from the spigot line on the west side of Cell B. The remaining fenced vegetation plots were taken down in the late summer of 2007 (Martens 2007). The removal of the fences provided the opportunity to observe wildlife utilization of the vegetation plots.

18.4.1.1 Research Summary Results

Vegetation research at Cell B determined the following native grass cultivars and indigenous species have potential for LLCF revegetation:

- Native grass cultivars that can provide plant cover on processed kimberlite include: *Festuca rubra* (Arctared fescue), *Deschampsia caespitose* (Nortran tufted hairgrass), *Poa alpina* (Gruening and Glacier alpine bluegrass), *Agropyron violaceum* (Violet wheatgrass), and *Festuca ovina* (sheep fescue). *Puccinellia borealis* (alkali grass), a native grass has colonized the LLCF and appears well suited to growth on processed kimberlite over a wide range of soil moisture conditions.
- Indigenous species tested and capable of providing plant cover on processed kimberlite include: *Betula glandulosa* (dwarf birch), *Salix* planifolia (willow), *Dryas integrifolia* (white dryad), *Oxytropis deflexa*, and *O. hudsonica* (reflexed and Hudson's locoweed), *Hedysarum boreale* var. *mackenzii* (liquorice-root), *Epilobium* spp. (fireweed), *Calamagrostis canadensis* (bluejoint reedgrass), *Carex aquatilis* (water sedge) and *Eriophorum vaginatum* (cotton grass).

18.4.1.2 Application of Lessons Learned

- Perennial grasses, in unprotected (not fenced) research plots on the LLCF between 2002 and 2005 persisted despite four years of grazing, however growth remained short and provided little protection from erosion – demonstrating that a vegetation cover can be maintained on the LLCF without protective fencing. The fact that the plants were grazed down to ground-level is attributed to the fact that the research plots were small (5 m x 5 m) and provided the only palatable forage in the immediate area.

- Utilization, after removal of fences in one of the Cell B revegetation research plots, was low and grazing effects largely unnoticeable, attributed to the maturity of the plant cover (i.e., the high proportion of dead to live plant cover). One crater where caribou had exposed plant roots was noted.

18.4.1.3 Data and Information Gaps

- The effects of grazing on LLCF vegetation when a large area of the LLCF is revegetated.
- The botanical effects of grazing.
- Grazing pressure (number of animals utilizing the LLCF in any one season). Because of the variability in the numbers of caribou passing through the EKATI mine site from year to year, the range of anticipated numbers (based on historic data) should be considered. Caribou are expected to be of greatest concern because of their physical size, the destructive action of trampling and the possible presence of large herds.

18.4.1.4 Recommendations for Future Work

- Establish field plots on the LLCF of blocks (e.g., 50 m x 100 m) of native-grass cultivars and indigenous species (as individual species and mixtures of species) and monitoring of wildlife utilization.
- Research seasonal grazing pressure by caribou and har.
- Research botanical effects of grazing.

18.5 REMAINING SCOPE TO BE COMPLETED

18.5.1 Detailed Work Scopes (next three years)

Table 5.1-4r provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Literature Review

- Review literature on caribou and hare preferences for revegetation species (native grass cultivars and indigenous species) with promise for vegetating the LLCF.
- Research Traditional Knowledge and Aboriginal elders and hunters on grazing preferences of caribou and hare.

18.5.2 Conceptual Work Scopes (2014 and following)

Research undertaken in 2013 and following will be undertaken on the Vegetation Pilot Study area and will build on revegetation research completed on the LLCF.

Task 2. Grazing Preference Study

- Research seasonal grazing pressure on pilot vegetation study plots
- Research botanical effects of grazing

Task 3. Assess Grazing Impacts

- Research physical effects of trampling and up-rooting of vegetation
- Research temporary control methods to control protect an establishing plant cover, such as:
  - Electric fencing,
  - Lure crops, or
  - Fertilization of adjacent indigenous vegetation to draw animals away from the vegetating surface.

Task 4. Botanical Composition Study

Research on this question will be conducted during the pilot vegetation study. The anticipated vegetation cover will be based upon identified grazing effects and anticipated successional trends on the LLCF (see Reclamation Research Plan #16 for research on successional trends). Vegetation specifications and management guidelines to achieve the anticipated vegetation cover will be provided.

18.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on grazing impacts on LLCF vegetation is linked to:

- Research on vegetation percent cover and surface stability for the LLCF and other mine components.
- Research on the use of indigenous plants and development of self-sustaining plant communities, for the LLCF and other mine components.
- Research on how Traditional Knowledge can assist in reclamation of the LLCF.
- Research on metals bioaccumulation from vegetation growing on the LLCF.
- Research on the surface stability of the LLCF.

Research on grazing impacts to vegetation started in 2002 in the LLCF, when the north end of Cell B was consolidated and safe for access to conduct research work. Further studies on grazing impacts will recommence in approximately 2013 when the northern end of Cell B will be available for an LLCF Reclamation Pilot Study. This study will build on previous results on vegetation research, and from what is known regarding the types of vegetation expected to grow on this facility at closure.

18.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-4r. Grazing Impacts on LLCF Vegetation

Research Task #	**Task**	**Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)**	**Research Start**	**Research Finish**
Short-term Research Tasks (within next 3 years)				
1	Literature Review	Literature Review, Community Consultation	2011	2012
Long-term Tasks (2014 and following)				
2	Grazing Preference Study	Field work, monitoring.	2014	2018
3	Assess Grazing Impacts	Field work, monitoring	2014	2018
4	Botanical Composition Study	Field work, monitoring	2014	2018

18.8 COST

Total expected costs are $100,000 - $200,000.

18.9 REFERENCES

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19. LLCF Cover Design

19.1 UNCERTAINTY

The sustainability of a long-term rock cover on the LLCF and the construction of a final landscape that would be safe for human and wildlife use.

19.2 RESEARCH OBJECTIVE

The reclamation plan for the LLCF is for a combination rock and vegetation cover over processed kimberlite. Three cover zones are included in the preliminary design. The Upper Zone will have a 100% rock cover approximately 1 m thick; the Central Zone will be a combination of rock and vegetation, with the rock laid out in bands 10 – 12 m wide and approximately 60 cm minimum thickness; and the Water Interface Zone would have a rock layer of 1 m thickness over soft, finer-texture processed kimberlite (Refer to 5.5.5.2 of the ICRP). This research focuses on a Constructability Study and wildlife monitoring than will be included as part of a large scale LLCF Reclamation Pilot Study in approximately 2013 in the upper section of Cell B. The objectives of the research are:

1. Physical Stability of the Rock Cover. Develop an understanding of the expected behaviour of the processed kimberlite in the LLCF and evaluate the stabilization post-closure. Research questions include:
    - What type of consolidation and/or frost heaving processes may occur on the processed kimberlite surface?
    - What level of erosion is expected on the processed kimberlite surface?
2. Safety of Wildlife Traveling on the Rock Cover. Design the LLCF rock cover sections in each of the three zones that ensures safe use by people and wildlife.
3. Closure Criteria. Development measurable criteria to meet the closure objective of LLCF surface stability.

19.3 RESEARCH PLAN

19.3.1 Tasks Completed or Initiated

No research has been completed at this time. However data and information currently available that will assist the research work is listed below.

1. Tailings Characterization

In 1998 a Tailings Characterization Study was conducted by EBA Engineering Consultants Ltd. (EBA) which included the following studies:

- Changes in the physical characteristics and properties of the tailings that were expected to have occurred due to the process modifications.
- Characterization of the thickened tailings after being coagulated, flocculated and thickened, and
- Establish whether or not the tailings would segregate due to destruction of the macro flocculated structure and the information on floc breakdown during transport would be incorporated into the sample preparation method. The load-deformation, water release and freezing and thawing characteristics would be determined for the anticipated discharge tailings stream (EBA 1998).

2. Processed Kimberlite Deposition

Two LLCF Processed Kimberlite Deposition Investigation studies were completed by EBA Engineering, in 2002 and in 2006. The first investigation assessed the physical properties of the processed kimberlite deposited in Cell B of the LLCF through a field program in 2001 and included recovery of processed kimberlite samples for physical property characterization. Ground temperature cables were also installed to measure the thermal regime in selected boreholes, and monitoring wells were installed to enable pore fluid collection within the processed kimberlite (EBA 2002).

The second Processed Kimberlite Deposition Investigation was conducted by EBA in 2006. The scope of the investigation was to obtain representative in situ samples of the deposited processed kimberlite in Cells B and C of the LLCF to assess its in situ physical characteristics (i.e, moisture content, particle size distribution and bulk density, and voids ratio) (EBA 2006a).

3. LLCF Performance Assessment

A performance assessment of the LLCF was completed by Robertson GeoConsulting in 2004. Two reports were produced as part of the assessment (Robertson 2004 as well as Robertson and Hayley 2004) and the final design plan was included in the 2007 Wastewater and Processed Kimberlite Management Plan (BHP Billiton 2007). Findings from the assessment were:

- The subaerial beaches of processed kimberlite within the LLCF are easily eroded by water flowing over the beach, as observed in Cell B.
- Summer and winter trafficability of the beached material becomes more difficult with increasing distance from the processed kimberlite discharge point and near the water's edge.
- The beached processed kimberlite material is highly frost susceptible.
- Geotechnical investigations within Cell B and Cell C found the soil profile below the beaches to be horizontally laminated with zones of frozen material and lenses of ground ice. The extent to which frozen material was encountered generally decreased closer to the cell water body.

- Experience with processed kimberlite deposition within the LLCF has shown that the material segregates along the deposited beach. The coarse fractions deposit close to the point of discharge and become finer with increasing distance down the beach. Free water emanating from the beach settled material tends to retain a portion of the finer clay and silt sized particles. This water plus fines flows over and down the tailings beach and joins the cell main water body, where it settles to form a deposit known as Extra Fine Processed Kimberlite (EFPK). EFPK rates of settling and consolidation are slow; thus the material could remain as a low density deposit for a long period. Generally the EFPK has very low shear strength and behaves essentially like a 'heavy' liquid flowing to fill the lower pond zone.

4. Geotechnical Screening

EBA Engineering undertook a geotechnical screening study in 2006 with respect to the future water management options for the LLCF. The project scope was to evaluate at a concept study level the feasibility and estimated costs associated with the following potential changes to the LLCF:

- Either conversion of Dike C into a dam to a maximum elevation of 459 m or construction of a new cross-lake dam in Cell D (referred to as Dam D) to a maximum elevation of 459 m.
- Collection and routing of surface run-on water on the east side of Cells B and C that currently reports to those cells and routing it directly into Cell D (East Ditch).
- Diversion of water from the pond complex west of Cell A around Cell C into Cell D or alternatively into the Exeter Watershed (EBA 2006b).

19.3.2 Short-term Tasks (to be started in the next three years)

See Section 19.5.1 for more detailed description of the research tasks.

1. Site Investigation

Conduct an updated site investigation to assess the physical properties of the processed kimberlite. The intent of the investigation will be to form a better understanding of the processed kimberlite consolidation and frost heave processes. Consolidation behaviour of the processed kimberlite is of particular interest in the water interface zones, where erosion protection will potentially be placed over EFPK.

2. Review LLCF Cover Design

Review the concept design plan in the ICRP and include findings from updates on the physical characteristics of the processed kimberlite and ensure the design includes considerations for safe wildlife travel across the facility after closure.

3. Water Management Plan

Develop a water management plan and design for the LLCF. Water presently flows into the facility from the surrounding catchment areas, and the intent of managing the surface runoff is to reduce the risk of erosion within the LLCF.

4. Monitor Phase 1 Pond Stability

Monitor the stability of the Phase 1 Pond following decommissioning. Information gathered from the monitoring will be used to develop the stabilization design for the LLCF.

5. Constructability Study

Conduct a Constructability Study to test the rock cover design as proposed in the ICRP. The study will test the use of equipment and trafffficability on the LLCF and the learnings will be used in the future reclamation of the remainder of the facility with the completion of processed kimberlite deposition.

19.3.3 Long-term Tasks (2014 and following)

See Section 19.5.2 for more detailed description of the research tasks.

6. Wildlife Monitoring

After the rock surface has been constructed the LLCF Reclamation Pilot Study will include a wildlife monitoring plan designed to assess wildlife behaviour near and within the study area with the focus on access, egress and surface conditions safe for wildlife use.

7. Geotechnical Monitoring

The rock cover areas in the Constructability Study (Upper, Central and Water Interface Zones) will be monitored for physical changes in the final surface (including material subsidence and erosion). Alternatively, a series of LiDAR surveys could be completed to assess surface movement. This would eliminate the need for finite monitoring points to be established and allow the entire facility to be monitored. Surface erosion will be monitored as part of the Water Management Plan, to assess the controls on any surface runoff into and within the facility.

8. Detailed Cover Design

The findings from Tasks 5, 6 and 7 will be used to construct a detailed design of the final rock cap for LLCF. The design should include where the rock will be placed, the depth and type of rock to be used, and what the final surface cover will look like with respect to long-term human and wildlife use.

9. Capping Materials Review

Estimate the volume of materials required for the final rock cap design for all containment cells in the LLCF, and sourcing of these materials. Clean granite waste rock will be required for the rock cap portion of the LLCF.

10. Develop Measurements for Closure Criteria

Use the information gathered from the Constructability Study stability observations to develop a measurement for surface stability on the LLCF after capping, and construction of internal channels.

19.4 FINDINGS OF RESEARCH COMPLETED

19.4.1 Research Summary Results

No research has been completed at this time.

19.4.2 Application of Lessons Learned

No research has been completed at this time.

19.4.3 Data and Information Gaps

No data and information gaps have been identified at this time.

19.5 REMAINING SCOPE TO BE COMPLETED

19.5.1 Detailed Work Scopes (next three years)

Table 5.1-4s provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Site Investigation

Sample the processed kimberlite in the LLCF to gain an understanding of settling and consolidation characteristics. Recovered samples will be tested to evaluate their physical properties and variability between locations. Testing may include particle size analysis, x-ray diffraction, specific gravity, frost heave evaluations and Atterberg limits (a common test for fine grained soils related to liquid limits and soil classification).

Once the testing is complete, the data will be compared against previously completed work. Information gained from sampling will be supplemented by previous studies conducted at the site for frost heave and the use of vegetation as a viable stabilization method.

Task 2. Review LLCF Cover Design

Based on the physical characteristics determined through the sampling described in Task 1, combined with the observations and learnings from the construction work for the Phase 1 Pond reclamation, a stabilization design can be developed for the LLCF. This design is to be compared to the conceptual design developed for the LLCF in the ICRP and will include a final cover design that allows safe access by people and wildlife. Concept level plans developed in the ICRP calls for a combination of rock and vegetation, with waste rock placed in an irregular patterned fashion. Vegetation would then be planted inside the grids. The intent of the cells would be to reduce surface flow velocities through the LLCF and give the vegetation time to root. Water Management studies in Task 3 will be completed concurrently to ensure the incorporation of surface runoff flow controls and better performance of a functional cover design.

Task 3. Water Management Plan

Develop a water management plan to limit the amount of overland surface water flow, thereby limiting the potential for erosion within the LLCF. Part of the water management plan will be to direct this runoff, where possible, towards settling ponds in each of the cells, or Cell D. Surface water within the LLCF is also to be managed through site grading and ditching to convey runoff to the designated outlet point. Run-on to the LLCF from outside catchments is to be prevented utilizing ditches and berms as appropriate. Design of grading and ditches will be based on expected surface water volumes to be determined through historic rainfall data from nearby weather stations. More detail on water management of the facility and the Option 3aM is found in the 2007 Wastewater and Processed Kimberlite Management Plan.

Regular inspections of the decommissioned Phase 1 Pond after reclamation activities should be performed to denote observed erosion, degradation/aggradation, cracking or sloughing of the surface. Surveys of the area should be considered for an increased level of accuracy.

Task 4. Monitor Phase 1 Pond Stability

Monitor the stability of Phase 1 Pond following decommissioning. The conditions of the Phase 1 Pond may be similar to those that can be expected in the LLCF post closure if the final design of the Phase 1 Pond is a rock cover. The observations of stability performance in the decommissioned area will provide transferable knowledge to LLCF stabilization design.

Task 5. Constructability Study

The Constructability Study will be part of the large scale LLCF Reclamation Pilot Study in 2013. The Constructability Study will reveal additional merits and drawbacks to the LLCF stabilization design; most importantly providing insight into constructability of the design. The study would include testing of appropriate equipment for quarrying, hauling and placement, trafficability on the processed kimberlite surface, dust generation and mitigation measures, and appropriate thickness covers for the three reclamation zones. Results from the study will be used to develop the final construction plan and associated schedule for the remainder of the facility. Any additional stabilization deemed necessary in the decommissioned Phase 1 Pond should be incorporated into the LLCF stabilization design.

19.5.2 Conceptual Work Scopes (2014 and following)

Table 5.1-4s provides an outline and schedule of tasks to be undertaken after 2014.

Task 6. Wildlife Monitoring

The focus of this research plan is the safe use of the LLCF by wildlife after the surface reclamation. A monitoring plan will be designed, through the WEMP, that will assess wildlife behaviour (specifically caribou) near and on the constructed surface in Task 5. Key points of the research will include physical factors such as surface cover design that will not cause injury and barriers that will not impede movement. Opportunities will also be discussed with communities to include a Traditional Knowledge component into the wildlife behaviour monitoring. The monitored area is proposed to be at the upper (northern) end of Cell B, covering a maximum area of 60 ha, and if possible include the three rock cover types as described in Section 5.5.5.2 of the ICRP. Because the LLCF Reclamation Pilot Study will also include other research studies such as vegetation research and grazing impacts on vegetation which also influence wildlife behaviour opportunities will be looked at to understand relationships between these studies and how resources can be pooled during monitoring and reporting of results.

Task 7. Geotechnical Monitoring

After the constructability test has been completed a geotechnical monitoring plan will be put in place to monitor any changes in the constructed surface. Monitoring points will be positioned at key locations to measure movement of the stabilization components (i.e., granite cover within the Upper, Central and Water Interface Zones, as well as vegetation areas). The monitoring points should be inspected on a regular basis with findings recorded in a consistent manner to allow for comparison over time. Any instability within the study area should be investigated, with the results lending towards potential design improvements.

Monitoring work will include regular topographic surveys of the study area to monitor elevation movement and changes over time, paying particular attention to any degradation leading towards instability. Any slope failures will be investigated to determine cause and implementation of additional stabilization as appropriate. The use of LiDAR surveys may provide more detail than visual observations and traditional survey techniques, therefore enabling better interpretation of cap movement.

Monitoring will be completed by a qualified geotechnical engineer and learnings from the constructability study will be used to assist the final design and construction methods for the remainder of the surface reclamation work in the LLCF.

Task 8. Detailed Cover Design

The findings from Tasks 5, 6 and 7 will be used to construct a detailed surface cover design of the final rock cap for LLCF. The design should include where the rock will be placed, the depth and type of rock to be used, and what the final surface cover will look like with respect to long-term human and wildlife use.

Task 9. Capping Materials Review

This task will estimate the volume of materials required for the final rock cap design for all containment cells in the LLCF, and sourcing of these materials. Clean granite waste rock will be required for the rock cap portion of the LLCF.

Task 10. Develop Measurements for Closure Criteria

Compare historic observations and aggradation/degradation (survey) records against soil conditions and stability to establish a quantifiable relationship. Results should be tabulated in such a way that long-term stability in the LLCF can be predicted with reasonable certainty based on the conditions in place at time of closure. Historic records should be analyzed by a qualified professional familiar with soil conditions in the area. A period of observation should commence following closure to ensure success has been obtained.

19.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Studies on processed kimberlite surface stability at the LLCF are linked to:

- Research on vegetation percent cover and surface stability for the LLCF.
- Research on permafrost growth in processed kimberlite in the LLCF.
- Research on the construction of stable internal drainage channels in the LLCF.
- Research on the water quality in the LLCF after mine closure.
- Research on Traditional Knowledge inclusion in reclamation planning for the EKATI mine components.

Because the current deposition plan for the LLCF has processed kimberlite discharge into all active containment cells until at least 2013 research studies on processed kimberlite surface stability will not fully commence until after that date. Preliminary research work will be conducted prior to 2013 on permafrost growth, and some information will be drawn from the reclamation research work for vegetation conducted at the northern end of Cell B between 2000 and 2006.

19.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-4s. LLCF Cover Design

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short-term Research Tasks (within next 3 years)				
1	Site Investigation	Investigation Report	2011	2011
2	Review LLCF Cover Design	Report	2011	2012
3	Water Management Plan	Report	2011	2012
4	Monitor Phase 1 Pond Stability	Geotechnical Survey	2011	2013
5	Constructability Study	Design Report, IFC Drawings	2013	2013
Long-term Tasks (2014 and following)				
6	Wildlife Monitoring	WEMP Report	2014	2017
7	Geotechnical Monitoring	Geotechnical Survey	2014	2017
8	Detailed Cover Design	Design Report, IFC Drawings	2016	2016
9	Capping Materials Review	Desktop Evaluation	2016	2016
10	Develop Measurements for Closure Criteria	Update to Closure Objectives & Criteria	2017	2018

19.8 COST

Total expected costs are $750,000 - $1,000,000

19.9 REFERENCES

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20. Establishment of Self-sustaining Plant Communities – Dams, Dikes and Channels

20.1 UNCERTAINTY

The development of self-sustaining plant communities within the Dams, Dikes and Channels mine component (i.e., banks of re-established or new channels, as well as channels through breached dams and dikes) that are compatible with the surrounding tundra environment.

20.2 RESEARCH OBJECTIVE

All dams, except the Panda Diversion Dam will be decommissioned and breached at mine closure to re-establish hydraulic connection with the surrounding watershed. Channels will be constructed, modified and in some cases re-established at various sites at EKATI for mine closure. The banks of these channels will need to be geotechnicaly stable, and any surface erosion controlled.

The study of vegetation growth on channel banks is divided into two research plans. This research plan focuses on finding the plant species and identification of substrate materials that will affect plant community composition. The second research plan (Vegetation Cover and Surface Stability on Dams, Dikes and Channels) focuses on the expected percentage of cover that will effectively maintain surface stability.

The research objective is to determine what self-sustaining plant community type(s) can be established on channel banks at mine closure.

20.3 RESEARCH PLAN

The target areas identified for revegetation are the channel banks above the water's edge. Vegetation studies conducted at the Panda Diversion Channel (PDC) and Fred's Channel is directly applicable to this research and provides early information on the use of vegetation to stabilize shorelines and channel entrances.

20.3.1 Tasks Completed or Initiated

1. Revegetation Locations

Determine locations along channel banks where vegetation establishment will be needed. This research began with the revegetation of PDC and Fred's Channel and will be expanded to involve a characterization of the substrate materials present along the channel and the effectiveness of vegetation in the stabilization of shorelines and channel entrances. Learnings from this preliminary research will be applied and expanded, as described in Section 20.4.1, to other sites as they become available.

2. Tundra Plant Species

Survey of tundra plant species with potential for revegetation of channel banks. BHP Billiton has committed to using native regional plants for revegetation work at EKATI. Native plant research includes identifying plants that would grow and sustain on a variety of soil conditions ranging in texture from the fine-grained sediments to coarse-grained gravels and crushed rock, typical of many channel banks constructed at EKATI. The survey of established and disturbed tundra plant communities within the EKATI mine area and the surrounding region has identified a number of tundra species with potential for revegetating shorelines. Potential species will be assessed, additional species may require testing.

3. Materials Assessment

Assessment of the suitability of channel banks to support a self-sustaining plant cover. Greenhouse trials have been completed and field trials initiated to assess the ability to establish and maintain a self-sustaining plant cover of local tundra species along channel edges. Continued monitoring of field trials is required.

4. Seed Collection, Storage and Propagation

A Standard Operating Procedure (SOP) has been developed that identifies seed sources and provides guidelines for collecting and processing seeds for use in revegetation. The SOP will be expanded as needed, to include updated species lists and related information.

5. Natural Colonization and Successional Trends

Continued monitoring of field trials is required to assess natural colonization and successional trends. Literature will also be reviewed to determine how natural colonization can be encouraged.

6. Weeds Monitoring

The presence of weeds at EKATI and at abandoned mines in the NWT has been assessed in the course of monitoring revegetation and rehabilitation. This practice will continue.

20.3.2 Short-term Tasks (to be started/continued in the next three years)

1. Revegetation Locations

This research will build on previous work.

Tundra Plant Species

This research will build on previous work.

3. Materials Assessment

This research will build on previous work.

4. Seed Collection, Storage and Propagation.

This research will build on previous work.

5. *Natural Colonization and Successional Trends.*

This research will build on previous work.

6. *Weeds Monitoring*

This research will build on previous work.

20.3.3 Long-term Tasks (2014 and following)

No additional long-term tasks are planned. Short-term tasks will be continued in the long-term, as required.

20.4 FINDINGS OF RESEARCH COMPLETED

20.4.1 Revegetation Locations

20.4.1.1 Research Summary Results

Locations where channel bank reclamation will be required include shorelines and sites where bridges and culverts will be removed and dam breach channels. Specific locations have not yet been identified.

20.4.1.2 Data and Information Gaps

- Locations where vegetation will be required to enhance surface stability.
- The need for erosion control measures to promote stability while vegetation establishes.

20.4.1.3 Recommendation for Future Work

- Determine site characteristics after all infrastructure development and removal is complete.
- Assess site conditions, flow patterns, flood events, sensitivity of substrate, erosion risks and where vegetation cover will be needed for erosion control.
- Determine specific erosion risks and the need for erosion control structures or materials.

20.4.2 Tundra Plant Species

20.4.2.1 Summary of Findings

Ecological mapping and vegetation inventories for EKATI were completed early in project development (BHP Billiton 1995), followed by an inventory of soils and vegetation for the Misery Esker (Kidd 1999). A Traditional Knowledge perspective on biodiversity in the mine area was provided the by Dogrib Treaty 11 (Dogrib 2000).

Ongoing revegetation studies at EKATI have identified potentially useful native species (Kidd 1996; Kidd and Rossow 1997, 1998; Kidd and Max 2000a; Martens 2005, 2008, 2009).

- In 1999, seed of several legume species was sown in a field plot at EKATI, with the intention of establishing a collection area. Species included were *Hedysarum mackenzii* (liquorice root), *Oxytropis deflexa* (deflexed oxytrope) and *Astragalus eucosmus* (elegant milkvetch) (Kidd and Max 2000a). Seed of several graminoid species was collected from wetland stands for testing of viability and germination (Kidd and Max 2000a). Species tested were *Eriophorum angustifolium* (tall cottongrass), *Carex aquatilis* (water sedge), *Arctagrostis latifolia* (polargrass), *Calamagrostis purpurascens* (bluejoint) and *Arctophila fulva* (pendant grass).

- Native plant species potentially useful for revegetation of various site types include *Epilobium angustifolium*, *E. latifolium*, and the legumes *Astragalus alpinus* (alpine milkvetch), *Hedysarum mackenzii*, *Oxytropis deflexa*, and *O. maydelliana* (Maydell's oxytrope). Species adapted to riparian habitats include *Salix* spp. (willows) and *Arctophila fulva*.

20.4.2.2 Application of Lessons Learned

A number of promising tundra species and native-grass cultivars have been identified for revegetation of channel banks.

20.4.2.3 Data and Information Gaps

- The need for additional species suitable for revegetation of channel banks.
- Cultivation methods and practices to enhance establishment of tundra species by means of direct seeding, use of containerized stock or planting into an existing grass cover.

20.4.2.4 Recommendations for Future Work

- Cultivation methods and practices that promote the establishment of tundra species by means of containerized stock or direct seeding.
- Review the list of promising species to determine whether additional species need to be added for successful revegetation of channel banks.

20.4.3 Materials Assessment

Field studies of plant cultivation treatments have been conducted at the PDC and Fred's Channel (Kidd and Max 2000a, 2000b, 2001 and 2002; Martens 2007 2009). The physical characteristics of both channels are expected to be similar to those of channel banks that will be constructed at mine closure.

20.4.3.1 Summary of Findings

- Survival of transplanted willows and *Arctophila* sprigs was moderately good at most locations in the PDC and Fred's Channel, except where high stream velocities or rapid changes in hydrology occurred.
- The legume *Hedysarum mackenzii* established well at the PDC, and some seedlings flowered in 2001. Seedlings of *Oxytropis deflexa* also were present, but were smaller and had not flowered.
- In 2006, the seeded native-grass cultivars were well established at the PDC, and were colonizing adjacent areas of fine-grained sediment.
- In 2008, several herbaceous species were colonizing the gravel flats adjacent to Fred's Channel, including *Calamagrostis canadensis* (bluejoint), *Eriophorum vaginatum* and *E. angustifolium* (cotton grass), and *Carex bigelowii*. *Salix planifolia* (diamond-leaf willow) had established on the lower reaches of the channel with finer-grained soils.

20.4.3.2 Application of Lessons Learned

- Native herbaceous and shrub species can be successfully established along channel banks and in shallow waters with low current velocity.
- The addition of fertilizer (16-16-16 NPK), applied at moderate levels (e.g., 150 kg/ha) will assist establishment of native-grass cultivars and other tundra species.

20.4.3.3 Data and Information Gaps

- Long-term survival and development of vegetation on channel banks.
- Requirement for nutrient input to sustain or enhance vegetation cover in the long-term.

20.4.3.4 Recommendations for Future Work

- Continued monitoring of plant cover at existing sites with similar characteristics
- Add additional study sites when suitable sites become available.
- Nutrient requirements to sustain long-term plant cover on channel banks.

20.4.4 Seed Collection, Storage and Propagation

20.4.4.1 Research Results

A Standard Operating Procedure (SOP) has been developed to identify seed sources and provide guidelines for collecting and processing seeds for use in reclamation (BHP Billiton 2004; Martens 2003, 2005).

The SOP provides information on locations, collection techniques and recommended harvesting dates for seed of several shrub, forb and graminoid species that have been found to be useful for reclamation at EKATI. Species listed include:

- *Arctostaphylos rubra, A. alpina* (bearberry)
- *Betula glandulosa* (dwarf birch),
- *Carex aquatilis* (water sedge)
- *Dryas integrifolia* (white dryad)
- *Empetrum nigrum* (crowberry)
- *Epilobium angustifolium, E. latifolium* (fireweed)
- *Eriophorum vaginatum* (cotton grass)
- *Hedysarum mackenzii* (Liquorice root)
- *Oxytropis deflexa* (reflexed locoweed), *O. maydelliana* (Maydell's oxytrope), **O. hudsonica* (Hudsons locoweed)
- *Vaccinium uliginosum* (bilberry)

Seed of tundra plants was collected between 2000 and 2004 for LLCF reclamation research, cleaned and stored in a deep freezer at the EKATI minesite. Germination tests conducted in 2008 indicated that the viability of all three *Oxytropis* spp. remained high (in excess of 90%, with scarification) after 4 to 8 years of storage. Viability of dwarf birch and fireweed seed, collected in 2004, remained at 55% and 69%, respectively.

20.4.4.2 Application of Lessons Learned

- A number of promising plant species for revegetation of channel banks have been identified through previous studies.

- Storage conditions optimum for legume seed may not be optimum for seeds with a thin seed coat, such as those from dwarf birch and fireweed.
- A commercial nursery was retained to develop methods and procedures for the large-scale production of containerized seedling stock.

20.4.4.3 Data and Information Gaps

- Review the existing information sources, including the SOP, to determine whether sources of seeds and/or live plant materials have been identified for all desired species. If needed, research additional collection sites.
- Species that can be readily established by direct seeding and species that are best established with containerized stock.
- Optimum time when seed should be collected.
- Collection methods:
  - by hand or machine assisted.
  - specialized methods for certain species.
- Estimated volumes of seed required by species.
- Storage conditions for each species to retain seed viability.
- Out-planting regime to minimize mortality.

20.4.4.4 Recommendations for Future Work

- Build on and expand the existing Seed Collection SOP and address missing information, as required.
- Work closely with Coast to Coast Nursery in the development of methods and practices that will minimize out-planting mortality, including practices such as forced senescence and planting dormant stock.

20.4.5 Natural Colonization and Successional Trends

Information on natural colonization is available from revegetation studies at the PDC and Fred's Channel (Martens 2007). The physical characteristics of both channels are similar to those of channel banks that will be reclaimed at mine closure. Natural colonization was also investigated at several other mine sites in NWT that included a variety of site conditions, but results were not presented for specific mine components (Kidd and Max 2001; Martens 2007).

20.4.5.1 Summary of Findings

- At Fred's Channel, natural colonizers present in 2006 included the grass *Calamagrostis canadensis* (bluejoint), the sedges *Eriophorum angustifolium* (tall cottongrass), *E. vaginatum* (tussock cottongrass) and *Carex bigelowii* (Bigelow's sedge), and *Salix planifolia* (diamondleaf willow).
- At the PDC, stands of the legumes *Hedysarum mackenzii*, *Oxytropis deflexa* and *Astragalus alpinus* were established at several locations. In total, at least 41 vascular and 6 nonvascular species were present, including *C. canadensis*, *Betula glandulosa* (dwarf birch), *Salix* spp., *Equisetum* spp. (horsetail), *Epilobium angustifolium* (fireweed), *Eriophorum* spp. and *Carex* spp. It appeared that areas with abundant fine-grained sediment were relatively favorable for natural colonization, as well as for the establishment of seeded species.
- In 2006, the seeded native-grass cultivars were well established at the PDC, and were colonizing adjacent areas of fine-grained sediment.

20.4.5.2 Application of Lessons Learned

Research at Fred's Channel and the PDC, sites with similar characteristics to those expected at other channel banks, indicates that indigenous species are establishing with assisted revegetation (seeding and planting) and by natural means.

20.4.5.3 Data and Information Gaps

- Methods to accelerated natural colonization
- Changes in plant community composition with time.

20.4.5.4 Recommendations for Future Work

- Methods to assist establishment of tundra species on channel banks.
- Continue monitoring successional trends at existing on site study sites.
- Review successional trends on similar sites in the NWT and YT and elsewhere.

20.4.6 Weeds Monitoring

20.4.6.1 Research Results

The presence of weeds at EKATI has been assessed periodically in the course of conducting rehabilitation monitoring. As of 2007, the only invasive weed recorded at EKATI is *Hordeum jubatum* (foxtail barley), which is limited to the area around the airport.

At the Giant Mine, near Yellowknife, extensive colonization by *H. jubatum* was noted in 2001 (Kidd and Max 2001). The only other non-native species present was *Equisetum pratense* (meadow horsetail). Non-native weed species recorded at the Rae Mine included *H. jubatum*, *Phalaris arundinacea* (reed canarygrass), *Taraxacum* spp. (dandelion) and *Polygonum* spp. (knotweed). At the Discovery Mine, weed species recorded included *H. jubatum*, *E. pratense*, and *Erigeron* sp. (fleabane). Martens (2007) assessed natural colonization at several disturbed sites in the region, but did not report the presence of any weedy species.

20.4.6.2 Application of Lessons Learned

Although the EKATI mine is remote, opportunity still exits for weeds to establish at the mine site – through natural vectors, via the winter road, or as contaminants in seed of native grasses grown on agricultural lands.

20.4.6.3 Data and Information Gaps

None

20.4.6.4 Recommendations for Future Work

- Continue to watch for weeds when monitoring revegetation success and moving about on the mine site.
- Take appropriate action if weeds are found
- Request Certificate of Analysis for every seed lot prior to purchase to ensure that no problem weeds are included. Refuse contaminated seed lots or request that they be cleaned again and sampled again for weeds. Note: many weeds common in agricultural fields will be killed by the harsh winters at EKATI (Hardy BBT 1986).

20.5 REMAINING SCOPE TO BE COMPLETED

20.5.1 Detailed Work Scopes (next three years)

Table 5.1-4t provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Revegetation Locations

- Review maps and final schematics of the area mine, in order to determine site characteristics after all infrastructure development and removal is complete.
- Establish field study sites and assess moisture regimes, substrate types, and areas of instability where cover vegetation will be needed.
- Research specific erosion risks at each site. Assess surface flow patterns, severity of expected flood events, and sensitivity of substrate to erosion.
- If hydraulic erosion is a concern, determine whether erosion control structures or geotextiles need to be in place prior to vegetation efforts.

Task 2. Tundra Plant Species

- Review the list of promising species to determine whether additional species need to be added for successful revegetation of channel banks. Research will include the plant communities established on disturbed sites and a review of pertinent literature.
- Establish field trials with additional species as required.

Task 3. Materials Assessment

- Continue to monitor plant cover at PDC and Fred's Channel to characterize the development of long-term plant cover.
- Review revegetation studies of similar sites in NWT, YT and elsewhere.
- Research nutrient requirements to support a self-sustaining plant cover on channel banks.

Task 4. Seed Collection, Storage and Propagation

Develop a program that will provide suitable native stock for revegetation of all mine components that require revegetation, including channel banks. Because native seed production is generally low and infrequent, seed collection and development of suitable methods and procedures must start early in the research program. In 2010-2014 the research will build on previous studies, by including seed collection, storage and propagation work specific to those plants already identified as candidates for the establishment of an early protective cover, and for a long-term cover on channel banks.

Sub-tasks to be undertaken:

a) Select Species

This will include species known to do well plus others identified in the assessment trials outlined above in Section 20.5.1.

b) Seed Collection

1. Seed Needs. Determine estimated quantity of seed of the target species required for revegetation research and the reclamation of channel banks. Seed requirements and storage viability will determine species collection priorities and quantities collected for future use.
2. Collection Sites. Identify accessible stands of selected species, where seed or other plant materials can be collected. Several locations (3 or 4) for each species will be selected to avoid intensive collection from the same area year after year. This may require the addition of two or three sites for those species already addressed in the SOP. Sites will be GPS referenced and marked on a collection site map.
3. Seed Harvesting. Research the use of handheld equipment to increase efficiency of seed collection.
4. Collection Schedule. Through germination testing, determine the phenology of seed ripening and visual cues to identify mature seed.
5. Seed Storage. Test various storage methods to maximize seed survival and germination. Research to date has shown that legume viability is maintained at a high level, after eight years of storage in a deep freeze. Small seeds with a thin seed coat, such as fireweed and dwarf birch may require different conditions to maintained viability.

c) Plant Propagation

Research into direct seeding and growing containerized seedling stock in the greenhouse for later planting will be continued. Research into the large-scale propagation of tundra species as containerized stock began in 2008. Coast to Coast nurseries, in Smokey Lake Alberta, are currently rearing six tundra species [*Betula glandulosa* (dwarf birch), *Vaccinium uliginosum* (bog bilberry), *Oxytropis deflexa* (reflexed locoweed), *Epilobium angustifolium & E. latifolia* (fireweed), *Empetrum nigrum* (crowberry) and *Hedysarum mackenzii* (Liquorice root)] for out-planting in the Rock Pad Reclamation Study in 2009 and 2010 (Martens 2009). These species all have promise for revegetation of channel banks. On-going research on the rearing of seedlings and development of practices to increase survival of out-planted seedlings will be directly applicable to revegetation of channel banks. Other species with potential for revegetation of this mine component will be added to the Coast to Coast seedling propagation program and the on-site field testing program.

Task 5. Natural Colonization and Successional Trends

- Research plant colonization and successional trends on comparable habitats in NWT and YT. Integral to this research will be the characterization, to the extent possible, of the expected plant community and the successional changes that might occur over time.
- Field assessment of natural colonization of existing study sites at PDC and Fred's Channel and other sites with similar characteristics.

Task 6. Weeds Monitoring

Continue to monitor reclamation sites within the EKATI mine area for the presence of introduced weeds. Determine whether weed control is needed, and develop a plan if appropriate.

20.5.2 Conceptual Work Scopes (2014 and following)

Build on existing studies outlined in Tasks 1 through 6. No additional work is planned at this time.

20.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on the use of native plants and establishment of self-sustaining plant communities along channel edges is linked to:

- Research on the establishment of self-sustaining plant communities in other mine components. In many cases site conditions, plant species present, and other community characteristics will be similar across mine components.
- Research on vegetation percent (%) cover and surface stability of channel banks and other mine components.
- Research on Traditional Knowledge inclusion in reclamation planning for the EKATI mine components.

The majority of dams and dikes will remain operational until the later part of the LOM Plan. As well, may of the post mining channels will not be re-established or constructed until after mining operations. Results from early research studies which have used vegetation to stabilize the PDC waterway and Fred's Channel at the Airport Esker will benefit similar work elsewhere. The early research from the PDC will also be useful in planning rehabilitation of pit lake perimeters and their adjoining streams, as well as individual channels constructed through dam and dike breaches, which have similar physical conditions.

20.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-4t. Sustainable Plant Communities – Dams, Dikes and Channels

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short-term Research Tasks (within next 3 years)				
1	Revegetation Locations	Planning and Field assessments	2010	2014
2	Tundra Plant Species	Literature review, field assessments	2010	2014
3	Materials Assessment	Field assessments, monitoring	2010	2014
4	Seed Collection, Storage and Propagation	Field work, nursery research (germination tests), monitoring.	2010	2014
5	Natural Colonization and Plant Successional Trends	Literature review, field assessments.	2010	2014
6	Weeds Monitoring	Ongoing monitoring, adaptive management (if required)	2010	On going
Long-term Tasks (2014 and following)				
1-6	Build on the Above Short-term Research Tasks	Field work, monitoring.	2014	2018

20.8 COST

Total expected costs are $100,000 - $150,000.

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21. Vegetation Cover and Surface Stability – Dams, Dikes and Channels

21.1 UNCERTAINTY

Plant cover required for long-term surface stabilization of sites in the Dams, Dikes and Channels mine component (i.e., banks of re-established or new channels, as well as channels through breached dams and dikes).

21.2 RESEARCH OBJECTIVE

All dams, except the Panda Diversion Dam will be decommissioned and breached at mine closure to re-establish hydraulic connection with the surrounding watershed. Channels will be constructed, modified and in some cases re-established at various sites at EKATI for mine closure. The banks of these channels will need to be geotechnicaly stable, and any surface erosion controlled.

The study of vegetation growth on channel banks is divided into two research plans. This research plan focuses on the expected percentage of cover that will effectively maintain surface stability. The second research plan (Establishment of Self-sustaining Plant Communities – Dams, Dikes and Channels) focuses on plant species and identification of substrate materials that will effect the plant community composition.

The research objective is to determine what percentage of vegetation cover will be needed to effectively provide surface stability of channel banks and to meet the closure objective.

21.3 RESEARCH PLAN

Research on the development of plant cover on channel banks has begun. This research plan will build on existing revegetation studies and expand the scope to include the assessment of the physical characteristics of the sites to be revegetated. Revegetation studies on the PDC and Fred’s Channel will be utilized. Vegetation research will focus toward those areas where there will be reconnection and/or construction of channels adjacent to pit lakes, and breach areas of dams of dikes. Vegetation cover may be required on slopes where surface stability will be necessary for erosion management. Much of the research for these sites will be drawn from studies for camp pads and laydown areas, because of the expected similarities in substrate materials. In addition, the relevant literature on revegetation of similar sites will be reviewed.

21.3.1 Tasks Completed or Initiated

Information is available on the establishment of plant cover on the PDC and Fred’s Channel, sites with similar characteristics to those along channel banks. The Rock Pad Reclamation study was constructed in 2007 and recultivation treatments will be completed in 2010 (Martens 2009). No work has been initiated or completed on the relationship between plant cover and surface stability on these materials.

21.3.2 Short-term Tasks (to be started/continued in the next three years)

To determine what percentage of vegetation cover will be needed to effectively provide surface stability on channel banks, the research will determine:

1. Plant Cover and Canopy Structure

Levels of plant cover and canopy structure needed to provide surface stability on vegetated sites. This information will be obtained in part by monitoring the results of the existing revegetation studies established at EKATI, and the review of relevant literature on revegetation of similar sites.

2. Plant Community Stability Characteristics

Plant community characteristics needed to indicate stability, and how they can be assessed. This research will include quantitative descriptions of reference tundra communities in the EKATI area, as well as a review of criteria that have been used to indicate stability of similar sites in other northern reclamation projects.

3. Development Rates

Rates of development of plant cover and community structure with time. This information will be obtained primarily by monitoring the results of ongoing revegetation studies at EKATI, particularly the studies already established at the PDC and Fred's Channel and the Rock Pad Reclamation Study. This research will be expanded in scope to include the assessment of physical characteristics of these sites. In addition, the relevant literature on revegetation of similar sites will be reviewed.

21.3.3 Long-term Tasks (2014 and following)

Short-term tasks identified in Section 21.3.2, above, will continue in 2014 and following. Because plant cover and community development is a slow process in the Low Arctic tundra, existing studies will be monitored to track long-term changes in plant cover and surface stability. Additional study sites may be added to provide information on the dynamics of early plant cover and surface stability on newly disturbed sites, at a time when disturbed sites are most vulnerable to erosion.

21.4 FINDINGS OF RESEARCH COMPLETED

21.4.1 Development Rates

21.4.1.1 Research Summary Results

- At Culvert Camp revegetated in 1997, total live cover of vascular plants in 2002 was approximately 15%, and consisted mainly of the seeded *Festuca rubra* (red fescue). Soil (a coarse gravel mix) was generally unfavourable for plant growth. Fertilizer was reapplied in fall 2004, resulting in increased total live vascular cover (17%) in 2005 (Martens 2006).
- At the Tercon laydown site, native-grass cultivars provided an average 15% total vascular cover five years after revegetation. The pad, comprised of a coarse-textured glacial till, was deep-ripped to relieve compaction and roughen the surface in preparation for revegetation (Kidd and Max 2002; Martens 2007).
- At the Paul Lake laydown site, total plant cover five years after revegetation, ranged from 7% to 17%; the majority (13.5%) provided by mosses and 4% to 6% provided by native vascular plants (graminoids, forbs and herbs). The waste rock pad had been removed to the extent possible, leaving the area largely covered with boulders with patches of exposed organic-rich tundra soil. Some natural recovery had occurred from the exposed tundra surface (Martens 2007).
- Native-grass cultivars were well established on the banks of the PDC in 2006, and were colonizing adjacent areas of fine-grained substrate (Martens 2007), but cover data were not obtained.

- Eleven years following construction at Fred's Channel, total vascular plant cover provided by indigenous species was 3.3% in the middle reach and 8.5% in the lower reach with finer grained soils, and non vascular plant cover was 7.1% and 18.8%, respectively. On an adjacent gravel esker deposit, total vascular and non-vascular plant cover was 5.1% and 10.8%, respectively (Martens 2009).

21.4.1.2 Application of Lessons Learned

- Native-grass cultivars can be successfully established, and natural colonization is occurring on study sites with similar site characteristics to channel banks.
- The rate at which plant cover develops and the resultant plant community structure will depend largely on the physical characteristics of the soil substrate.

21.4.1.3 Data and Information Gaps

- Levels of plant cover, canopy height, etc. needed to stabilize the surface of channel banks, taking into consideration such factors as substrate and slope angle, and the importance of root biomass.
- Characteristics of adjacent and/or predisturbance tundra plant communities on similar sites, to assist in developing criteria for a stable post-reclamation community.
- Longer-term data on plant community development in the study plots at PDC and Fred's Channel, Tercon laydown, Culvert Camp, Rock Pad Revegetation Study, and other sites with similar characteristics.

21.4.1.4 Recommendations for Future Work

- Build on plant cover assessment work at PDC and Fred's Channel, Tercon laydown, Culvert Camp, Rock Pad Revegetation Study, and other sites with similar characteristics.
- Add additional study sites as disturbed areas with suitable site characteristics become available.

21.5 REMAINING SCOPE TO BE COMPLETED

21.5.1 Detailed Work Scopes (next three years)

Table 5.1-4u provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Plant Cover and Canopy Structure

- Monitor and assess the relationship between vegetation cover/canopy structure and surface stability at PDC and Fred's Channel, Tercon laydown, Culvert Camp, Rock Pad Revegetation Study and other revegetated sites with suitable site characteristics.
- Assess the physical characteristics of sites to be revegetated (e.g., grain size distribution, organic matter content, bulk density).
- Assess the rate of soil loss on vegetated sites.
- Assess the relationship of plant cover and canopy structure on surface stability.
- Research revegetation cover and surface stability at similar sites in NWT, YT and elsewhere.

Task 2. Plant Community Stability Characteristics

- Quantitative field assessment of reference tundra communities in the EKATI area.

- Research criteria (plant cover and surface soils) that have been used to indicate stability in other northern reclamation projects.

Task 3. Development Rates

- Review and assess the rate of development of plant cover and other community characteristics over time, on revegetated channel banks along PDC and Fred's Channel, and sites with similar characteristics including Tercon laydown, Culvert Camp and Rock Pad Revegetation Study.
- Expand the scope of ongoing studies to include the assessment of surface physical characteristics of sites to be revegetated (terrestrial and aquatic habitats).
- Review relevant literature on revegetation of similar sites.

21.5.2 Conceptual Work Scopes (2014 and following)

Task 4. Ongoing Monitoring

- Continue to build on the existing work scope, to acquire long-term information on plant cover and community development and surface stability
- Add study sites as suitable sites become available; to expand the application and confidence with which information acquired can be applied to the revegetation of channel banks at EKATI.

21.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on vegetation cover and stability of channel banks is linked to:

- Research on the establishment of self-sustaining plant communities in other mine components. In many cases site conditions, plant species present, and other community characteristics will be similar across mine components.
- Research on the use of native plants and establishment of self-sustaining plant communities on channel banks.
- Research on Traditional Knowledge inclusion in reclamation planning for the EKATI mine components.

The construction of channels next to pit lakes will not take place until later in the mine life, and the majority of dams and dikes will remain operational until the later part of the LOM Plan. Results from early research studies which have used vegetation to stabilize the PDC waterway and Fred's Channel at the Airport Esker will benefit similar work elsewhere. The early research from the PDC will also be useful in planning rehabilitation of pit lake perimeters and their adjoining streams, as well as individual channels constructed through dam and dike breaches, which have similar physical conditions.

21.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-4u. Vegetation Cover and Surface Stability – Dams, Dikes and Channels

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short-term Research Tasks (within next 3 years)				
1	Plant Cover and Community Structure	Field work, literature review	2010	2014
2	Plant Community Stability Characteristics	Field work, literature review	2010	2014
3	Development Rates	Field work, literature review	2010	2014
Long-term Tasks (2014 and following)				
4	Ongoing Monitoring of Existing Studies, Add New Sites	Field work, monitoring.	2014	2028

21.8 COST

Total expected costs are $100,000 - $150,000.

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Reid, N. and M. A. Naeth. 2002. Establishment of a Vegetation Cover on Kimberlite Mine Tailings. Report prepared for BHP Billiton Diamonds Inc., Yellowknife, NT, Canada by Department of Renewable Resources, University of Alberta, Edmonton, AB, Canada.

22. Fish Migration Corridor King Pond – Cujo Lake

22.1 UNCERTAINTY

The design criteria for the fish migration corridor that will be required to connect the closed King Pond Settling Facility (KPSF) to Cujo Lake have not been defined. Although the design itself will be an engineering task, a number of biophysical requirements will form part of the design criteria for the corridor. The present lack of design criteria for corridor therefore, represents an uncertainty.

22.2 RESEARCH OBJECTIVE

The King Pond was been modified into a settling facility for use as a sedimentation pond and containment facility for mine water and other runoff associated with Misery Pit operations. Water that collects in the settling facility is only released into the receiving environment (i.e., Cujo Lake) when it meets the Water Licence effluent quality criteria. Fisheries Authorization SC00028 outlines the following rehabilitation requirements for closure of the KPSF in SectionS 6.2.4 and 6.2.5 of the authorization:

6.2.4 Re-establish the King Pond outflow, and
6.2.5 Enhance the drainage and migration corridor between the King Pond and Cujo Lake.

The objective of the research is to define the relevant biophysical requirements for a fish corridor between the KPSF and Cujo Lake at closure. For continuity of tasks, the objective is also extended to encompass the engineering design for the corridor.

22.3 RESEARCH PLAN

22.3.1 Tasks Completed or Initiated

No research has been completed at this time. However information currently available that will assist the research work is listed below.

1. Baseline Information

Baseline data exist for fish and fish habitat in King Pond prior to mine development (e.g., BHP-Dia Met 1995). There is also fish habitat information for other migration corridors on the EKATI Claim Block (e.g., Rescan 2008). Baseline discharge flow from King Pond to Cujo Lake has also been previously documented (e.g., BHP-Dia Met 1995).

2. Panda Diversion Channel

The Panda Diversion Channel (PDC) was designed to divert flow from Upper Panda Lake, around Panda and Koala pits and underground operations, to Kodiak Lake, as well as to compensate for loss of fish habitat from all streams across the mine site that are affected by mining operations. The channel was designed and constructed from 1995 to 1997 to carry the stream flowing from Grizzly and Buster lakes, runoff from sub-basins adjacent to the channel, as well as fish passage to lakes upstream of Kodiak Lake.

22.3.2 Short-term Tasks (to be started/continued in the next three years)

No short-term tasks have been identified prior to 2014.

22.3.3 Long-term Tasks (2014 and following)

See Section 22.5.2 for more detailed description of the research.

1. Discussions with Department of Fisheries and Oceans

The Department of Fisheries and Oceans (DFO) has set out the reclamation requirements for this channel. Discussions with the DFO will take place near the outset and periodically through the course of this project to maintain clear communications on the work being designed.

2. Baseline Review

A review of baseline information will be undertaken to further define the biophysical requirements for fish passage so that the connector resembles pre-development fish passage conditions.

3. Review Information on other Migration Corridors at EKATI

A review of success and challenges of other migration corridors at EKATI (e.g., PDC and other diversion channels) will be undertaken to help in screening potential design concepts so that the selected design benefits from practical considerations for a maintenance free and effective connector.

4. Closure Criteria

Determine design criteria based on restoring to original status.

22.4 FINDINGS OF RESEARCH COMPLETED

22.4.1 Research Summary Results

22.4.1.1 Baseline Information

Baseline information is documented in the EIS (BHP-Dia Met 1995) and in Rescan (2008) for migration corridors on EKATI Claim Block.

22.4.1.2 Panda Diversion Channel

In 2006, the PDC had been in operation for 9 years and it is functioning much like any other stream in the region. Annual monitoring has shown that the PDC is an active fish passage route, that it provides spawning, rearing and foraging habitat for Arctic grayling (*Thymallus articus*) fry, slimy sculpin (*Cottus cognatus*) and lake chub (*Couesius plumbeus*). It also provides rearing habitat for juveniles and adults of species that spawn in lakes: burbot (Lota lota), lake trout (*Salvelinus namaycush*), longnose sucker (*Catostomus catostomus*) and round whitefish (*Prosopium cylindraceum*) (Rescan 2007 and 2008).

22.4.2 Application of Lessons Learned

The development and monitoring of the PDC provides information on the performance of a diversion channel at EKATI (Rescan 2008). This information is being used in the design of other diversion channels and their monitoring programs at EKATI, and will be used to help develop design criteria for the design of the King-Cujo fish migration corridor.

22.4.3 Data and Information Gaps

No data and information gaps have been identified at this time.

22.5 REMAINING SCOPE TO BE COMPLETED

22.5.1 Detailed Work Scopes (next three years)

No short-term tasks have been identified prior to 2014.

22.5.2 Conceptual Work Scopes (2014 and following)

Table 5.1-4v provides an outline and schedule of conceptual tasks to be undertaken in 2014 and following.

Task 1. Discussions with Department of Fisheries and Oceans

The Department of Fisheries and Oceans (DFO) has set out the reclamation requirements for this channel. Discussions with the DFO will take place near the outset and periodically through the course of this project to maintain clear communications on the work being designed.

Task 2. Baseline Review

A review of baseline information will be undertaken to further define the biophysical requirements for fish passage so that the connector resembles pre-development fish passage conditions.

Task 3. Review Data on other Migration Corridors at EKATI

A review of success and challenges of other migration corridors at EKATI (e.g., PDC and other diversion channels) will be undertaken to help in screening potential design concepts so that the selected design benefits from practical considerations for a maintenance free and effective connector.

Task 4. Closure Criteria

Determine design criteria based on restoring to original status. Habitat characteristics that will be present in the stream at closure will be reviewed to evaluate the level of effort required to bring the connector stream at closure to the level required by the engineering design.

22.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on the construction of a fish migration corridor between Cujo Lake and King Pond is linked to:

- Research on King Pond fish habitat.

Research on the reconnection of the flow and fish migration between King Pond and Cujo Lake establishment will commence later in the LOM Plan, prior to the end of mining cessation in the Misery open pit. The Misery pit operations are completed in 2018 (Refer to the ICRP).

22.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-4v. Fish Migration Corridor King Pond-Cujo

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Long-term Tasks (2014 and following)				
1	Discussions with DFO	Agreement Document	2015	2018
2	Baseline Review	None	2015	2015
3	Review Information on Other Fish Migration Corridors at EKATI	None	2016	2016
4	Closure Criteria	Design Criteria Report	2017	2018

22.8 COST

Total expected costs are $100,000 - $150,000.

22.9 REFERENCES

BHP-Dia Met. 1995. NWT Diamonds Project Environmental Impact Statement. Prepared for BHP Minerals Ltd. and Dia Met Inc. by Rescan Environmental Services Ltd.

Rescan. 2007. EKATI Diamond Mine: Panda Diversion Channel Monitoring Program 2006. Report prepared for BHP Billiton Diamonds Inc. by Rescan Environmental Services Ltd. February 2007.

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23. King Pond Fish Habitat

23.1 UNCERTAINTY

The uncertain final pond bathymetry of the King Pond Settling Facility (KPSF) and the characteristics of sediments at closure create an uncertainty for designing enhancements to diversify fish habitat in the pond at closure.

23.2 RESEARCH OBJECTIVE

The King Pond was been modified into a settling facility for use as a sedimentation pond and containment facility for mine water and other runoff associated with Misery Pit operations. Water that collects in the settling facility is only released into the receiving environment (i.e., Cujo Lake) when it meets the Water Licence effluent quality criteria. Fisheries Authorization SC00028 outlines the following rehabilitation requirements for closure of the KPSF in Section 6.2.1 through 6.2.3 of the authorization:

> 6.2.1 Remove sediments accumulated within the King Pond that degrade the quality of or interfere with the enhancement of fish habitat,
> 6.2.2 Enhance the bathymetry within the King Pond to promote overwintering habitat,
> 6.2.3 Increase habitat diversity within King Pond.

The research objectives are to determine:

- The amount of sediments in KPSF that need to be removed at the completion of Misery pit operations,
- The level of enhancement required to promote overwintering habitat, and
- The enhancements required to diversify fish habitat.

23.3 RESEARCH PLAN

23.3.1 Tasks Completed or Initiated

No research has been completed at this time. However information currently available that will assist the research work is listed below.

1. *Baseline Information*

   Data from baseline reports for King-Cujo Watershed, the operational Aquatic Effects Monitoring Program and Surveillance Network Program (SNP) will provide the necessary water and sediment quality data at closure.

23.3.2 Short-term Tasks (to be started/continued in the next three years)

No short-term tasks have been identified prior to 2014.

23.3.3 Long-term Tasks (2014 and following)

See Section 23.5.2 for more detailed description of the research.

1. Discussions with Fisheries and Oceans Canada

Fisheries and Oceans Canada (DFO) has set out the reclamation requirements for this pond. Discussions with the DFO will take place near the outset and periodically through the course of this project to maintain clear communications on the work being designed.

2. Review Baseline Fish Data

Review baseline fish community to identify required habitat diversity.

3. Design Fish Habitat

Design fish habitat necessary to meet diversity and overwintering requirements.

4. Measure Sediment and Water Quality

Measure conditions and have a preliminary design plan in place at least two years prior to mine closure and make any necessary final refinements to the reclamation workplan at closure of Misery operations.

5. Measure Bathymetry and Existing Fish Habitat

Conduct a bathymetric survey of King Pond at least two years prior to mine closure and make any necessary final refinements to the reclamation workplan at closure of Misery operations.

23.4 FINDINGS OF RESEARCH COMPLETED

23.4.1 Research Summary Results

23.4.1.1 Baseline Information

Baseline reports for King-Cujo Watersheds provide information on fish habitat prior to mine development (BHP-Dia Met 1995) that can be used to help define the required modifications at closure. The operational Aquatic Effects Monitoring Program (e.g., Rescan 2008) and Surveillance Network Program (SNP) will provide the necessary water and sediment quality data at closure.

23.4.2 Application of Lessons Learned

No research has been completed at this time.

23.4.3 Data and Information Gaps

No data and information gaps have been identified at this time.

23.5 REMAINING SCOPE TO BE COMPLETED

23.5.1 Detailed Work Scopes (next three years)

No short-term tasks have been identified prior to 2014.

23.5.2 Conceptual Work Scopes (2014 and following)

Table 5.1-4w provides an outline and schedule of tasks to be undertaken in 2014 and following.

Task 1. Discussions with DFO

DFO has set out the reclamation requirements for this pond. Discussions with the DFO will take place near the outset and periodically through the course of this project to maintain clear communications on the work being designed.

Task 2. Review Baseline Fish Data

Review baseline fish community to identify required habitat diversity.

Task 3. Design Fish Habitat

Design fish habitat necessary to meet diversity and over-wintering requirements.

Task 4. Measure Sediment and Water Quality

Measure conditions and have a preliminary design plan in place at least two years prior to mine closure and make any necessary final refinements to the reclamation workplan at closure of Misery operations.

Task 5. Measure Bathymetry and Existing Fish Habitat

Conduct a bathymetric survey of King Pond at least two years prior to mine closure and make any necessary final refinements to the reclamation workplan at closure of Misery operations.

23.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on the construction of a fish habitat in the King Pond Settling Facility linked to:

- Research on the fish migration corridor between King Pond and Cujo Lake.

Research on the establishment of fish habitat in the KPSF will commence later in the LOM Plan, prior to the end of mining cessation in the Misery open pit. The Misery pit operations are completed in 2018.

23.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-4w. King Pond Fish Habitat

Research Task #	Task	Project Tracking (Reporting, Modeling, Field Work, Engineering Designs)	Research Start	Research Finish
Long-term Tasks (2014 and following)				
1	Discussions with Fisheries and Oceans	TBD	2014	2018
2	Review Baseline Fish Data	Summary memorandum	2015	2015
3	Design Fish Habitat	Design report	2016	2016
4	Measure Sediment and Water Quality	Summary memorandum	2016	2016
5	Measure Bathymetry and Existing Fish Habitat)	Summary memorandum	2016	2016

23.8 COST

Total expected costs are $200,000 - $250,000.

23.9 REFERENCES

BHP-Dia Met. 1995. NWT Diamonds Project Environmental Impact Statement. Prepared for BHP Minerals Ltd. and Dia Met Inc. by Rescan Environmental Services Ltd.

Rescan. 2008. EKATI Diamond Mine: Aquatic Effects Monitoring Program. Prepared for BHP Billiton Diamonds Inc. by Rescan Environmental Services Ltd. April 2008.

24. Establishment of Self-sustaining Plant Communities – Buildings and Infrastructure

24.1 UNCERTAINTY

The development of sustainable plant communities within the Buildings and Infrastructure mine components (e.g., camp pads, laydown areas, quarry sites) that are compatible with the surrounding tundra environment.

24.2 RESEARCH OBJECTIVE

The reclamation of buildings and infrastructure at EKATI includes roads, camp pads, laydown areas, fuel storage sites, sumps and exploration sites. Where surface stabilizing work is required these sites will have a granite cover or will be vegetated with native vegetation. Surface drainage will be re-established where necessary. An assessment of remaining surfaces will be conducted and selected sites will be landscaped to encourage natural vegetation through trenching and boulder placement to create depressions for snow capture and plant colonizes to collect and propagate. Those areas with potential for erosion (wind or water) will be stabilized with rock or vegetation cover, with the use of salvaged topsoil in places where vegetation will have the best opportunity for establishment (Refer to Section 5.7.7.1 of the ICRP).

The vegetation research studies for buildings and infrastructure mine components will help determine the best methods for establishment of plant communities, and the most effective use of salvaged topsoils to create landscapes that best ensure sustainability of plant communities that will be compatible with surrounding tundra ecosystems. The research is divided into two areas. This research plan focuses on finding the plant species and identification of substrate materials that will effect plant community composition. The second research plan (Vegetation Cover and Surface Stability on the Building and Infrastructure Mine Component) focuses on the expected percentage of cover that will effectively maintain surface stability.

The research objective is to determine what self-sustaining plant community type(s) can be established in the camp pads, laydown areas, quarry sites and roads at mine closure.

24.3 RESEARCH PLAN

This research will be used to develop methods for establishing self-sustaining plant communities with native vegetation, both planted and naturally colonizing, to enhance surface stability of camp pads, laydown areas, airstrip, roads, fuel storage sites, quarry sites and exploration sites. For efficiency this research plan discusses studies for camp pads and laydown areas, but is also applicable in most cases, to the above listed sites.

24.3.1 Tasks Completed or Initiated

1. Revegetation Locations

Camp pads and laydown area are constructed of a layer (2 to 3 m thick) of waste rock placed directly over tundra vegetation. Pads are level and substrate at the surface is comprised of a mixture of granular crushed rock and finer grained materials such as lake sediment and glacial till spread on the surface to improve trafficability.

Locations where vegetation establishment will be needed will be determined by a review of final site layout at mine closure, assessment of the characteristics of the surface substrate, susceptibility to erosion or instability, assessment of flow patterns and severity of flood events.

Research results from the Rock Pad Reclamation Study will provide guidance on the placement of growth materials to enhance the reclamation potential of rock pads and laydown areas, and expand locations where vegetation can be established.

2. Tundra Plant Species

Conduct a survey of tundra plant species with potential for revegetation of pads and laydown areas. BHP Billiton has committed to using native regional plants for revegetation work at EKATI. The survey of tundra communities within the EKATI mine area and the surrounding region would identify plant species with potential for revegetating camp pads and laydown areas, quarry sites and other locations requiring revegetation after removal of infrastructure. Surveys could include the plant community and landscape characteristics of tundra communities on similar substrates within the mine area.

The survey of established and disturbed tundra plant communities within the EKATI mine area and the surrounding region has identified a number of tundra species with potential for revegetating camp pads and laydown areas. Potential species will be assessed, additional species may require testing.

3. Materials Assessment

Assessment of the suitability of pads and laydowns to support a self-sustaining plant cover. Greenhouse trials have been completed and field trials initiated to assess plant establishment, growth and persistence at selected sites, or at sites with similar physical characteristics. Continued monitoring of field trials is required.

4. Seed Collection, Storage and Propagation

A Standard Operating Procedure (SOP) has been developed that identifies seed sources and provides guidelines for collecting and processing seeds for use in revegetation. The SOP will be expanded as needed, to include updated species lists and related information.

5. Natural Colonization and Successional Trends

Research natural colonization by native plants along roads, quarry sites, camp pads and laydown areas, and/or sites with similar characteristics. This research will include field studies within the EKATI mine area and literature review.

6. Weed Monitoring

The presence of weeds at EKATI and at abandoned mines in the NWT has been assessed in the course of monitoring revegetation and rehabilitation. This practice will continue.

24.3.2 Short-term Tasks (to be started/continued in the next three years)

See Section 24.5.1 for more detailed description of the research.

1. Revegetation Locations

This research will build on previous work.

2. Tundra Plant Species

This research will build on previous work.

3. Materials Assessment

This research will build on previous work.

4. Seed Collection, Storage and Propagation.

This research will build on previous work.

5. Natural Colonization and Successional Trends.

This research will build on previous work.

6. Weed Monitoring

This research will build on previous work.

24.3.3 Long-term Tasks (2014 and following)

7. Refinement of Revegetation Locations

Determine final locations where vegetation establishment will be needed.

24.4 FINDINGS OF RESEARCH COMPLETED

Research on the reclamation of camp pads and laydown areas components is underway at a number of sites at EKATI. The first reclamation research study on an abandoned pad was established at Fox Portal in 1995. A number of buildings and infrastructure sites have been reclaimed and are important sources of information in the development of self-sustaining plant communities at the EKATI mine site. This includes a section of the Old Camp road and Culvert Camp pad reclaimed in 1997, the Tercon and Paul Lake laydown areas reclaimed in 2000 and portions of the Airport Esker quarry (Fred's Channel) reclaimed in 2002. Most recently, a Rock Pad Revegetation Study was established on the Panda/Koala/Beartooth WRSA in 2008. Plot construction has been completed, and recultivation treatments are planned for 2010 (Martens 2009).

24.4.1 Revegetation Locations

24.4.1.1 Summary of Findings

- Reclamation activities have been completed at the Tercon and Paul Lake laydown areas, Culvert Camp, sections of closed roads and a depleted quarry site (i.e., Airport Esker).
- The surfaces of camp pads and laydown areas, at mine closure, will generally be level and compacted, rapidly draining and generally inhospitable to plant growth but capable of supporting primarily lichens and xeric mosses.

- Stored growth materials, i.e., topsoil, lake sediment/glacial till that were removed during site development, could be applied as a top dressing to enhance the revegetation potential of camp pads and laydown areas.
- A Rock Pad Revegetation Study has been established to research methods to determine how best to use the limited growth materials in a manner that will provide maximum benefit to the establishment of vegetation on camp pads and laydown areas (Martens 2009).

24.4.1.2 Application of Lessons Learned

- The surfaces of pads and laydown areas are constructed of waste rock and/or granular materials and have limited suitability for revegetation.
- Potential plant growth materials, such as topsoil, glacial till and lake sediment, that will enhance the revegetation potential, are available for reclamation of camp pads and laydown areas, the supply, however, is limited.

24.4.1.3 Data and Information Gaps

- Development of plant cover on different plant growth materials available at EKATI.
- How best to use the limited supply of plant growth materials in the reclamation of camp pads and laydown areas.
- Erosion control structures/materials needed to promote stability while vegetation establishes.

24.4.2 Tundra Plant Species

24.4.2.1 Summary of Findings

Ecological mapping and vegetation inventories for EKATI were completed early in the project development (BHP Billiton 1995), followed by an inventory of soils and vegetation for the Misery Esker (Kidd 1999). A Traditional Knowledge perspective on biodiversity in the mine area was provided by the Dogrib Treaty 11 (Dogrib 2000).

Ongoing revegetation studies at EKATI have identified potentially useful native species (Kidd 1996; Kidd and Rossow 1997, 1998; Kidd and Max 2000a; Martens 2005, 2008, 2009).

- In 1999, seed of several legume species was sown in a field plot at EKATI, with the intention of establishing a collection area. Species included were *Hedysarum mackenzii* (liquorice root), *Oxytropis deflexa* (deflexed oxytrope) and *Astragalus eucosmus* (elegant milkvetch) (Kidd and Max 2000a). Seed of several graminoid species was collected from wetland stands for testing of viability and germination (Kidd and Max 2000a). Species tested were *Eriophorum angustifolium* (tall cottongrass), *Carex aquatilis* (water sedge), *Arctagrostis latifolia* (polargrass), *Calamagrostis purpurascens* (bluejoint) and *Arctophila fulva* (pendant grass).
- Native plant species potentially useful for revegetation of various site types include *Epilobium angustifolium*, *E. latifolium*, and the legumes *Astragalus alpinus* (alpine milkvetch), *Hedysarum mackenzii*, *Oxytropis deflexa*, and *O. maydelliana* (Maydell's oxytrope). Species adapted to riparian habitats include *Salix* spp. (willows) and *Arctophila fulva*.

24.4.2.2 Application of Lessons Learned

A number of promising tundra species and native-grass cultivars have been identified for vegetation of the camp pads and laydown areas.

24.4.2.3 Data and Information Gaps

- The need for additional species suitable for vegetation of camp pad and laydown areas.
- Cultural methods and practices to enhance establishment of tundra species by means of direct seeding, use of containerized stock or planting into an existing grass cover.

24.4.2.4 Recommendations for Future Work

- Cultural methods and practices that promote the establishment of tundra species by means of containerized stock or direct seeding.
- Review the list of promising species to determine whether additional species need to be added for successful revegetation of camp pad and laydown areas.

24.4.3 Materials Assessment

Field studies of plant cultivation treatments have been conducted at Fox Portal, Culvert Camp, Tercon and Paul Lake laydown areas. The Rock Pad Reclamation Study was constructed in 2008 and recultivation treatments are planned for 2010.

24.4.3.1 Summary of Findings

- At Fox Portal, only the plots seeded with native-grass cultivars had more than minimal cover of vascular plants by 2000 (Kidd and Max 2000b). Total vascular cover varied among topdressing treatments, with much higher cover on organic soil (25 to 30%) than on the other topdressings (< 10%). The seeded grasses were dominant and cover of other species was generally low, except for *E. angustifolium* (8.7%) in plots with organic soil and surface rocks (to reduce the effects of wind).
- At Culvert Camp, total live cover of vascular plants in 2002 was approximately 15%, and consisted mainly of the seeded *Festuca rubra* (red fescue). Soil (a coarse gravel mix) was generally unfavourable for plant growth. In 2004, total live vascular cover had declined to 11% (Martens 2005). Fertilizer was reapplied in fall 2004, resulting in increased total live vascular cover (17%) in 2005 (Martens 2006).
- At the Tercon laydown site, native-grass cultivars provided an average 15% total vascular cover five years after the application (at 10 kg/ha) of a native grass cultivar seed mix (50% *Poa alpina* and 50% *Deschampsia caespitose*) and fertilizer (16-16-16 NPK at 130 kg/ha). The pad, comprised of a coarse-textured glacial till, was deep-ripped to relieve compaction and roughen the surface in preparation for revegetation (Kidd and Max 2002; Martens 2007).
- At the Paul Lake laydown site, total plant cover five years after revegetation, ranged from 7% to 17%; the majority (13.5%) provided by mosses and 4% to 6% provided by native vascular plants (graminoids, forbs and herbs). The waste rock pad had been removed to the extent possible, leaving the area largely covered with boulders with patches of exposed organic-rich tundra soil. Some natural recovery had occurred from the exposed tundra surface (Martens 2007).
- At Airport Esker, four years following final site preparation and seeding, total live plant cover ranged from 9.2% in the control to 21.2% in the area seeded with native-grass cultivars. Cover in the forb-seeded treatment was 9.7%, similar to the control. Total non-vascular cover (primarily mosses) was greatest in the seeded treatments, in response to the fertilizer applied with the seed (Martens 2007).
- At a pullout along the Old Camp road, total vascular cover, twelve years after the application of seed and fertilizer, averaged 5%, provided primarily by native-grass cultivars. Non-vascular plants (primarily mosses) provided an additional 20.2% cover (Martens 2009).

- Rock Pad Revegetation Research Study
- The objective of the Rock Pad Revegetation Study is to build on the learnings from the Fox Portal Study and other relevant reclamation research at EKATI and Diavik. Specific objectives are to:
  - Assess plant response to growth materials available on site but not yet tested as a top dressing or subsoil,
  - Reassess the concept of pocket placement of growth materials,
  - Further evaluate plant cultivation techniques most effective in establishing plant growth,
  - Evaluate an alternative method of creating surface roughness and micro-relief to the benefit of vegetation establishment,
  - Evaluate methods and equipment used in plot construction, and
  - Identify methods and procedures most suitable to the operational reclamation of camp pads and laydown areas.

Two methods of utilizing growth materials are being studied:

- Topdressing – spreading growth materials over the pad surface
  - 20 cm lake sediment
  - 20 cm topsoil
  - 20 cm topsoil over 20 cm lake sediment
  - 0 to 5 cm lake sediment
- Topsoil Pockets – placement of topsoil in excavated pockets (2.0 m x 2.0 m x 0.5 m) distributed in a grid over the surface of the pad.

One of the following six recultivation treatments was applied to each topdressing:

- Natural – no recultivation treatment
- Seeded with native grass cultivar mix (NGC) and native legume mix
- NGC plus tundra seedlings
- Tundra seedling plugs
- Seeded to native legumes
- Transplanted tundra plugs

24.4.3.2 Application of Lessons Learned

- Vegetation can be successfully established on closed pads and laydown area with the application of seed and fertilizer.
- Sites with more favourable soil properties e.g., Tercon laydown (glacial till), and Airport esker (glacial till), provided the greatest plant cover four to five years following site reclamation.
- The addition of fertilizer (16-16-16 NPK), applied at moderate levels (e.g., 150 kg/ha) assisted the establishment of native-grass cultivars and other tundra species.
- Coarse grained soils (e.g., Culvert Camp) cannot maintain a vigorous grass cover without maintenance fertilizer.

- Plant cover on coarse grained soils will be slow to develop and will comprise of native grass cultivars and indigenous species adapted to xeric site conditions, similar to that found on esker deposits in the area.
- Plant cover is not required to maintain surface stability on coarse grained substrate materials.
- Native legume seedling plugs (*Oxytropis* spp.) established as containerized seedlings on Airport Esker, thrived for three years before being flooded out during spring thaw.
- *Betula glandulosa* (dwarf birch) and *Vaccinium uliginosum* (bilberry) established as containerized seedlings continued to prosper, with 74% and 94% survival, respectively, four years after planting in Airport Esker.

24.4.3.3 Data and Information Gaps

- Long-term survival and development of vegetation on closed camp pads and laydown areas.
- Requirement for nutrient input to sustain or enhance vegetation cover in the long-term.

24.4.3.4 Recommendations for Future Work

- Continued monitoring of plant cover at existing sites with similar characteristics.
- Add additional revegetation study sites when suitable sites become available.
- Nutrient requirements to sustain long-term plant cover on camp pads, and laydown areas and sites with similar characteristics.

24.4.4 Seed Collection, Storage and Propagation

24.4.4.1 Research Results

A Standard Operating Procedure (SOP) has been developed to identify seed sources and provide guidelines for collecting and processing seeds for use in reclamation (BHP Billiton 2004; Martens 2003, 2005).

The SOP provides information on locations, collection techniques and recommended harvesting dates for seed of several shrub, forb and graminoid species that have been found to be useful for reclamation at EKATI. Species listed include:

- *Arctostaphylos rubra, A. alpina* (bearberry)
- *Betula glandulosa* (dwarf birch),
- *Carex aquatilis* (water sedge)
- *Dryas integrifolia* (white dryad)
- *Empetrum nigrum* (crowberry)
- *Epilobium angustifolium, E. latifolium* (fireweed)
- *Eriophorum vaginatum* (cotton grass)
- *Hedysarum mackenzii* (Liquorice root)
- *Oxytropis deflexa* (reflexed locoweed), *O. maydelliana* (Maydell's oxytrope), **O. hudsonica* (Hudsons locoweed)
- *Vaccinium uliginosum* (bilberry)

Seed of tundra plants was collected between 2000 and 2004 for LLCF reclamation research, cleaned and stored in a deep freezer at the EKATI Minesite. Germination tests conducted in 2008 indicated that the viability of all three *Oxytropis* spp. remained high (in excess of 90%, with scarification) after 4 to 8 years of storage. Viability of dwarf birch and fireweed seed, collected in 2004, remained at 55% and 69%, respectively.

24.4.4.2 Application of Lessons Learned

- A number of promising plant species for vegetation of closed camp pads and laydown areas have been identified through previous studies.
- Storage conditions optimum for legume seed may not be optimum for seeds with a thin seed coat, such as those from dwarf birch and fireweed.
- A commercial nursery was retained to develop methods and procedures for the large-scale production of containerized seedling stock.

24.4.4.3 Data and Information Gaps

- Review the existing information sources, including the SOP, to determine whether sources of seeds and/or live plant materials have been identified for all desired species. If needed, research additional collection sites.
- Species that can be readily established by direct seeding and species that are best established with containerized stock.
- Optimum time when seed should be collected.
- Collection methods:
  - by hand or machine assisted.
  - specialized methods for certain species.
- Estimated volumes of seed required by species.
- Storage conditions for each species to retain seed viability.
- Out-planting regime to minimize mortality.

24.4.4.4 Recommendations for Future Work

- Build on and expand the existing Seed Collection SOP and address missing information, as required.
- Work closely with Coast to Coast Nursery in the development of methods and practices that will minimize out-planting mortality, including practices such as forced senescence and planting dormant stock.

24.4.5 Natural Colonization and Successional Trends

Information on natural colonization is available from a number of studies at EKATI including Culvert Camp, Airport Esker, Old Camp road, and Tercon and Paul Lake laydown areaa.

24.4.5.1 Summary of Findings

- At the EKATI Airstrip research results in 2001 indicated that mean total vascular plant cover in the seeded areas was similar between 1998 (32.8%) and 2001(40.6%) (Figure II-2), but taxonomic richness was considerably higher (ABR 2001). Plant cover was dominated by graminoids, mainly polar grass (*Acrtogrosrostis latifolia*), and in the recently re-graded area at the south end of the airstrip, by northern alkali grass (*Puccinellia borealis*). Natural colonizers included a variety of forbs, shrubs, and willows. Many of the forbs were commonly found on eskers in the mine area.

Research in 2007 found that species diversity of the shrubs increased and that of the forbs decreased, compared with 2001 (ABR 2001). Highest plant cover was found along the east side and north end of the airstrip where soils and moisture conditions were more favourable. The reduction in vascular plant cover since 2001 is attributed to the reduction in graminoids, likely as a result of low soil nutrient levels. Native nonvasculars increased slightly since the last monitoring, to 12.8% from 10.4% (HMA 2007).

- At Culvert Camp, naturally colonizing vascular plants accounted for 1.2% cover after five growing seasons (Kidd and Max 2002). Species present included the grass *Calamagrostis canadensis*, the sedges *Carex bigelowii* (Bigelow's sedge) and *C. rotundata* (beaked sedge), the shrubs *B. glandulosa*, *Salix* spp. (willows) and *Rubus chamaemorus* (cloudberry) and the forb *Epilobium angustifolium*.
- At Fox Portal, natural colonization within the first 5 growing seasons was minimal, limited to trace cover of *Carex* sp. (sedge) and *Epilobium angustifolium* (fireweed) (Kidd and Max 2000b). Six years later, several additional species (*Betula glandulosa, Empetrum nigrum,* and *Salix planifolia*) had colonized the study plots, however, cover of all species remained sparse (Martens 2007).
- At Tercon laydown, where with exception of several scattered plants of *Epilobium* spp. (fireweed), vascular plant cover in 2006 consisted almost entirely of the seeded grasses (15%) (Martens 2007).
- At Paul Lake laydown, species present two years after pad removal included *Carex* spp (sedges), *Calamagrostis canadensis* (bluejoint), *Vaccinium uliginosum* (bilberry), *V. vitis ideae* (mountain cranberry), *Betula glandulosa*, (dwarf birch) and *Salix* spp. (willow). Additional species present six years after reclamation, included *Empetrum nigrum* (crowberry) and *Ledum decumbens* (Labrador tea) (Martens 2007).
- At the Old Camp road, colonizing (vascular) species included *Epilobium* spp. (fireweed), *Carex* spp. (sedges), *Calamagrostis canadensis* (bluejoint), *Vaccinium uliginosum* (bilberry), *Empetrum nigrum* (crowberry) and *Betula glandulosa* (dwarf birch). Non-vascular mosses and lichens provided the most abundant cover (21%) (Martens 2009).

24.4.5.2 Application of Lessons Learned

Research at several building and infrastructure study sites, with variable site conditions, indicates that indigenous species are establishing with assisted revegetation (seeding and planting) and by natural means.

24.4.5.3 Data and Information Gaps

- Methods to accelerated natural colonization on camp pads, laydown areas and similar sites.
- Changes in plant community structure and composition with time.

24.4.5.4 Recommendations for Future Work

- Methods to assist establishment of tundra species on camp pad and laydown sites.
- Continue monitoring successional trends at existing study sites.
- Review successional trends on similar sites in the NWT and YT and elsewhere.

24.4.6 Weed Monitoring

24.4.6.1 Research Results

The presence of weeds at EKATI has been assessed periodically in the course of conducting rehabilitation monitoring. As of 2007, the only invasive weed recorded at EKATI is *Hordeum jubatum* (foxtail barley), which is limited to the area around the airport.

At the Giant Mine, near Yellowknife, extensive colonization by *H. jubatum* was noted in 2001 (Kidd and Max 2001). The only other non-native species present was *Equisetum pratense* (meadow horsetail). Non-native weed species recorded at the Rae Mine included *H. jubatum*, *Phalaris arundinacea* (reed canarygrass), *Taraxacum* spp. (dandelion) and *Polygonum* spp. (knotweed). At the Discovery Mine, weed species recorded included *H. jubatum*, *E. pratense*, and *Erigeron* sp. (fleabane). Martens (2007) assessed natural colonization at several disturbed sites in the region, but did not report the presence of any weedy species.

24.4.6.2 Application of Lessons Learned

Although the EKATI mine is remote, opportunity still exits for weeds to establish at the mine site – through natural vectors, via the winter road, or as contaminants in seed of native grasses grown on agricultural lands.

24.4.6.3 Data and Information Gaps

None

24.4.6.4 Recommendations for Future Work

- Continue to watch for weeds when monitoring revegetation success and moving about on the mine site.
- Take appropriate action if weeds are found
- Request Certificate of Analysis for every seed lot prior to purchase to ensure that no problem weeds are included. Refuse contaminated seed lots or request that they be cleaned again and sampled again for weeds. Note: many weeds common in agricultural fields will be killed by the harsh winters at EKATI (Hardy BBT 1986).

24.5 REMAINING SCOPE TO BE COMPLETED

24.5.1 Detailed Work Scopes (next three years)

Table 5.1-4x provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Field Trials

Review and assess results at Rock Pad Revegetation study, Tercon and Paul Lake laydown areas, Culvert Camp and Airport Esker to determine revegetation potential of different topdressing materials and substrates.

Task 2. Tundra Plant Species

- Review the list of promising species to determine whether additional species need to be added for successful revegetation of camp pads, laydown areas, quarry sites and other similar sites.

Research will include the plant communities established on disturbed sites and a review of pertinent literature.

- Establish field trials with additional species as required.

Task 3. Materials Assessment

- Continue to monitor plant cover at the Rock Pad Revegetation study, Tercon and Paul Lake laydown areas, Culvert Camp and Airport Esker to characterize the development of long-term plant cover.
- Review revegetation studies of similar sites in NWT, YT and elsewhere.

Task 4. Seed Collection, Storage and Propagation

Develop a program that will provide suitable native stock for revegetation of all mine components that require revegetation, including camp pad and laydown areas. Because native seed production is generally low and infrequent, seed collection and development of suitable methods and procedures must start early in the research program. In 2010-2014 the research will build on previous studies, by including seed collection, storage and propagation work specific to those plants already identified as candidates for the establishment of an early protective cover, and for a long-term succession cover on camp pads, laydown areas and sites with similar characteristics.

Sub-tasks to be undertaken:

a) Select Species

This will include species known to do well plus others identified in the assessment trials outlined above in Section 24.5.1.

b) Seed Collection

1. Seed Needs. Determine estimated quantity of seed of the target species required for revegetation research and the reclamation of camp pads, laydown areas and similar sites. Seed requirements and storage viability will determine species collection priorities and quantities collected for future use.
2. Collection Sites. Identify accessible stands of selected species, where seed or other plant materials can be collected. Several locations (three or four) for each species will be selected to avoid intensive collection from the same area year after year. This may require the addition of two or three sites for those species already addressed in the SOP. Sites will be GPS referenced and marked on a collection site map.
3. Seed Harvesting. Research the use of handheld equipment to increase efficiency of seed collection.
4. Collection Schedule. Through germination testing, determine the phenology of seed ripening and visual cues to identify mature seed.
5. Seed Storage. Test various storage methods to maximize seed survival and germination. Research to date has shown that legume viability is maintained at a high level, after eight years of storage in a deep freeze. Small seeds with a thin seed coat, such as fireweed and dwarf birch may require different conditions to maintained viability.

c) Plant Propagation

Research into direct seeding and growing containerized seedling stock in the greenhouse for later planting will be continued. Research into the large-scale propagation of tundra species as containerized stock began in 2008. Coast to Coast nurseries, in Smokey Lake Alberta, are currently rearing six tundra species [*Betula glandulosa* (dwarf birch), *Vaccinium uliginosum* (bog bilberry), *Oxytropis deflexa* (reflexed locoweed), *Epilobium angustifolium & E. latifolia* (fireweed), *Empetrum nigrum* (crowberry) and *Hedysarum mackenzii* (Liquorice root)] for out-planting in the Rock Pad Reclamation Study in 2009 and 2010 (Martens 2009). These species all have promise for revegetation of camp pads and laydown areas. On-going research on the rearing of seedlings and development of practices to increase survival of out-planted seedlings will be directly applicable to revegetation of camp pads and laydown areas. Other species with potential for revegetation of this mine component will be added to the Coast to Coast seedling propagation program and the on-site field testing program.

Task 5. Natural Colonization and Successional Trends

- Research plant colonization and successional trends on comparable habitats in NWT and YT. Integral to this research will be the characterization, to the extent possible, of the expected plant community and the successional changes that might occur over time.
- Field assessment of natural colonization of existing study sites at Fox Portal, Culvert Camp, Airport esker, Paul Lake and Tercon laydown areas, Old Camp road, and the newly established Rock Pad Reclamation study.

Task 6. Weed Monitoring

Continue to monitor reclamation sites within the EKATI mine area for the presence of introduced weeds. Determine whether weed control is needed, and develop a plan if appropriate.

24.5.2 Conceptual Work Scopes (2014 and following)

Task 7. Refinement of Revegetation Locations

Determine locations within the buildings and infrastructure mine component where vegetation establishment will be needed. Camp pads and laydown areas are constructed of a layer (2 to 3 m think) of waste rock placed directly over tundra vegetation. Pads are level and substrate at the surface is comprised of a mixture of granular crushed rock and finer grained materials such as lake sediment and glacial till spread on the surface to improve trafficability.

Locations where vegetation establishment will be needed will be determined by a review of final site layout at abandonment, assessment of the characteristics of the surface substrate, susceptibility to erosion or instability, assessment of flow patterns and severity of flood events.

Research results from the Rock Pad Reclamation Study will provide guidance on the placement of growth materials to enhance the reclamation potential of rock pads and laydown areas, and expand locations where vegetation can be established. Planning will include the Main Camp site, as well as laydown areas associated with the Pigeon, Sable, Fox and Misery pits.

- Review maps and final schematics of the area mine, in order to determine site characteristics after all infrastructure development and removal is complete and identify locations where growth materials will be applied to promote plant establishment.

- Assess moisture regimes, substrate types, and areas of instability where cover vegetation will be needed.
- Determine specific erosion risks at each site. Assess surface flow patterns, severity of expected flood events, and sensitivity of substrate to erosion.
- If hydraulic erosion is a concern, determine whether erosion control structures or geotextiles need to be in place prior to revegetation efforts.

Tasks 3 and 5.

Continue to monitor vegetation on reclaimed camp pads, laydown areas, quarries and roads to gather information on plant cover development, successional trends and characteristics of the plant community in the long-term.

24.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on the use of native plants and establishment of self-sustaining plant communities on camp pads and laydown areas is linked to:

- Research on the establishment of self-sustaining plant communities in other mine components. In many cases the site conditions, plant species present, and other community characteristics will be similar across mine components.
- Research on vegetation percent cover and surface stability of camp pads and laydown areas and other mine components.
- Research on Traditional Knowledge inclusion in reclamation planning for the EKATI mine components.

The majority of early research for reclamation within the Buildings and Infrastructure mine components will be completed on research pads (Fox Portal, and Rock Pad Reclamation Research Plots), small laydown pads, and disturbed areas located alongside roadways and the Airport esker. Most of the Buildings and Infrastructure mine component, particularly large components, (roads, airstrip, camp pads) will be in active operations until the end of the operations phase of the LOM Plan, necessitating that most of the vegetation research to answer how these areas will be stabilized by plant cover, must be completed on research plots and on the smaller, available sites.

24.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-4x. Sustainable Plant Communities – Buildings and Infrastructure

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short-term Research Tasks (within next 3 years)				
1	Revegetation Locations	Planning and Field assessments	2010	2014
2	Tundra Plant Species	Literature review, field assessments	2010	2014
3	Materials Assessment	Field assessments, monitoring	2010	2014
4	Seed Collection, Storage and Propagation	Field work, nursery research (germination tests), monitoring.	2010	2014

(continued)

Table 5.1-4x. Sustainable Plant Communities – Buildings and Infrastructure (completed)

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
5	Natural Colonization and Plant Succession	Literature review, field assessments.	2010	2014
6	Weed Monitoring	Ongoing monitoring, adaptive management (if required)	2010	On going
Long-term Tasks (2014 and following)				
7	Refinement of Revegetation Locations	Desktop Evaluation	2014	2018
3, 5	Build on the above short-term Research tasks	Field work, monitoring	2014	2018

24.8 COST

Total expected costs are $100,000 - $150,000.

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25. Vegetation Cover and Surface Stability – Buildings and Infrastructure

25.1 UNCERTAINTY

Plant cover required for long-term surface stabilization of sites in the Buildings and Infrastructure mine components (e.g., camp pads, laydown areas, quarry sites).

25.2 RESEARCH OBJECTIVE

The reclamation of buildings and infrastructure at EKATI includes roads, camp pads, laydown areas, fuel storage sites, sumps and exploration sites. Where surface stabilizing work is required these sites will have a granite cover or will be vegetated with native vegetation. Surface drainage will be re-established where necessary. An assessment of remaining surfaces will be conducted and selected sites will be landscaped to encourage natural vegetation through trenching and boulder placement to create depressions for snow capture and plant colonizes to collect and propagate. Those areas with potential for erosion (wind or water) will be stabilized with rock or vegetation cover, with the use of salvaged topsoil in places where vegetation will have the best opportunity for establishment (Refer to Section 5.7.7.1 of the ICRP).

The vegetation research studies for buildings and infrastructure mine components will help determine the best methods for establishment of plant communities, and the most effective use of salvaged topsoils to create landscapes that best ensure sustainability of plant communities that will be compatible with surrounding tundra ecosystems. The research is divided into two areas. This research plan focuses on the expected percentage of cover that will effectively maintain surface stability. The second research plan (Establishment of Self-sustaining Plant Communities – Buildings and Infrastructure) focuses on plant species and identification of substrate materials that will effect the plant community composition.

The research objective is to determine what percentage (%) of vegetation cover will be needed to effectively provide surface stability of camp pads, laydown areas, quarry sites and roads at mine closure and other sites requiring vegetation after removal of infrastructure, and to meet the closure objective.

25.3 RESEARCH PLAN

This research plan focuses on the following components in the Buildings and Infrastructure Mine Component (e.g., camp pads, laydown areas, airstrip, roads, fuel storage sites, quarry sites and exploration sites. For efficiency the research discusses the studies for camp pads and laydown areas, but is also applicable in most cases, to the above listed sites.

Research on the development of plant cover on camp pads and laydown areas has begun. This research plan will build on existing revegetation studies and expand the scope to include the assessment of the physical characteristics of the sites to be revegetated. In addition, the relevant literature on revegetation of similar sites will be reviewed.

25.3.1 Tasks Completed or Initiated

Information on plant cover establishment on camp pads and laydowns is available at several sites at EKATI including camp pads, laydown areas, quarry sites and closed roads. The most recent study, the Rock Pad Revegetation study was constructed in 2008 and the application of recultivation treatments will be completed in 2010 (Martens 2009). No work has been initiated or completed on the relationship between plant cover and surface stability on these materials.

25.3.2 Short-term Tasks (to be started/continued in the next three years)

To establish what percentage of vegetation cover will be needed to effectively provide surface stability for the above mine components the research will determine:

1. Plant Cover and Canopy Structure

Levels of plant cover and canopy structure needed to provide surface stability on vegetated sites. This information will be obtained in part by monitoring the results of the existing revegetation studies established at EKATI, and the review of relevant literature on revegetation of similar sites.

2. Plant Community Stability Characteristics

Plant community characteristics needed to indicate stability, and how they can be assessed. This research will include quantitative descriptions of reference tundra communities in the EKATI area, as well as a review of criteria that have been used to indicate stability of similar sites in other northern reclamation projects.

3. Development Rates

Rates of development of plant cover and community structure with time. This information will be obtained primarily by monitoring the results of ongoing revegetation studies at EKATI, particularly the studies already established on camp pads, laydown areas, quarry sites and the Rock Pad Revegetation Study. This research will be expanded in scope to include the assessment of physical characteristics of these sites. In addition, the relevant literature on revegetation of similar sites will be reviewed.

25.3.3 Long-term Tasks (2014 and following)

Short-term tasks identified in Section 25.3.2, above, will continue in 2014 and following. Because plant cover and community development is a slow process in the Low Arctic tundra, existing studies will be monitored to track long-term changes in plant cover and surface stability. The Rock Pad Revegetation is expected to be instructive in understanding the dynamics of early plant cover and surface stability on newly disturbed sites, at a time when disturbed sites are most vulnerable to erosion.

25.4 FINDINGS OF RESEARCH COMPLETED

25.4.1 Development Rates

25.4.1.1 Research Summary Results

- At Fox Portal, only the plots seeded with native-grass cultivars had more than minimal cover of vascular plants by 2000 (Kidd and Max 2000b). Total vascular cover varied among topdressing treatments, with much higher cover on organic soil (25 to 30%) than on the other topdressings (<10%). Permanent transects were established in 2008 at Fred's Channel for quantitative assessment of plant cover development at several sites with different surface substrate materials (Martens 2009).
- At Culvert Camp, total live cover of vascular plants in 2002 was approximately 15%, and consisted mainly of the seeded *Festuca rubra* (red fescue). Soil (a coarse gravel mix) was generally unfavourable for plant growth (Kidd and Max 2000b).
- At the Tercon laydown site, native-grass cultivars provided an average 15% total vascular cover five years after the application (at 10 kg/ha) of a native grass cultivar seed mix (50% *Poa alpina* and 50% *Deschampsia caespitose*) and fertilizer (16-16-16 NPK at 130 kg/ha) (Martens 2007).
- At the Paul Lake laydown site, total plant cover five years after revegetation, ranged from 7% to 17%; the majority (13.5%) provided by mosses and 4% to 6% provided by native vascular plants (graminoids, forbs and herbs) (Martens 2007).
- At Airport Esker, four years following final site preparation and seeding, total live plant cover ranged from 9.2% in the control to 21.2% in the area seeded with native-grass cultivars. Cover in the forb-seeded treatment was 9.7%, similar to the control (Martens 2007).
- At a pullout along the Old Camp road, total vascular cover, twelve years after the application of seed and fertilizer, averaged 5%, provided primarily by native-grass cultivars. Non-vascular plants (primarily mosses) provided an additional 20.2% cover (Martens 2009).
- Soil physical and chemical properties are described for most study sites (Kidd and Max 2000b; Martens 2007, 2009).

25.4.1.2 Application of Lessons Learned

- Native-grass cultivars can be successfully established, and natural colonization is occurring on all study sites.
- The rate at which plant cover develops and the resultant plant community structure will depend largely on the physical characteristics of the soil substrate.

25.4.1.3 Data and Information Gaps

- Levels of plant cover, canopy height, etc. needed to stabilize the surface of the buildings and infrastructure mine components, taking into consideration such factors as substrate and slope angle, and the importance of root biomass.
- Characteristics of adjacent and/or predisturbance tundra plant communities on similar sites, to assist in developing criteria for a stable post-reclamation community.

- o Longer-term data on plant community development on revgetation study sites on camp pads and laydown areas. In addition, research long-term results of revegetation at other sites with similar characteristics.

25.4.1.4 Recommendations for Future Work

- o Continued monitoring of established study sites including Culvert Camp, Tercon and Paul Lake laydown areas, Airport esker, Old Camp road, and the Rock Pad Revegetation Study.
- o Add study sites as disturbed areas in the buildings and infrastructure mine components become available.

25.5 REMAINING SCOPE TO BE COMPLETED

25.5.1 Detailed Work Scopes (next three years)

Table 5.1-4y provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Plant cover and Canopy Structure

- o Monitor and assess the relationship between vegetation cover/canopy structure and surface stability at Culvert Camp, Tercon and Paul Lake laydown areas, Airport Esker, Old Camp road, and the Rock Pad Revegetation Study and other revegetated sites with suitable site characteristics.
- o Assess the physical characteristics of sites to be revegetated (e.g., grain size distribution, organic matter content, bulk density).
- o Assess the rate of soil loss on vegetated sites.
- o Assess the relationship between surface stability and plant cover and canopy structure.
- o Research revegetation cover and surface stability at similar sites in NWT, YT and elsewhere.

Task 2. Plant Community Stability Characteristics

- o Quantitative field assessment of reference tundra communities in the EKATI area.
- o Research criteria (plant cover and surface soils) that have been used to indicate stability in other northern reclamation projects.

Task 3. Development Rates

- o Research the rate of development of plant cover and other community characteristics over time, at Culvert Camp, Tercon and Paul Lake laydown areas, Airport Esker, Old Camp road, and the Rock Pad Revegetation Study and other sites with similar characteristics.
- o Expand the scope of ongoing studies to include the assessment of surface physical characteristics of sites to be revegetated (terrestrial and aquatic habitats).
- o Review relevant literature on revegetation of similar sites.

25.5.2 Conceptual Work Scopes (2014 and following)

- o Continue to build on existing work scope, to acquire long-term information on plant cover and community development and surface stability
- o Add study sites as suitable sites become available, to expand the application and confidence with which information acquired can be applied to camp pads and laydown areas at EKATI.

25.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on the vegetation cover and stability of camp pads and laydown areas is linked to:

- Research on the use of native plants and development of self-sustaining plant communities, for camp pads, laydown areas, and other mine components.
- Research on vegetation cover and surface stability for other mine components. In many cases site conditions, plant species present, and other community characteristics will be similar across mine components.
- Research on Traditional Knowledge inclusion in reclamation planning for the EKATI mine components.

The majority of early research for reclamation within the Buildings and Infrastructure mine components will be completed on research pads (Fox Portal, and Rock Pad Reclamation Research Plots), small laydown pads, and disturbed areas located alongside roadways and the Airport Esker. Most of the Buildings and Infrastructure mine component, particularly large components, (roads, airstrip, camp pads) will be in active operations until the end of the operations phase of the LOM Plan, necessitating that most of the vegetation research to answer how these areas will be stabilized by plant cover, must be completed on research plots and on the smaller, available sites.

25.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-4y. Vegetation Cover and Surface Stability – Buildings and Infrastructure

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short-term Research Tasks (within next 3 years)				
1	Plant Cover and Community Structure	Field work, literature review	2010	2014
2	Plant Community Stability Characteristics	Field work, literature review	2010	2014
3	Development Rates	Field work, literature review	2010	2014
Long-term Tasks (2014 and following)				
1-3	Continued monitoring of existing studies, add new sites	Field work, monitoring.	2014	2018

25.8 COST

Total expected costs are $100,000 - $150,000.

25.9 REFERENCES

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26. TK Incorporation in Reclamation Planning

26.1 UNCERTAINTY

Traditional Knowledge (TK) inclusion in reclamation planning for the EKATI mine components.

26.2 RESEARCH OBJECTIVE

Closure and reclamation objectives for the EKATI mine consider the expectation of stakeholders for post closure land use and respect of traditional values. TK is currently used at EKATI in environmental operations, particularly in areas related to wildlife safety. TK is available from Inuit, Dene and Métis who are all traditional users of the EKATI area. TK has been included in research plans where TK is immediately relevant to the research study. However a research plan for TK incorporation will assist in addressing the process in which TK will be brought into the research, and through that process examine other research areas where TK will benefit the reclamation activity and the final closure of mine components. The objectives of the TK research are:

1. Identify opportunities for inclusion of TK in reclamation and closure of EKATI.
2. Develop methods and approaches to involve and encourage TK input from communities.

26.3 RESEARCH PLAN

26.3.1 Tasks Completed or Initiated

No research has been completed at this time. However data and information currently available that will assist the research work is listed below.

1. Caribou and Roads Project

The Caribou and Roads Traditional Knowledge Project was initiated in 2002. The objective is to address current issues with caribou on roads and near pits at EKATI. The project has resulted in the formation of an Inuit Elder's Advisory Group. Examples of the types of recommendations the Elder's Advisory Group have made include:

- The use of inokhok at the mine site to deter caribou during spring migration.
- The use of gates across roads in specific areas such as on the Sable Road near the Beartooth Pit.
- The construction of a temporary fence at Beartooth Pit to protect caribou (implemented in 2006).
- New caribou road crossings where needed on the Misery, Fox and Sable Roads.
- Improving existing caribou crossings on roadways.
- Removing road berms where less obstructive solutions would meet mine safety requirements.

- Constructing berms to act as barriers where caribou needed to be deterred.
- Continuing to use people on the ground to divert caribou when necessary.

2. Naonaiyaotit Traditional Knowledge Project (NTKP)

The NTKP collected information on regional movements of species such as caribou, bears and waterfowl over a span of time that covers decades and provides regional understanding of migratory paths. It is a long-term project that was initiated in 1996 during the environmental assessment of EKATI. From that initial impetus, the project developed into a land-use planning tool that provides Inuit with a means of responding to land-use applications and of integrating TK into environmental assessments throughout their area of historical and current use (KIA 2006). The project is ongoing, and throughout it there has been an ongoing dialogue between Inuit and industry about the appropriate application of traditional Inuit cultural and natural history knowledge to environmental assessment and management. A series of reports in English on land use and wildlife were compiled and printed in 2006, and a GIS database was transferred to the Kitikmeot Inuit Association by BHP Billiton in 2006 with the intention to continue training and building capacity within the community to use and apply the database.

26.3.2 Short-term Tasks (to be started/continued in the next three years)

See Section 26.5.1 for more detailed description of the research tasks.

1. Literature Review.

Literature review of minesites and other industries that have closed operations and have used TK and/or have developed methods for bringing TK into mine closure.

2. Past and Current TK Projects

Review past and current TK projects at EKATI, and assess whether these operational projects are pertinent to reclamation and closure, and what learnings can be used from these projects.

3. Community Meeting Plan and Schedule

Develop a community meeting plan and schedule with communities to develop TK incorporation into how mine components will be reclaimed based on the ICRP.

4. TK Reclamation Strategy Outline

Develop a community TK Reclamation Strategy Outline which includes meeting summaries, recommendations from communities, as well as a strategy and schedule for TK incorporation.

26.3.3 Long-term Tasks (2014 and following)

No long-term tasks have been identified at this time.

26.4 FINDINGS OF RESEARCH COMPLETED

26.4.1 Research Summary Results

No research has been completed at this time.

26.4.2 Application of Lessons Learned

No research has been completed at this time.

26.4.3 Data and Information Gaps

No data and information gaps have been identified at this time.

26.5 REMAINING SCOPE TO BE COMPLETED

26.5.1 Detailed Work Scopes (next three years)

Table 5.1-4z provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Literature Review

Literature review of minesites and other industries that have closed operations and have used TK and/or have developed methods for bringing TK into mine closure. This review would include mine operations in the NWT and NU, (e.g., Colomac, GIANT, Port Radium, Polaris, Nanisivik, Pine Point). All of these mines are located near or within traditional Aboriginal land use areas and all have been reclaimed to various degrees of closure. The review will also include BHP Billiton's current commitments for TK use and community consultation in our corporate and regulatory requirements, and other guidelines.

Task 2. Past and Current TK Projects

Review past and current TK projects at EKATI, and assess whether these operational projects are pertinent to reclamation and closure, and what learnings can be used from these projects.

Task 3. Community Meeting Plan and Schedule

Develop a community meeting plan and schedule with communities to develop TK incorporation into how mine components will be reclaimed based on the ICRP. Various processes will be reviewed on how community meetings will take place, to ensure that opportunity is provided for communities to participate (community dependent), and the best format (or method of consultation) is used to ensure effective involvement. Examples of methods and formats may include: workshops, questionnaires, site visits, focus groups.

Task 4. TK Reclamation Strategy Outline

Develop a community TK Reclamation Strategy Outline which includes:

- Summaries of the findings from community meetings and questionnaires,
- Recommendations provided by communities that address how TK should be incorporated in the reclamation research, and
- Strategy and schedule going forward which outlines how and when TK will be part of the research planning.

26.5.2 Conceptual Work Scopes (2014 and following)

No long-term tasks have been identified at this time.

26.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Early input from communities in the assessment of closure options for the minesite revealed a high level of concern regarding final water quality and safety for wildlife, and these are included as part of the closure objectives and will be a key part of the research that ensures those objectives are met. Some examples of where TK can be incorporated into reclamation research plans are:

- Pit Safety – through the design of barriers that prevent wildlife from entering open pits during pit flooding.
- WRSA Access Ramps – that allow access and egress from WRSA after mine closure.
- LLCF Cover Design – through the LLCF Reclamation Pilot Study which will include a cover design that is safe for wildlife use, vegetation areas on the processed kimberlite, and impacts from grazing of vegetation.

TK should be linked to reclamation research early in the closure planning process to ensure inclusion in appropriate studies. The strategy and schedule for TK incorporation will be developed around the 2005 LOM Plan, and will be reviewed and modified with changes to the LOM Plan, and successive updates of the ICRP prior to mine closure.

26.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-4z. TK Incorporation in Reclamation Planning

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short-term Research Tasks (within next 3 years)				
1	Literature Review	Review Report	2011	2012
2	Past and Current TK Projects	Review Report	2012	2012
3	Community Meeting Plan and Schedule	Community Meeting Plan and Schedule	2012	2013
4	TK Reclamation Strategy Outline	Strategy Outline Document	2013	2013

26.8 COST

Total expected costs are $100,000 - $150,000.

26.9 REFERENCES

BHPB, 2005. Caribou and Roads – Implementing Traditional Knowledge in Wildlife Monitoring at the EKATI Diamond Mine, 2005 Annual Report. Final report prepared by Rescan Environmental Services Ltd. Vancouver, BC. May 2006.

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27. Wildlife Closure Objectives and Criteria

27.1 UNCERTAINTY

The development of appropriate closure objectives and criteria for wildlife safety at EKATI is required to ensure wildlife will have safe access to the mine area once reclamation activities have been completed.

27.2 RESEARCH OBJECTIVE

Wildlife will have access to the mine area once reclamation work has been completed. Closure objectives will focus on safe access and use by wildlife Closure criteria will be used to measure objective success. The research will be guided by data collected during the Wildlife Effects Monitoring Program (WEMP) in combination with Traditional Knowledge from Aboriginal communities. Reference will also be made to the Valued Ecosystem Components established as part of EKATI's Environmental Impact reporting.

The objective of the research plan is to identify the most appropriate closure objectives and criteria that will ensure safe access and use of the EKATI minesite by wildlife following full reclamation.

27.3 RESEARCH PLAN

27.3.1 Tasks Completed or Initiated

See Section 27.4.0 for more detailed description of the research.

1. WEMP Reports

The annual Wildlife Effects Monitoring Program (WEMP) provides data and observations of wildlife interactions with mine infrastructure.

Work conducted as part of the WEMP covers the general lease area, with specific focus on mine infrastructure, especially roadways. The majority of the data and information can be used to assist future tasks listed in Sections 27.3.2 and 27.3.3 of this research plan.

2. Caribou and Roads

The Caribou and Roads Project examined the effect of Misery Road as a barrier to caribou movement, and conversely the use of deflectors to move caribou away from potentially unsafe areas of the mine.

The WEMP has monitored caribou distribution relative to roads and road permeability to caribou during both the northern and southern migration periods. The recent installation of wildlife monitoring cameras will provide additional information on the distribution of caribou (and other wildlife) relative to roads, barrier fences, and other mine infrastructure.

27.3.2 Short-term Tasks (to be started/continued in the next three years)

See Section 27.5.1 for more detailed description of the research tasks.

1. Literature Review

Conduct a literature review to assess where wildlife closure objectives and criteria have been used as part of reclamation of minesites. Particular focus will be on northern minesites.

2. WEMP Reports Review

Review past WEMP reports and assess where monitoring programs and results might be of use to the minesite or specific mine component reclamation.

3. Develop Preliminary Wildlife Closure Objectives and Criteria

Following the literature review and the review of the EKATI WEMP reports, a set of preliminary wildlife closure objectives and criteria will be developed.

4. Develop Wildlife Closure Objectives and Criteria with Communities

Meet with Aboriginal communities to discuss proposed wildlife closure objectives and criteria.

27.3.3 Long-term Tasks (2014 and following)

See Section 27.5.2 for more detailed description of the research.

5. Refine Wildlife Closure Objectives and Criteria

Test the appropriateness of the closure objectives and criteria on progressively reclaimed sites and modify where necessary.

27.4 FINDINGS OF RESEARCH COMPLETED

27.4.1 Research Summary Results

27.4.1.1 Wildlife Effects Monitoring Program

The WEMP is a monitoring requirement of BHP Billiton's Environmental Agreement and the Wildlife Effects Monitoring Plan. The WEMP has been conducted since 1997 and has 14 years of reporting. The WEMP uses scientific methodology and incorporates traditional knowledge as a source of information regarding wildlife and local ecology. The WEMP is based on Environmental Impact Statements and predictions that led to a series of monitoring objectives and subsequent scientific studies which, with community input, were designed to determine whether mine activities have effects on wildlife and/or wildlife habitat.

The WEMP was developed through extensive consultation with stakeholders, including regulators, scientists, and Aboriginal people. The WEMP focuses on wildlife species that were indentified during the Environmental Assessment Review Process as being of social or economic importance or of particular ecological or conservation concern (i.e., Valued Ecosystem Components [VEC]). Focal species for the monitoring program include caribou, grizzly bears, wolves, wolverines, breeding birds, and falcons. Annual WEMP Reporting includes the following:

- Monitoring of interactions between wildlife and traffic, and assessing success of mitigation measures.
- Monitoring of wildlife mortalities and incidents and assessing the effectiveness of mitigation measures.
- Monitoring of potential wildlife attractants and assessing the effectiveness of waste management efforts.
- Inspecting buildings and fencing structures at EKATI and Misery Camps for evidence of interaction with or disturbance by wildlife.
- Documenting incidental caribou and caribou herd observations.
- Assessing caribou behaviour.
- Assessing caribou distribution relative to EKATI roads.
- Assessing permeability of EKATI roads to caribou.
- Monitoring caribou interactions with the LLCF.
- Documenting incidental grizzly bear observations.
- Documenting incidental wolf observations.
- Assessing wolf breeding success and occupancy of natal dens.
- Documenting incidental wolverine observations.
- Documenting incidental fox observations.
- Participating in the North American Breeding Bird Survey.
- Assessing nesting occupancy and productivity of raptors on pitwalls.
- Assessing regional falcon nesting and reproductive activity.

For more information and results from the WEMP reporting please refer to the most current EKATI Diamond Mine Wildlife Effects Monitoring Program Report (Rescan 2011).

27.4.1.2 Caribou and Roads

The Caribou and Roads Traditional Knowledge Project was initiated in 2002. The objective was to involve traditional knowledge in a meaningful way in the environmental monitoring program at the BHP Billiton EKATI Diamond Mine. The project resulted in the formation of an "Elders Advisory Group".

At a workshop held in Kugluktuk in January 2006, the Inuit elders recommended that BHP Billiton erect a temporary snow fence to protect caribou while mining was occurring in the Beartooth Pit. During June 26-30 2006, a group consisting of Moses Elatiak (an elder), Louie Kakolak, Helen Enogaloak and Vivian Banci came to EKATI to build the fence. Approximately half of the 1,100 m fence was built at that time. The fence was completed in August with the assistance of two youths (Andrew Mahoney Enogaloak and Preston Kaitak) and EKATI Environment Department technicians. This was meant to be a temporary measure, and removed once mining at the pit and adjacent traffic had ceased. The involvement of youth has always been a request of the elders, so that they could participate in the program, learn from the elders, and potentially obtain future employment at EKATI. The fence, snow accumulation, and its effectiveness at deterring caribou required monitoring.

During a visit to EKATI in June and August of 2007, inokhok were built at the Airstrip, Pigeon Pit and Fox Pit. Building more inokhok and making them more visible by painting "hats" on them and attaching flagging tape was a recommendation of the Kugluktuk elders during the 2006 workshop.

27.5 REMAINING SCOPE TO BE COMPLETED

27.5.1 Detailed Work Scopes (next three years)

Table 5.1-4aa provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Literature Review

Conduct a literature review to assess the effectiveness of various closure and reclamation objectives and criteria used elsewhere, with a particular emphasis on northern minesites. The literature review will examine the types of closure mechanisms that have been used at minesites or similar industrial locations or along roads, their geographical extent (regional and/or site specific) and measures of success.

Task 2. WEMP Reports Review

Review past WEMP reports and assess where results might inform closure and reclamation activities. The WEMP has a significant amount of data that has already been collected. It is anticipated that the objectives and results will assist with closure and reclamation planning. Examples of WEMP activities and results that could be used are: wildlife interactions with mine infrastructure (e.g., camera monitoring along roads and fences), removal of waste attractants, assessing changes in wildlife behaviour around mine infrastructure, and pit wall nesting by raptors.

Task 3. Develop Preliminary Closure Objectives and Criteria

Following the literature review and the review of the EKATI WEMP reports, a set of preliminary closure objectives and criteria for wildlife will be developed.

Task 4. Develop Wildlife Closure Objectives and Criteria with Communities

BHP Billiton will meet with Aboriginal communities to discuss the proposed closure objectives and criteria developed in Task 3. The engagement process has not yet been determined, but may include discussions with individual communities or a workshop with community representatives. Following these discussions, BHP Billiton will finalize the closure objectives and criteria to be added to Appendix 5.1-1 of the ICRP.

27.5.2 Conceptual Work Scopes (2014 and following)

Table 5.1-4aa provides an outline and schedule of conceptual tasks to be undertaken in 2014 and following.

Task 5. Refine Wildlife Closure Objectives and Criteria

Test the effectivness of the closure objectives and criteria on progressively reclaimed sites and modify where necessary.

27.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on the development of closure objectives and criteria for wildlife health is linked to the following Reclamation Research Plans and Reclamation Engineering Studies:

- Research on the safety of wildlife and people near open pits during pit flooding and post closure.
- Research the design and location of WRSA ramps that allows safe access and egress by people and wildlife.
- Research on metals bioaccumulation – the understanding of safety for wildlife that directly ingest processed kimberlite soils and vegetation growing on processed kimberlite.
- Research on the LLCF cover design.
- Research on Traditional Knowledge inclusion in reclamation planning for EKATI mine infrastructure.

As mine components are progressively reclaimed, the closure objectives and criteria will be refined, along with the WEMP.

27.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-4aa. Pit Perimeter Safety

Research Task #	Task	Project Tracking (*Reporting*, *Modeling*, *Field Work*, *Engineering Designs*)	Research Start	Research Finish
Short-term Research Tasks (within next 3 years)				
1	Literature Review	Literature Review	2011	2012
2	WEMP Reports Review	Report	2011	2012
3	Preliminary Objectives & Criteria	Report	2012	2013
4	Meetings with Communities	Community Meeting Report	2013	2013
Long-term Tasks (2014 and following)				
5	Refine Objectives & Criteria	Report (If required)	2014	2016

27.8 COST

Total expected costs are $150,000 - $200,000.

27.9 REFERENCES

Rescan, 2007. EKATI Diamond Mine Caribou and Roads. Prepared for BHP Billiton Diamonds Inc. by Rescan Environmental Consultants Ltd. with input from the Kugluktuk Elders Advisory Committee. October 2007.

Rescan. 2010. EKATI Diamond Mine: 2010 Wildlife Effects Monitoring Program. Prepared for BHP Billiton Diamonds Inc. by Rescan Environmental Consultants Ltd. March 2011.

Appendix 5.1-5

Reclamation Engineering Studies Plan

Appendix 5.1-5. Reclamation Engineering Studies Plan

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1. Final Pit Perimeter Stability

1.1 UNCERTAINTY

The areas of instability in pit walls, the processes that will affect stability and how instability will be mitigated to ensure safe use of the pit lake by people and wildlife at mine closure.

1.2 RESEARCH OBJECTIVE

The purpose of this research plan is to determine the stability of pit walls of those pits with and without connecting underground mines at mine closure. Objectives of the research will include:

- Assessment of ground stability at pit lake edges and pit walls during and after pit flooding.
- Expected pit wall degradation processes (geotechnical stability and surface erosion) during and over the next 50 years, including post flooding.
- Closure criteria for measuring pit wall stability.

The research is linked to the timing of final ore extraction of open pits and underground mines in the 2005 LOM Plan (see Figure 1.1-2 of the ICRP). The first available pit for reclamation will be Fox Pit, in 2014. The research objectives will focus on individual pits, with the learnings passed on with each successive pit reclamation.

1.3 RESEARCH PLAN

1.3.1 Tasks Completed or Initiated

No research has been completed at this time. However data and information currently available that will assist the research work are listed below:

1. EBA Pit Flooding Study (EBA 2006). This was a conceptual study completed for the 2007 Draft ICRP. The study included volumes and discharge rates for pit flooding.
2. Structural maps available for all pits (3-dimensional solids of the major structures - in Vulcan software). This information is a requirement of the NWT Workers Compensation Board (WCB).
3. Geological maps, as well as geotechnical properties information for all pits and underground mines. This information is a requirement of the WCB.
4. As-Built surveyed plans for all underground and open pit infrastructure (3-dimensional solids, in Vulcan). This information is a requirement of the WCB.
5. Rock mass models for the pit wall failure (cavability) analysis. The study was completed as a requirement for the feasibility assessment for underground mine development for Panda and Koala North and Koala Underground Mines, and was focused specifically on pit wall stability during the operations period (Mathis 1998a, 1998b, 2000, 2002a, 2002b, 2003, 2004a, 2004b, 2005, 2006a, 2006b).
6. Thermistor data. Some of this data is available currently. Assessment of the current data will determine whether additional data should be collected.

7. Numeric stability analysis by Beck Arndt (2007a, 2007b) for the Panda Pit Wall Stability during Sub Level Caving operations in the Panda Underground mine. The time frame of study was from 2007 to 2010. The report indicated areas of lower stability on the East and West margins of the Panda open pit. The study did not however suggest that there would be any large scale pit wall degradation over that time period. This analysis was specifically focused toward geotechnical stability during the period of mining operations.
8. In 2009, EBA Engineering Consultants Ltd undertook a Beartooth Water Storage Definition Study with the following objectives:
   - Determine the probability and mechanism for any leakage from the pit during and post water placement,
   - Determine the probability and mechanism for any major pit wall instability associated with pit flooding, and
   - Should any leakage or instability be probable, assess the potential impact on both existing infrastructure and the environment (EBA 2009).

1.3.2 Short Term Tasks (to be started/continued in the next three years)

Short term research tasks will focus on the stability of Fox pit which will be available for reclamation in 2014. See Section 5.1 for more detailed description of the research tasks.

1. Literature Review

Conduct a literature review to understand closure procedures and processes at other minesites with open pits (flooded and non-flooded).

2. Review Open Pit Structural Environment

Review structural environment of Fox open pit with respect to stability in pit wall sections.

3. Conduct Wall Failure Analysis

Conduct wall failure (cavability) analysis for Fox pit. This study will use information from Task 2 in association with industry standard empirical engineering analysis methods.

1.3.3 Long-Term Tasks (2014 and following)

See Section 5.2 for more detailed description of the research tasks.

4. Assessment of Talik Zone Thickness

Assess talik zone thickness, and assess thaw zones in instrumented pit walls (this information can be drawn from an existing thermistor database).

5. Assessment of Surface Movement

Review of methods for assessing surface movement and associated erosion, to assist in the application of qualitative closure criteria. The study will include a desktop review of appropriate and current industry practices for remote data collection and assessment.

1.4 FINDINGS OF RESEARCH COMPLETED

1.4.1 Research Summary Results

No research has been completed at this time.

1.4.2 Application of Lessons Learned

No research has been completed at this time.

1.4.3 Data and Information Gaps

No data and information gaps have been identified at this time. The first task, literature review, will be used to identify initial gaps in information.

1.5 REMAINING SCOPE TO BE COMPLETED

1.5.1 Detailed Work Scopes (next three years)

Table 5.1-5a provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Literature Review

Conduct a literature review to understand closure procedures and processes at other minesites with open pits (flooded and non-flooded). This information will be drawn from internal (e.g., Communities of Practice - Geotechnical and Closure), and external sources. The review will include assessment of minesites in Arctic environments, with similar geotechnical and mining characteristics and flooding processes.

Task 2. Review Open Pit Structural Environment

Review structural environment of Fox open pit with respect to stability in pit wall sections. Kinematic (wedge/block) assessment of multiple large scale structures will be undertaken using standard geotechnical mine design software with appropriate design factors of safety. This research will be completed for each pit as each will have its own unique physical characteristics.

Task 3. Conduct Wall Failure Analysis

Conduct wall failure (cavability) analysis for Fox pit. This study will use information from Task 2 in association with industry standard empirical engineering analysis methods. This project will involve a contractor who will use a sophisticated flow modeling software (e.g., Abacus) to digitally simulate the degradation of the pit walls and underground workings over a 50 year period.

1.5.2 Conceptual Work Scopes (2014 and following)

Table 5.1-5a provides an outline and schedule of conceptual tasks to be undertaken in 2014 and following.

Task 4. Assessment of Talik Zone Thickness

Assess talik zone thickness, and assess thaw zones in instrumented pit walls (this information can be drawn from an existing thermistor database).

Task 5. Assessment of Surface Movement

Review of methods for assessing surface movement and associated erosion, to assist in the application of closure criteria. The study will include a desktop review of appropriate and current industry practices for remote data collection and assessment.

1.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on pit perimeter stability in the Open Pits mine component is linked to:

- Research on the safety of wildlife and people near open pits during pit flooding and post closure.

The majority of the geotechnical information on pit walls is developed early in the pit operations, to determine the geologic characteristics of the bedrock and to assist in the open pit and underground mine design. This information is developed and compiled as part of the feasibility study required for each mine. Studies on the stability of pit walls during and after pit flooding will use the geotechnical information from each pit as each pit in the LOM Plan nears the end of mining operations.

1.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-5a. Final Pit Perimeter Stability

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short Term Research Tasks (within next 3 years)				
1	Literature Review	Literature review	2012	2013
2	Review Open Pit Structural Environment	Survey work, geotechnical reporting	2012	2014
3	Conduct Wall Failure Analysis	Modeling and simulation	2013	2014
Long Term Tasks (2014 and following)				
4	Assessment of Talik Zone Thickness	Field work, Instrumentation Monitoring	2014	2018
5	Assessment of Surface Movement	Literature review, review field data	2018	2020

1.8 COST

Total expected costs are $1,000,000 to $1,500,000.

1.9 REFERENCES

Beck Arndt. 2007a. Panda Overhang Instability. Presentation. Prepared by Beck Arndt Engineering. April 2007. (BHP Billiton Internal Document).

Beck Arndt. 2007b. Panda Mine Pit Wall Stability During SLC Operations. Presentation. Prepared by Beck Arndt Engineering. May 2007. (BHP Billiton Internal Document).

EBA. 2006. Open Pit Flooding Study EKATI Diamond Mine. Prepared by EBA Engineering Consultants Ltd. August 2009.

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2. Pit Lake Perimeters and Connector Channel Design

2.1 UNCERTAINTY

The design of final pit lake perimeter areas including littoral and riparian zones, access and egress areas for people and wildlife, connector channel design, and the stability of remaining highwalls.

2.2 RESEARCH OBJECTIVE

The research objective is to design pit lake perimeter areas to become a functional part of the landscape. This will include consideration of:

- littoral zones in those perimeter areas that do not interfere with nearby infrastructure such as WRSA or unstable ground that facilitate the establishment of a self-sustaining aquatic ecosystem (see ICRP Section.5.2.5);
- connector channels that safely pass runoff flows and that are safe for fish (see ICRP S.5.2.5);
- bank stability and erosion control;and
- safe access and egress points for people and wildlife.

As part of this engineering study BHP Billiton will develop a Design Report that will outline how the Company will construct the littoral zones and connector channels.

2.3 RESEARCH PLAN

2.3.1 Tasks Completed or Initiated

No research has been completed at this time. However data and information currently available that will assist the research work is listed below:

1. Baseline Hydrology (see 1995 and 2000 environmental assessments in BHP-Dia Met (1995, 2000) and current operational hydrology (see AEMP reports, e.g., Rescan 2008). Several years of meteorological and hydrological data are available for the EKATI mine site through the AEMP. Surface flow contribution to pit lakes has been identified in the pit lake research as a key component in the pit lakes water balance. Surface flow data is available but will need to be developed as part of the pit lakes research.
2. Open pit topography and pit limits at completion are available for operating pits and can be estimated for the undeveloped pits that are part of the Life of Mine Plan..
3. Verification of final pit lake elevations has been initiated in this ICRP, however they remain conceptual until the final pit perimeters have been designed or constructed.

2.3.2 Short-Term Tasks (to be started/continued in the next three years)

1. Map Pit Operations Perimeters

Using survey data map the perimeter of open pits that have completed ore extraction or which are currently under production and have an established final pit perimeter (Panda, Beartooth, Koala, Koala North, Fox). Using available open pit design concepts, estimate the perimeter areas of possible future open pits that are part of the Life of Mine Plan.

2. Verify Final Pit Lake Elevations

Verify final lake elevations for the open pits listed in the previous task, with seasonal fluctuations, with consideration of the invert elevations for outflow channels, the elevations of connected natural flowpaths and lakes, and surficial materials along the channel flowpath.

3. Develop Pit Lake Perimeter Design

Using pit lake water elevations, determine the type and extent of perimeter rock that will be exposed above lake water and submerged in near shore areas. Provide a design report for littoral zones that facilitate the establishment of an aquatic ecosystem in the pit lakes per the design considerations in the ICRP Section 5.2.5. Also, provide safe access and egress locations for people and wildlife.

4. Develop Connector Channel Design

Determine outflow/inflow channel design requirements for inclusion into the design report prepared in task 3 that are designed to provide for safe routing of surface flows and to be safe for fish (as described in the ICRP Section 5.2.5).

2.3.3 Conceptual Work Scopes (2014 and following)

5. Refine Designs for Future Pits As Completed

Refine the data and designs for future pits (i.e. Tasks 1 through 4) based on survey of final pit perimeter areas as these become available.

2.4 FINDINGS OF RESEARCH COMPLETED

2.4.1 Research Summary Results

No research has been completed at this time.

2.4.2 Application of Lessons Learned

No research has been completed at this time.

2.4.3 Data and Information Gaps

No data and information gaps have been identified at this time.

2.5 REMAINING SCOPE TO BE COMPLETED

2.5.1 Detailed Work Scopes (next three years)

Task 1. Map Pit Operations Perimeters

Survey data (for pits with established final perimeter areas) or open pit design concepts (for possible future pits) will be used to to show the final pit wall area above and below the expected lake level elevation.

Task 2. Verify Final Pit Lake Elevations

In order to verify final lake elevations, with seasonal fluctuations, and with consideration of the invert elevations for outflow channels, the elevations of connected natural flowpaths and lakes, and surface materials along the channel flowpath, the following will also need to be reviewed:

- Review the final 3-dimensional open pit topography for current open pits and open pit design concepts for future open pits and extract relevant surface data.
- Review and extract relevant surface hydrology data for the current and future open pits, and expected seasonal fluctuations.

Task 3. Develop Pit Lake Perimeter Design

Using pit lake water elevations, determine the type and extent of perimeter rock that will be exposed above lake water and submerged in near shore areas. The research will use results from the Final Pit Perimeter Stability Research to assist in designing a perimeter area that is safe for wildlife access and reduces the potential for long term erosion. It will also include the design of shallow zones and low sloping areas for access and egress points. Design near shore areas that allow for surface overland flow to enter pit lakes, without the risk of surface erosion. Provide a design report for littoral zones that facilitate the establishment of an aquatic ecosystem in the pit lakes per the design considerations in the ICRP Section 5.2.5.

Task 4. Develop Connector Channel Design

The channel design task will focus on the design of new channel sections that have been altered due to mining operations, and re-establishing flow through undisturbed channel areas that connect with the pit lakes. Connector channels will be designed to be safe for fish (as described in Section 5.2.5), and fish access may be intermittent and may not be possible every year in some instances, being dependent on natural flow conditions in the small catchment areas around the pit lakes. Channel bank design will include stabile banks that ensure no long term effects from surface erosion and ground instability. The channel design will be included into the design report prepared in Task 3.

2.5.2 Conceptual Work Scopes (2014 and following)

Task 5. Refine Designs for Future Pits As Completed

Refine the data and designs for future pits (i.e. Tasks 1 through 4) based on survey of final pit perimeter areas as these become available

2.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Engineering studies on final pit lake perimeter designs and surface elevations, as well as connector channels is linked to:

- Research on the safety of wildlife and people near open pits during pit flooding and post closure. The research looks at what types of barriers should be used to prevent access to pit lakes during flooding, as well as access to areas of instability after pit flooding.
- Research on the physical stability of land surfaces around pit lakes, and pit lake walls during and after pit flooding. The research looks at the geotechnical controls on instability, location and extent of instabilities.
- Research on plant cover required for long term surface stabilization of disturbed sites in the Open Pits mine component. With focus on riparian habitat in near shore lake areas and along channel banks connected with pit lakes.

Establishment of final pit perimeters topography, above and below water will be important in determining the type of landscape each pit perimeter will have in relation to perimeter stability, plant communities, and safety for people and wildlife. Results from research focused on individual pits will be used for successive pits as they near cessation of mining operations.

2.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-5b. Physical Topography of Final Pit Perimeters

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short Term Research Tasks (within next 3 years)				
1	Map Pit Operations Perimeters	3D Model	2011	2011
2	Verify Final Pit Lake Elevations	Desktop Evaluation	2011	2012
3	Develop Pit Lake Perimeter Design	Design Plan	2012	2013
4	Develop Connector Channel Design	Design Plan	2012	2013

(continued)

Table 5.1-5b. Physical Topography of Final Pit Perimeters (completed)

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Long Term Tasks (2014 and following)				
5	Refine Designs for Future Pits as Completed	3D Model	2014	2016

2.8 COST

Total expected costs are $300,000 to $800,000.

2.9 REFERENCES

BHP-Dia Met. 1995. NWT Diamonds Project Environmental Impact Statement. Prepared for BHP Minerals Ltd and Dia Met Inc. by Rescan Environmental Services Ltd.

BHP-Dia Met. 2000. EKATI Diamond Mine: Environmental Assessment Report for Sable, Pigeon and Beartooth Kimberlite Pipes. Submitted to MVEIRB by BHP Diamonds Inc. and Dia Met Minerals Ltd., April 2000.

Rescan. 2008. EKATI Diamond Mine: Aquatic Effects Monitoring Program. Prepared for BHP Billiton Diamonds Inc. by Rescan Environmental Services Ltd., April 2008.

3. Pit Flooding Infrastructure

3.1 UNCERTAINTY

What infrastructure will be required to implement pit flooding?

3.2 RESEARCH OBJECTIVE

The open pits at EKATI will be flooded from source lakes as each of the pits and connected underground mines completes mining operations. Pipelines will be constructed from source lakes to open pits along the routes outlined in Figures 5.1-2g through 5.1-2j of the ICRP. Infrastructure construction will be timed with the availability of materials, and pit flooding schedule. Materials and infrastructure needs include rock materials for pipeline beds and maintenance roads, pipelines of appropriate dimensions for pit flooding, electrical cable and pump stations. When possible infrastructure will be reused from mining operations and other pit flooding operations during reclamation, otherwise sufficient lead time is needed for transport of new materials to the minesite, and preparation of crush materials for road and platform surfaces. Granite rock availability is dependent on timing of excavation from open pits and underground mines and other requirements during mining operations, and must consider opportunities that prevent double handling of materials. The first open pit to commence flooding will be Fox Pit in 2015 (Refer to Figure 5.2-18).

The objective of the research is to determine what infrastructure is necessary to have in place when open pits are available for flooding.

3.3 RESEARCH PLAN

3.3.1 Tasks Completed or Initiated

No research has been completed at this time. However data and information currently available that will assist the research work is listed below.

1. Timing of Pit Availability

The information is available in the 2005 LOM Plan.

2. Identification of Source Lakes

Source lakes will be those lakes which have sufficient volume and recharge rate to have limited aquatic effects from water withdrawal. This will be determined in the Open Pit Source Lakes Study (EBA 2007).

3. Volumes and Rates of Water Withdrawal

Volumes and withdrawal rates will be used for pipeline sizing and pump capacities. This information will be based on environmental assessment of impacts to source lakes from water withdrawal, as determined in the Open Pit Source Lakes Study.

4. Pumping Schedule

Develop pumping schedule for each of the open pits. The pumping schedule will be dependent on climatic variability, other users (e.g., Diavik in Lac de Gras), and effects on source lakes. The pumping schedule will be based on monthly, annual and seasonal variations.

3.3.2 Short-Term Tasks (to be started/continued in the next three years)

No short term tasks have been identified prior to 2014.

3.3.3 Long-Term Tasks (2014 and following)

See Section 5.2 for more detailed description of the research.

1. Environmental Procedures

Identify environmental procedures for pumping systems. Pump stations will be located near water bodies, therefore protection of fish and aquatic habitat must be included as part of the pumping infrastructure.

2. Source Materials

Identify source material for road construction, where this material will come from and when it will be available (with the aim of reducing double handling). Table 5.4-6 of the ICRP includes an estimated volume of 50,000 m^3 of clean granite required to pipeline bases and access roads.

3. Infrastructure Requirements

Identify infrastructure required for flooding pits. Pit flooding infrastructure will be roads, pipelines, and pumps. Roads will be constructed from clean granite waste rock, with a crush gravel top surface. Pipeline size will be dependent on flow rates and topographic variability. Pump stations will be used to withdraw from lakes and move water along pipelines.

4. Flooding Methods

Identify flooding methods into open pits. These include dissipation methods, and access to open pits for flooding monitoring. Flooding methods will align with requirements for pit wall stability, to maintain pit access, if needed.

3.4 FINDINGS OF RESEARCH COMPLETED

3.4.1 Research Summary Results

No research has been completed at this time.

3.4.2 Application of Lessons Learned

No research has been completed at this time.

3.4.3 Data and Information Gaps

No data and information gaps have been identified at this time.

3.5 REMAINING SCOPE TO BE COMPLETED

3.5.1 Detailed Work Scopes (next three years)

No short term tasks have been identified prior to 2014.

3.5.2 Conceptual Work Scopes (2014 and following)

Table 5.1-5c provides an outline and schedule of conceptual tasks to be undertaken in 2014 and following.

Task 1. Environmental Procedures

Identify environmental procedures for pumping systems. Pump stations will be located near water bodies, therefore protection of fish and aquatic habitat must be included as part of the pumping infrastructure.

Task 2. Source Materials

Identify source material for road construction, where this material will come from and when it will be available (with the aim of reducing double handling).

Task 3. Infrastructure Requirements

Identify infrastructure required for flooding pits. Pit flooding infrastructure will be roads, pipelines, and pumps. Roads will be constructed from clean granite waste rock, with a crush gravel top surface. Pipeline size will be dependent on flow rates and topographic variability. Pump stations will be used to withdraw from lakes and move water along pipelines.

Task 4. Flooding Methods

Identify flooding methods into open pits. These include dissipation methods, and access to open pits for flooding monitoring. Flooding methods will align with requirements for pit wall stability, to maintain pit access, if needed.

3.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on the infrastructure requirements to pipe water from source lakes to flood open pits is linked to:

- Research on the effects of water withdrawal on aquatic habitat in source lakes and adjoining streams.

Identification of material needs and sourcing is best completed early enough in the mine planning to reduce double handling of materials. Where this is not possible materials may be sourced from WRSA, and/or use previously established pipeline routes during operations. New pipeline routes and maintenance roads for pit flooding will be constructed prior to cessation of each open pit or underground mine if this infrastructure does not interfere with mining operations, or when mining operations cease, and prior to the sequencing of each pit's flooding schedule in the Final Closure Plan.

The first open pit to commence flooding is Fox Pit in 2015. The research plan will be updated with changes in timing of pit closures in the EKATI LOM Plan and any changes made to source lake locations.

3.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-5c. Pit Flooding Infrastructure

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Long Term Tasks (2014 and following)				
1	Environmental Procedures	Standard Operating Procedure (SOP)	2014	2014
2	Source Materials	Desktop Evaluation	2014	2014
3	Infrastructure Requirements	Infrastructure Report	2014	2014
4	Flooding Methods	Report	2015	2015

3.8 COST

Total expected costs are $100,000 to $150,000.

3.9 REFERENCES

EBA. 2007. Open Pit Flooding Study EKATI Diamond Mine. Prepared for BHP Billiton Diamonds Inc. by EBA Engineering Consultants Ltd., Yellowknife, Northwest Territories. June 2007.

4. Fish Barriers for Pit Lakes and LLCF

4.1 UNCERTAINTY

What are the characteristics of fish barriers that will prevent fish passage into pit lakes and the LLCF, should barriers be required during reclamation?

4.2 RESEARCH OBJECTIVE

Reclamation strategies for open pits at EKATI, as outlined in the ICRP, include the facilitation of aquatic ecosystems at pit water edges, establishing water quality in pit lakes to meet water licence criteria, and stabilization of pit perimeters to reduce the potential for erosion.

The design of barriers is needed prior to the completion of pit flooding. The first pit scheduled to complete pit lake fill is Pigeon pit in 2019.

The objective of this research plan is to design temporary fish barriers that would prevent fish passage into pit lakes and/or Cell E of the LLCF should the water quality in pit lakes not reach water licence criteria. After BHP Billiton has submitted to the WLWB that it believes conditions are safe for fish passage, and the WLWB has solicited comment from DFO and other parties, the decision on whether to allow fish passage will rest solely with the Board.

4.3 RESEARCH PLAN

4.3.1 Tasks Completed or Initiated

No research has been completed at this time. However data and information currently available that will assist the research work is listed below.

1. AEMP Reports

AEMP (e.g., Rescan 2008a) and PDC (e.g., Rescan 2008b) reports that describe local fish communities, fish sizes, etc.

2. Baseline Reports

Numerous fish and fish habitat baseline reports for EKATI watersheds that describe fish sizes.

4.3.2 Short-Term Tasks (to be started/continued in the next three years)

No short term tasks have been identified prior to 2014.

4.3.3 Long-Term Tasks (2014 and following)

1. Literature Review

Identify and review other similar designs and operational performance data for fish barriers in the North.

2. Materials Sourcing

Identify appropriate local materials that can be used for fish barriers.

3. Identify Possible Fish Migrants

Review characteristics of local fish populations to identify smallest potential migrants.

4. Design Barriers

Provide the design of fish barriers to meet the research objective.

4.4 FINDINGS OF RESEARCH COMPLETED

4.4.1 Research Summary Results

No research has been completed at this time.

4.4.2 Application of Lessons Learned

No research has been completed at this time.

4.4.3 Data and Information Gaps

No data and information gaps have been identified at this time.

4.5 REMAINING SCOPE TO BE COMPLETED

4.5.1 Detailed Work Scopes (next three years)

No short-term tasks have been identified prior to 2014.

4.5.2 Conceptual Work Scopes (2014 and following)

Table 5.1-5d provides an outline and schedule of conceptual tasks to be undertaken in 2014 and following.

Task 1. Literature Review

Identify and review other similar designs and operational performance data for fish barriers in the North.

Task 2. Materials Sourcing

Identify appropriate local materials that can be used for fish barriers.

Task 3. Identify Possible Fish Migrants

Review characteristics of local fish populations to identify smallest potential migrants.

Task 4. Design Barriers

Determine sufficient depth and length of barrier to prevent fish passage based on available material size (design criteria). The design criteria will be used for all fish barriers to be constructed for closure.

4.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on the construction of fish barriers in the Open Pit mine component is linked to:

- Research on Traditional Knowledge inclusion in reclamation planning for the EKATI mine components.

The design and construction of fish barriers for pit lakes will not be required until the first pit is nearing flooding completion. The first pit to be flooded will be Pigeon in 2019.

4.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-5d. Fish Barriers for Pit Lakes and LLCF

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Long Term Tasks (2014 and following)				
1	Literature Review	Review Report	2015	2015
2	Materials Sourcing	Desktop and field Evaluation	2016	2016
3	Identify Possible Fish Migrants	Report	2016	2016
4	Design Barriers	Design Plan	2016	2016

4.8 COST

Total expected costs are $100,000 to $150,000.

4.9 REFERENCES

Rescan. 2008a. EKATI Diamond Mine: Aquatic Effects Monitoring Program. Prepared for BHP Billiton Diamonds Inc. by Rescan Environmental Services Ltd., April 2008.

Rescan. 2008b. EKATI Diamond Mine: Panda Diversion Channel Monitoring Program 2007. Report prepared for BHP Billiton Diamonds Inc. by Rescan Environmental Services Ltd., September 2008.

5. Processed Kimberlite Backfill into Open Pits

5.1 UNCERTAINTY

1. What is the expected behaviour of processed kimberlite and/or extra fine processed kimberlite (EFPK) stored in open pits once the pits are flooded?
2. What thickness of water cap would be required to isolate the Processed kimberlite from surface waters in an open pit setting?

5.2 RESEARCH OBJECTIVE

The open pits at EKATI will be flooded with water from source lakes when each of the pits is no longer required for mining operations. A number of closure options were discussed with communities and regulatory agencies as part of the ICRP development and selection process for open pit reclamation. One of the options was backfilling with processed kimberlite and/or EFPK. Open pit processed kimberlite backfilling may be viable where an open pit(s) is available for closure during the mining operations phase, and should the open pit/s be within reasonable proximity to the Process Plant operations. BHP Billiton recognizes the potential benefits of pumping processed kimberlite to open pit/s, to take advantage of processed kimberlite storage available at EKATI, and as a contingency, should EFPK management be identified as a concern for the LLCF post closure. The study of uncertainties of processed kimberlite backfill into open pits will have the following objectives:

a) Determine the settling and density characteristics of processed kimberlite and/or EFPK to estimate their behaviour in flooded open pits and underground mines.

b) Estimate the water cap required above the processed kimberlite/EFPK to ensure no mixing of the processed kimberlite/EFPK with the upper pit lake water column.

5.3 RESEARCH PLAN

5.3.1 Tasks Completed or Initiated

No research has been completed at this time. However data and information currently available that will assist the research work is listed below.

Experience with processed kimberlite deposition within the LLCF has shown that the material segregates along the deposited beach. The coarse fractions deposit close to the point of discharge and become finer with increasing distance down the beach. Free water emanating from the beach settled material tends to retain a portion of the finer clay and silt sized particles. This water plus fines flows over and down the tailings beach and joins the cell main water body, where it settles to form a deposit known as EFPK. The properties, settling characteristics and distribution of the EFPK within the LLCF are part of ongoing studies and field programs. In summary, some of the results from these field programs are:

- EFPK comprises fine silt and clay sized particles,
- The volume of EFPK generated is a function of the host kimberlite material (i.e., Fox ore tends to generate more EFPK because smectite clays are liberated during the ore separation process).
- Reagent and flocculent additions, including chloride, can achieve desirable settling characteristics for processed material.
- EFPK rates of settling and consolidation are slow; thus the material could remain as a low density deposit for a long period (research still being undertaken or planned).
- Within the cell water body, the EFPK tends to gravitate and fill the deeper areas and appears to have an almost horizontal density gradient.
- The EFPK appears to be displaced by the encroaching beaches of coarser processed kimberlite.
- Plumb surveys show that most EFPK has very low shear strength above the plumbed depth.

5.3.2 Short-Term Tasks (to be started/continued in the next three years)

See Section 5.1 for more detailed description of the research tasks.

1. Literature review

Conduct a literature review to learn about experiences of tailings disposal into open pits at other mining operations. This should be undertaken in conjunction with the collation of EFPK data that exists for the LLCF.

2. EFPK Density Profile in the LLCF

Measure in situ density of EFPK in the LLCF.

3. EFPK Settling Characterization

Perform long-term and short-term settling tests of processed kimberlite/EFPK to determine settling characteristics in open pits.

4. EFPK Production Estimate

Estimate volume of processed kimberlite and EFPK that could be placed in open pits and/or underground mines prior to pit flooding.

5. Potential Impact of EFPK on Pit Lake Water Quality

Predict behaviour of processed kimberlite/EFPK in flooded open pit and/or underground mines, with respect to potential impacts on pit lake water quality.

5.4 FINDINGS OF RESEARCH COMPLETED

5.4.1 Research Summary Results

No research has been completed at this time.

5.4.2 Application of Lessons Learned

No research has been completed at this time.

5.4.3 Data and Information Gaps

No data and information gaps have been identified at this time. The first task, literature review will be used to identified initial gaps in information.

5.5 REMAINING SCOPE TO BE COMPLETED

5.5.1 Detailed Work Scopes (next three years)

Table 5.1-5e provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Literature Review

Conduct a literature review to learn about experiences of open pit backfilling from other mining operations. This should be undertaken in conjunction with the collation of EFPK data that exists for the LLCF.

Task 2. EFPK Density Profile in the LLCF

Use the existing accumulations of EFPK within the LLCF as a basis to evaluate the expected EFPK density profile. This should be determined by conducting periodic plumb line surveys within the deeper portions of the LLCF. This information will provide a snapshot of the EFPK settling profiles and will assist with modeling of future EFPK settlement.

Repeating these profiles at the same location on a periodic basis will enable a better understanding of how these material densities change with time.

Task 3. EFPK Settling Characterization

Column sedimentation testing of EFPK will be completed as part of this task. This testing will evaluate time-dependent behaviour on a sample of EFPK.

The proposed testing will estimate settling rates, density, and shear strength gain with time. This will provide a benchmark to compare the results of plumb line surveys.

Task 4. EFPK Production Estimate

Estimate the volume of processed kimberlite and EFPK that could be placed in open pits and/or underground mines prior to pit flooding. The waste management plan for the mine will be used to estimate the duration, tonnage and volume of EFPK to be deposited within the open pits and flooded underground mine workings. This information will be compared with the pit and/or underground stage storage relationship to determine the minimum depth of the EFPK below the flooded pit surface water elevation.

Task 5. Potential Impact of EFPK on Pit Lake Water Quality

Based on the above, analytical modelling will be undertaken to evaluate the potential sensitivity of the EFPK to water cover depth in terms of EFPK re-suspension under expected climatic conditions (i.e., winds, wave action, wind direction, freshet, water density inversions). This modelling will be used to estimate the impact of the EFPK on the pit lake water quality.

5.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on processed kimberlite backfill into open pits is linked to:

- Research on the stabilization of EFPK in the LLCF,
- Research on the water quality of the flooded open pits in the EKATI Mine Plan at mine closure.

One of the objectives of the LLCF EFPK Stabilization Research is to develop an understanding of the expected behaviour of the EFPK in the LLCF and evaluate how to maintain EFPK containment within the LLCF post closure. The research on open pit backfill of processed kimberlite/EFPK will be completed as a contingency plan, in case the research on stabilization of EFPK in the LLCF is unsuccessful.

5.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-5e. Processed Kimberlite Backfill into Open Pits

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Long Term Tasks (2014 and following)				
1	Literature Review	Internal Memo	2011	2011
2	EFPK Density Profile in the LLCF	Internal Memo	2010	2015
3	EFPK Settling Characterization	Report	2010	2015
4	EFPK Production Estimate	Internal Memo	2013	2015
5	Potential Impact of EFPK on Pit Lake Water Quality	Report	2013	2015

5.8 COST

Total expected costs are $500,000 to $750,000

5.9 REFERENCES

BHP-Dia Met. 1995. NWT Diamonds Project Environmental Impact Statement. Prepared for BHP Minerals Ltd and Dia Met Inc. by Rescan Environmental Services Ltd.

Fluor. 2006. BHP Billiton Diamonds Inc. - Managing EKATI Water Quality. Prepared by Fluor Australia Pty Ltd. May 2006. (BHP Billiton Internal Document).

Rescan. 2006. EKATI Diamond Mine: Fox Ore Trial Water Quality Assessment. Prepared for BHP Billiton Diamonds Inc. by Rescan Environmental Services Ltd. January 2006.

Rescan. 2008. Conceptual Plan for Storage of Mine Water and Processed Kimberlite in Beartooth Pit. Prepared for BHP Billiton Diamonds Inc. by Rescan Environmental Services Ltd. March 2008. (BHP Billiton Internal Document).

Robertson. 2004. Five Year Performance Review of EKATI Mine Processed Kimberlite Containment Facility and Assessment of Options for Optimized Future Development. Prepared by Robertson GeoConsultants Inc. August 2004

Robertson and Hayley. 2004. EKATI Mine Processed Kimberlite Containment Facility Summary of Lessons Learned from 5 Year Performance Review. Prepared by Robertson GeoConsulting Inc. and EBA Engineering Consultants Ltd. October 2004.

6. Landfill Volumes, Location and Placement

6.1 UNCERTAINTY

The best location for the demolition landfill, and placement strategies that ensures no negative impacts on the surrounding environment.

6.2 RESEARCH OBJECTIVE

Approximately 2.4M m^3 of demolition material will be buried in landfills when the buildings and infrastructure are decommissioned at mine closure (from Section 5.7.9.15 of the ICRP). Reclamation research will assist in determining the most appropriate location to place this material, and the strategy for placement. Specific research objectives are:

- Determine the expected volume and type of landfill material at mine closure after demolition of infrastructure, and after the removal of hazardous materials, and salvage of re-usable materials.
- Determine where this demolition material will be landfilled.
- Design a Standard Operating Procedure for landfilling that ensures effective materials separation and handling, no negative effects on the environment and the final landscape is safe for people and wildlife use post closure.

6.3 RESEARCH PLAN

6.3.1 Tasks Completed or Initiated

No research has been completed at this time. However data and information currently available that will assist the research work is listed below.

1. Landfill Volume

Landfill volume estimates were completed as part of the 2002 Liability Estimate. The total predicted volume from main camp demolition, after salvageable materials are removed was 1.2M m^3 +/- 10%.

A preliminary update of landfill estimate with the addition of Underground site infrastructure was completed in 2006 for the update of the ICRP. The total volume estimate was 2.4M m^3 +/- 30%.

6.3.2 Short-Term Tasks (to be started/continued in the next three years)

See Section 5.1 for more detailed description of the research tasks.

1. Identify Material Type/Volume

Determine the expected volume and type of landfill material at mine closure after demolition of infrastructure, and after the removal of hazardous materials and salvage of re-usable materials.

2. Complete Location Assessment

Assess and confirm appropriate location for demolition landfill at EKATI.

3. Assess Timing of Infrastructure Demolition

Assess progressive reclamation timing for each mine component, and develop a schedule for demolition and placement for landfill waste.

4. Develop Demolition SOP

Develop an SOP for demolition to allow for segregation of materials, and, where appropriate, review MSDS to ensure landfill materials are inert. Include procedures that ensure waste materials are progressively landfilled to ensure containment of waste and safety for people and wildlife.

5. Estimate Landfill Material Needs

Determine the volume of waste rock required for landfilling, and the timing of material needs. This task is linked to the volume of materials to be landfilled in Task 1 and the location of the landfill in Task 2. Material needs will include assessment of clean granite available for landfill use.

6.4 FINDINGS OF RESEARCH COMPLETED

6.4.1 Research Summary Results

The 2001 Liability Estimate for the EKATI Diamond Mine included a preliminary assessment of materials volumes and costs for landfill of demolition waste (Komex 2001). This estimate was updated in 2003 with the addition of the Sable, Pigeon and Beartooth Liability Estimate (Komex 2003). The total estimated combined landfill volume in 2003 was 1.2M m^3. The estimate was reviewed by BHP Billiton in 2006 as part of the update of the ICRP, and calculated at 2.4M m^3 to remain current with new infrastructure development at the Koala North Underground and Fox Mine sites.

6.4.2 Application of Lessons Learned

The 2001 and 2003 volumes for landfill materials were at concept level, calculated as part of the EKATI Diamond Mine Liability Estimate. The updated volume estimate in 2006 by BHP Billiton was also at concept level. A more precise calculation will be developed for this study.

6.4.3 Data and Information Gaps

No data and information gaps have been identified at this time.

6.5 REMAINING SCOPE TO BE COMPLETED

6.5.1 Detailed Work Scopes (next three years)

Table 5.1-5f provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Identify Material Type/Volume

The landfill material is expected to contain building materials, equipment, fuel tank infrastructure, pipelines and other infrastructure used for mining operations. This material will be categorized into salvageable, recyclable, hazardous and landfill materials. Only inert materials that will not have negative environmental effects will be landfilled, in keeping with current operational policies. The expected volume of material for landfilling will be estimated by external consultants.

Task 2. Complete Location Assessment

The 2002 approved A&R Plan designated the Panda/Koala/Beartooth WRSA for the landfill site for demolition material, and currently landfill sites for operations are located in the Misery and Panda/Koala WRSA. In 2006, BHP Billiton identified a need for an updated assessment of final demolition landfill location at closure. Three locations have been identified for demolition landfill materials: WRSA, open pits and underground mines. Specific site options under examination are centrally located in the EKATI Main Camp area: Panda/Koala/Beartooth WRSA, the Beartooth, Panda and/or Koala open pits and the Panda and Koala underground mines. Other areas will be reviewed on an as required basis. Each of these locations will be assessed for volume availability, placement strategy, materials needs, and water quality effects.

Task 3. Assess Timing of Infrastructure Demolition

For each mine component, the progressive reclamation timing is to be assessed. The timing of reclamation will initially come from the 2005 LOM Plan, but may require update with changes to the LOM Plan from mining operations. The current schedule for progressive reclamation is based on the EKATI Reclamation Schedule in Figure 8.5-1 of the ICRP.

Task 4. Develop Demolition SOP

Inclusions in the demolition SOP will be a strategy for demolition and placement, and procedures for segregation of materials. Reviews of the appropriate MSDS are to be undertaken to ensure landfill materials are inert. Operating procedures will be in place to protect people and wildlife and ensures no negative effects on the environment. Demolition and materials separation will take place progressively, over a number of years, therefore progressive landfill development procedures will be in place to ensure effective containment and landform stability.

Task 5. Estimate Landfill Material Needs

This task is linked to the volume of materials to be landfilled in Task 1 and the location of the landfill in Task 2. Material needs will include assessment of clean granite available for landfill use. Timing requirements for these volumes will also be calculated.

6.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Landfill sites during mining operations are located in the Panda/Koala/Beartooth, and Misery WRSA. Because of volume restrictions these sites will not be used for landfilling demolition materials at mine closure; a new landfill site will be constructed or designated due to the large volume of inert materials to be landfilled over a short period of time at the end of mining. In 2002, an area for landfilling was designated in the center of the Panda/Koala/Beartooth WRSA. However, as the mine infrastructure grows, and the WRSA close to mine infrastructure nears completion, other sites will need to be researched. The final location for demolition landfill will need to be established prior to 2014 when the first of the open pits (Fox) nears completion and infrastructure materials will need to be landfilled.

6.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-5f. Landfill Volumes, Location and Placement

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short Term Research Tasks (within next 3 years)				
1	Identify material type/volume	Demolition Estimate	2011	2011
2	Completed Location Assessment	Field work, Desktop Evaluation	2012	2012
3	Assess Timing of Infrastructure Demolition	Desktop Evaluation	2012	2012
4	Develop Demolition SOP	SOP	2013	2013
5	Estimate Landfill Material Needs	Desktop Evaluation	2013	2013

6.8 COST

Total expected costs are $400,000 to $500,000.

6.9 REFERENCES

Komex. 2001. Reclamation Liability Estimate for the EKATI Diamond Mine. Prepared by Komex International Ltd. May 2001.

Komex. 2003. Demolition and Salvage Estimate Sable, Pigeon and Beartooth, for the EKATI Diamond Mine. Prepared by Komex International Ltd, in association with Stay Sales Ltd. July 2003.

7. WRSA Surface Stability after Quarry Work

7.1 UNCERTAINTY

The mitigation and/or reduction of potential instability from reclamation activities on the WRSA as a result of quarry work, and the development of measurable closure criteria that ensures success in stabilizing the WRSA after quarry work is completed.

7.2 RESEARCH OBJECTIVE

The Panda/Koala/Beartooth WRSA has been identified in the ICRP as a source of rock for capping of the LLCF, and for pipeline construction for flooding, landfilling, and stabilizing camp pads. BHP Billiton also recognizes that the Fox WRSA may also be a source candidate for future capping materials. Smaller quarries may also be required at each of the Sable, Pigeon and Misery sites for the construction of pit flooding pipelines and capping of pads and laydown areas. For this reason all constructed and proposed WRSA are included in the following research plan.

The largest volume of rock materials will be used for capping processed kimberlite in the LLCF. The concept design for the cover is presented in Section 5.5.5.2 of the ICRP. Approximately 2.8M m^3 of rock will be quarried from the Panda/Koala WRSA and trucked to the LLCF between 2013 and 2022. Table 5.4-6 in the ICRP lists the future construction uses for granite waste rock.

The research will determine the best location/s for quarry work and the controls and mitigations needed to ensure stable landforms during and after quarrying. The research will also develop closure criteria to measure the success of stabilizing the WRSA after quarry work is completed. Specific objectives of the research are:

- Determine the location(s) of quarry work for reclamation needs.
- Develop a WRSA Quarry Management Plan that outlines controls needed to ensure surface stability (subsidence and erosion) of the WRSA is maintained during and after quarrying work.
- Develop measurable criteria to meet the closure objective of WRSA stability after the quarry work has been completed.

7.3 RESEARCH PLAN

7.3.1 Tasks Completed or Initiated

Research Completed:

No research has been completed at this time. However data and information currently available that will assist the research work is listed below.

1. Waste Rock Dump Analysis

A Waste Rock Dump Analysis was completed by EBA in preparation for the 1995 EIS (BHP Billiton 1995). This analysis outlined a hypothesis to characterize how water was expected to flow through the materials and the rate at which permafrost was expected to aggrade into the waste rock piles.

2. Ground Temperature Information

Existing ground temperature instrumentation is in place for Panda/Koala, Misery, and Fox WRSA. Ten ground temperature cables have been installed in the Panda/Koala WRSA, and temperature has been monitored there since 1998. Eight ground temperature cables have been installed in the Misery WRSA, and temperature has been monitored there since 2000. Three ground temperature cables have been installed in the Fox toe berms and monitoring has been conducted there since 2002. Three ground temperature cables have been installed in the Fox WRSA, and have been monitored since 2007.

3. WRSA Thermal Evaluation

Thermal evaluation of the Panda/Koala, Misery, and Fox WRSA completed by EBA in 2006. The evaluation developed a model to predict long-term temperatures and permafrost stability in the waste rock piles at EKATI. The model considered convective cooling processes in the piles as well as climate warming with time.

4. Surveys

WRSA surveys are completed as part of ongoing mine operations.

7.3.1.1 Thermal Data Results Summary

Thermal data results that may be applicable to this research are summarized as follows.

Panda/Koala WRSA

The entire WRSA is in permafrost condition except for the seasonal thaw depth in the order of 4 to 6 m that is tending to decrease with time. Temperatures around the perimeter of the pile (around 200 m) are colder than in the centre of the pile due to convective cooling at the pile perimeter. Temperatures in the centre of the pile are controlled by conduction similar to undisturbed terrain, and getting colder with time.

Addition of materials around and/or on top of the pile created colder temperatures at depth, and reduced the amplitude of the season temperature fluctuations. This phenomenon was observed under the presence of toe berms and stockpiled overburden till.

Misery WRSA

The entire Misery WRSA is in a permafrost condition except for the seasonal thaw depth, which is between 3 m to 21 m. The areas of the pile with shallower active layer perform similarly to Panda/Koala WRSA. The amplitudes of season fluctuations are decreasing with time. The foundation temperatures approach normal ground temperatures found at Misery typically at -4ºC.

The thicker active layers are in locations having no typical terrain conditions such as near the outside slope or in the snow drift. One of those locations is speculated not to freeze due to the presence of ponded water on the foundation before the pile was constructed. In this location, longer time is anticipated to overcome this originally warmer state.

Fox WRSA

Three ground temperature cables were installed within the Fox WRSA during October 2006. The results of the ground temperature readings indicated that some active temperature equilibration is still occurring within the pile; however, there is a general cooling trend with most of the measured temperatures still being above freezing.

7.3.2 Short-Term Tasks (to be started/continued in the next three years)

See Section 5.1 for more detailed description of the research tasks.

1. WRSA Topographic Survey Prior to Quarrying

Complete a survey of all WRSA before the end of their mining operations. This information will outline the footprint area, slope angles, and elevations of the WRSA.

2. WRSA Material Zone Map

Complete a record of materials (including volume and location of materials) for WRSA before the end of their mining operations. This information will be valuable when assessing the location of clean rock for quarrying needs and delineating those areas that will not be disturbed during quarry operations.

3. WRSA Instrumentation

Assess ground temperature cable locations and determine whether additional temperature cables are required in the WRSA for monitoring ground temperatures during and after quarry work.

4. WRSA Quarry Management

Develop a Quarry Management Plan that outlines quarry location/s and controls needed to ensure surface stability (subsidence and erosion) of the WRSA is maintained during and after quarrying work

7.3.3 Long-Term Tasks (2014 and following)

See Section 5.2 for more detailed description of the long-term research tasks.

5. Instrumentation Monitoring

Monitor ground temperatures in WRSA during quarrying.

6. WRSA Topographic Survey after Quarrying

Survey WRSA after quarrying is complete. This information will be used to assess for any significant subsidence after quarrying.

7. WRSA Closure Criteria

Develop measurable criteria to meet the closure objective of WRSA stability after quarry work in WRSA has been completed.

7.4 FINDINGS OF RESEARCH COMPLETED

7.4.1 Research Summary Results

No research has been completed at this time.

7.4.2 Application of Lessons Learned

No research has been completed at this time.

7.4.3 Data and Information Gaps

No data and information gaps have been identified at this time.

7.5 REMAINING SCOPE TO BE COMPLETED

7.5.1 Detailed Work Scopes (next three years)

Task 1. WRSA Topographic Survey Prior to Quarrying

A topographic survey of all WRSA should be undertaken at the end of mining and before quarrying works. The purpose of the survey is to detail the extent and elevation of the waste rock areas. This should include break point surveys of the shoulder and toe of the waste rock areas as well as benches and other linear features including slope angles. Task 1 research will initially focus on the Panda/Koala and Fox WRSA in preparation for quarry activities associated with the rock cover construction in the 2013 LLCF Reclamation Pilot Study, and the pit flooding pipeline construction for Fox pit, which completes mining operations in 2014.

Task 2. WRSA Material Zone Map

A waste rock deposition model will be developed from historical materials placement records. The model will three-dimensionally show the location of different material types within the WRSA. Task 2 research will initially focus on the Panda/Koala and Fox WRSA in preparation for quarry activities associated with the rock cover construction in the 2013 LLCF Reclamation Pilot Study, and the pit flooding pipeline construction for Fox pit, which completes mining operations in 2014. This model will form the waste rock deposition record whereby clean rock for quarrying can be identified and delineated.

Task 3. WRSA Instrumentation

Thermal data for the WRSA will be reviewed to determine the possible requirement for additional ground temperature cables placed to monitor potential quarry locations. This task will build on the findings from Task 2. The requirements for this engineering study should refer to other research studies to optimize cable installations. (Refer to Reclamation Research Plan # 7 Permafrost Growth in WRSA). The purpose of these ground temperature cables is to monitor the waste rock temperatures during and after quarrying. The ground temperature cables should be installed well in advance of quarrying to enable a base set of equilibrated reading to be taken.

Task 4. WRSA Quarry Plan

The WRSA quarry plan should identify the location, volumes and type of waste rock required for reclamation projects. Based on the WRSA Material Zone Map the quarrying of material can be optimized based on location relative to the final point of use. Local stability analyses of excavated waste rock face should be incorporated into the design. In addition, the quarry plan should identify how the waste rock will be excavated: can it be mechanically excavated or will blasting be required to loosen and break up the waste rock? Quarry sites will be initially determined for the LLCF 2013 Reclamation Pilot Study and the Fox pit flooding pipeline needs, and will expand to finalize the quarrying plan for the complete LLCF reclamation needs and other sites based on an assessment of the performance of the initial quarrying activity. The Quarry Plan will also include controls and mitigations needed to ensure stable landforms during and after quarrying. The final landform will also consider the final reclamation objectives for the WRSA, incorporation of access ramps for wildlife and a design that enables maintenance of permafrost in the rock pile. For example, from existing information, it appears that convective cooling achieves permafrost conditions more rapidly than conduction cooling. Convection cooling can be disrupted by the placement of fine layers to hinder the air flow within the waste rock material. Planning of the WRSA design after quarrying should include the promotion of convective cooling as a means of rapidly creating permafrost conditions within the WRSA. Additional WRSA final design requirements are included in Section 5.4.5 of the ICRP.

7.5.2 Conceptual Work Scopes (2014 and following)

Table 5.1-5g provides an outline and schedule of tasks to be undertaken after 2014.

Task 5. Instrumentation Monitoring

The ground temperature cables should be monitored on a regular basis during and after quarrying. This data should be entered into a database for future reference and interpretation.

Task 6. WRSA Topographic Survey After Quarrying

Once quarrying is complete for the initial quarry work (LLCF Reclamation Pilot Study and the Fox pipeline), a comparative topographic survey of the quarry area will be undertaken. Again, this should include break point surveys of the shoulder and toe of the waste rock areas as well as benches and other linear features including slope angles.

Task 7. WRSA Closure Criteria

Closure of the WRSA quarry areas should meet with the closure objectives of the overall WRSA. This will require the development of guidelines that cover physical and chemical stability, local water management, environmental regulations, and traditional needs.

7.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on the stability of WRSA after quarry activities is linked to:

- Research on the state/extent of permafrost in WRSA at mine closure.

The main source of quarry material for rock capping of the LLCF, landfilling, and stabilizing of camp pads is projected to come from the Panda/Koala/Beartooth WRSA, with smaller amounts from other WRSA for landfilling and pipeline construction. The majority of the Panda/Koala WRSA has been completed, with small additions coming from the Koala and Koala North Underground mines and the coarse rejects from the Processing Plant. The Fox WRSA will be completed with the end of Fox operations in 2014. Capping material will be needed for the LLCF Reclamation Pilot Study in 2013 and construction of the Fox pit flooding pipeline in 2014.

The larger volume of quarry materials will likely not be required until approximately 2017 for LLCF capping work and 2018 for pipeline construction.

7.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-5g. WRSA Stability After Quarry Work

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short Term Research Tasks (within next 3 years)				
1	WRSA Topographic Survey Prior to Quarrying	Survey Model	2011	2011
2	WRSA Material Zone Map	Deposition Report	2011	2011
3	WRSA Instrumentation	GTC installation in WRSAs	2012	2012
4	WRSA Quarry Management	Management Plan	2012	2012
Long Term Tasks (2014 and following)				
5	Instrumentation Monitoring	Monitoring Report	2014	2017
6	WRSA Topographic Survey After Quarrying	3D model	2015	2015
7	WRSA Closure Criteria	Report	2017	2017

7.8 COST

Total expected net present value costs are $500,000 to $750,000.

7.9 REFERENCES

BHP Diamonds Inc. 1995. NWT Diamonds Project, Environmental Impact Statement.

BHP Billiton Diamonds Inc. 1999. Project Description, Proposed Development of Sable, Pigeon and Beartooth Kimberlite Pipes. October 1999.

BHP Billiton Diamonds Inc. 2000. Addendum #1, Waste Rock and Ore Storage Management Plan, Support Document N, February 2000. June 2002.

EBA Engineering Consultants Ltd. 2004. Bearclaw Lake (Seep 18) Toe Berm Construction, Letter submitted to BHP Billiton Diamonds Inc., November 2, 2004. EBA File No.: 0101-94-115800620.002. (BHP Billiton Internal Document).

EBA Engineering Consultants Ltd. 2005. Fox Waste Rock Storage Pile, Toe Berm, As Built Construction Report, April 2005, EBA File: 0101-94-11580062.001.

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EBA Engineering Consultants Ltd. 2007b. Toe Berm Effectiveness Evaluation, EKATI Diamond Mine, NT. Issued for Review (Draft) Report submitted to BHP Billiton Diamonds Inc., November 2007, EBA File No. E14100001.005. (BHP Billiton Internal Document).

EBA Engineering Consultants Ltd. 2008. Summary of Ground Temperatures in Waste Rock Storage Areas, EKATI Diamond Mine, NT. Letter report submitted to BHP Billiton Diamonds Inc., February 19, 2008, EBA File No. E14100017.005. (BHP Billiton Internal Document).

8. Stability of LLCF Internal Drainage Channels

8.1 UNCERTAINTY

The long term stability of LLCF internal drainage channels and closure criteria used to measure success of the stability objective.

8.2 RESEARCH OBJECTIVE

The reclamation plan for the LLCF is for a combination rock and vegetation cover over processed kimberlite. Three zones are included in the proposed LLCF closure cover design: Upper Zone, Central Zone, and Water Interface Zone. External channels will convey surface water originating from the surrounding tundra as much as possible around the facility to reduce the potential for erosion and increased transport of kimberlite fines into the lower cells. Streams in direct contact with Central and Water Interface zones will be restricted to short segments that interconnect with the ponds. A channel will also be constructed through the LLCF Outlet Dam to restore hydrologic connection with Leslie Lake (Please refer to Section 5.5.5.2 of the ICRP for the LLCF cover design, Section 5.5.5.6 for LLCF water management, and Figure 5.5.5 for location of diversion channels). The stability of the LLCF external channels will be covered under the Dams, Dykes and Channels research 'Long-Term Channel Bank Stability' and will not be covered here. This research will focus on internal channels that are constructed for long term surface flow management within the processed kimberlite deposition area, and will address the uncertainties around drainage channel stability using the following research objectives:

- Create a drainage channel design plan for the LLCF that meets the following criteria:
  - Ensures that internal channels can be constructed on processed kimberlite;
  - Maintains surface flow through the LLCF post closure; and

– Remains stable post-closure and ensures limited erosion of processed kimberlite into lower containment cells.

- Develop measurable criteria to meet the closure objective of LLCF internal channel bank stability.

8.3 RESEARCH PLAN

8.3.1 Tasks Completed or Initiated

No research has been completed at this time. However data and information currently available that will assist the research work is listed below.

1. Option 3aM LLCF Drainage Designs

Locations for internal drainage channels were completed for the 2004 LLCF deposition plan review. Option 3aM in the WPKMP (BHP Billiton 2007) has identified the following 4 locations where internal channels will be constructed in the LLCF:

1. Cell B Interior Channel located at the eastern edge of Cell B to direct drainage from the central zone to a small pond at the southern end of the cell.
2. Cell C Interior Channel at the north end of Cell B which directs flow from Cell B into Cell C pond.
3. Cell A East Channel which carries runoff from the catchment area north of Cell A into the Cell C pond.
4. Cell A South Channel which directs flow from the central zone in Cell A to the Cell C Pond.

2. Geotechnical Investigations

Geotechnical investigations (EBA 2002, 2006) within Cell B and Cell C found the soil profile below the beaches to be horizontally laminated with zones of frozen material and lenses of ground ice. The extent to which frozen material was encountered generally decreased closer to the cell water body.

The information summarized above will be used as a basis for monitoring long-term internal drainage channel stability. Historic inspections provide an indication of the stability of existing channels over time, which can be extrapolated to new channel construction and design. At the time of closure, sufficient historic data should be available to accurately predict the long-term stability of internal drainage channels as required to manage surface water runoff appropriately.

8.3.2 Short-Term Tasks (to be started/continued in the next three years)

See Section 5.1 for more detailed description of the research tasks.

1. Review Current PK Deposition Plan

Review status of processed kimberlite deposition near end of mine life. An updated deposition plan will be used to finalize internal channel locations. The channel locations will be selected to capture runoff from within the LLCF, and to direct runoff through the LLCF containment ponds, or to its discharge point at the south end of Cell E.

2. Hydrologic Assessment

Conduct a hydrologic assessment. This task will involve determining catchment areas contributing to the internal channels and estimating design flows through the channels. Meteorological data and measured flows from nearby channels will be used as data inputs into the hydrological model.

3. Lessons Learned from Phase 1 Pond

Review the Phase 1 Pond reclamation for lessons learned for channel design in the LLCF.

8.3.3 Long-Term Tasks (2014 and following)

See Section 5.2 for more detailed description of the research.

4. Pilot Study to Test Conceptual Design

Design internal channels. The channel design will need to provide sufficient grade through the LLCF to transport flow. Erosion protection will likely be required in high-flow areas. Graded filter mats will probably be required to prevent fine-grained substrate soils from piping through coarser-grained erosion protection.

5. Internal Channel Monitoring

Identify opportunities to conduct a pilot study to assess the constructability and effectiveness of the conceptual design outlined in the ICRP. As part of the pilot study, a monitoring program should be established to monitor channel performance, including channel bank movement and sediment transport.

6. Closure Criteria

Develop measurable criteria based on results of the pilot study and monitoring of the Phase 1 Pond.

8.4 FINDINGS OF RESEARCH COMPLETED

8.4.1 Research Summary Results

No research has been completed at this time.

8.4.2 Application of Lessons Learned

No research has been completed at this time.

8.4.3 Data and Information Gaps

No data and information gaps have been identified at this time.

8.5 REMAINING SCOPE TO BE COMPLETED

8.5.1 Detailed Work Scopes (next three years)

Table 5.1-5h provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Review Current PK Deposition Plan

Develop map/plan of end of mine life processed kimberlite depositions. The plan should identify preferred channel locations and surrounding topography, and should be developed in conjunction with an hydrologic assessment (Task 2) to identify contributing catchments.

Task 2. Hydrologic Assessment

Examine meteorological data for the area to determine surface water volumes expected for an appropriate design event. Additionally, examine local flow data from surrounding gauged streams to estimate expected flows within remaining operational channels. Determine catchment sizes and appropriate channel locations to capture and direct runoff in conjunction with Task 1.

Using information compiled from above, calculate expected flow volumes within internal drainage channels and ensure that these flows can be accommodated.

The aim of the hydrologic assessment is to capture and direct runoff through the LLCF to its discharge point at the south end of Cell E.

Task 3. Learnings from Phase 1 Pond

The Phase 1 Pond is currently planned to be decommissioned within the next 3 years. Stability performance in the decommissioned area, including any drainage channels constructed in the processed kimberlite, will provide transferable knowledge to the LLCF stabilization design.

8.5.2 Conceptual Work Scopes (2014 and following)

Table 5.1-5h provides an outline and schedule of conceptual tasks to be undertaken in 2014 and following.

Regular inspections of channels within the decommissioned Phase 1 Pond should be performed to note observed erosion, degradation/aggradation, and cracking or sloughing of the surface/channel banks. Learnings from these observations should be incorporated into future channel stabilization design, including any erosion and sediment control measures utilized.

Task 4. Pilot Study to Test Conceptual Design

The current design for the LLCF has one internal drainage channel located along the east perimeter of Cell B and two channels at the northern end of Cell C. The current deposition plan for the LLCF will mean that most of the lower portion of Cell B as well as Cells A and C will remain active for a number of years, and the opportunity to test stability of internal drainage channels may be not come until later in the mine life. Early opportunities for a pilot study to test conceptual internal drainage designs will be looked at, either as part of the 2013 LLCF Reclamation Pilot Study, or as a separate study later in the deposition plan.

Task 5. Internal Channel Monitoring

If a pilot study is completed, then a monitoring plan will include points at key locations to measure movement or erosion of the drainage channels. The monitoring points should be inspected regularly with findings recorded consistently to allow for comparison over time. Any instability within the pilot study area should be investigated, with the results lending towards potential improvements in channel stabilization design.

Monitor channel cross-section geometry over time and observe changes, paying particular attention to any degradation leading towards critical slip surfaces within channel banks. Flatten bank slopes if instability is observed. Investigate slope failures to determine cause, implement additional stabilization as appropriate, and adjust channel design for future channel construction/channel upgrades.

Additional erosion and sediment control measures should be implemented in areas of high flow or as conditions indicate based on pilot study observations. Sufficient data on processed kimberlite erosion and transport characteristics should be available at the time of design from research ongoing at the mine.

Task 6. Closure Criteria

Develop measurable criteria based on results of the pilot study and monitoring of the Phase 1 Pond.

8.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Studies on stability of LLCF internal drainage channels is linked to:

- Research on processed kimberlite surface stability on the LLCF.
- Research on vegetation percent cover and surface stability for the LLCF.
- Research on permafrost growth in processed kimberlite in the LLCF.
- Research on the water quality in the LLCF after mine closure.

Internal drainage channels will be constructed after all processed kimberlite deposition has been completed in each of the LLCF containment cells. An opportunity for some early research may come from the reclamation and closure of Old Camp Phase 1 Pond, if the final design includes a channel in the processed kimberlite in that containment area. Conceptual designs for LLCF internal channels were developed for the 2008 Draft ICRP. Actual research will likely not commence until construction of the first internal channel in the LLCF after 2014 when the processed kimberlite is sufficiently consolidated for construction work.

8.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-5h. Stability of PKCA Internal Drainage Channels

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short Term Research Tasks (within next 3 years)				
1	Review Current PK Deposition Plan	Working drawings of channel locations	2011	2011
2	Hydrologic Assessment	Hydrologic Assessment Report	2011	2011
3	Learnings from Phase 1 Pond	Phase 1 Pond Final Reclamation Plan	2013	2013
Long Term Tasks (2014 and following)				
4	Pilot Study to Test Conceptual Design	Pilot Study Report	2015	2015
5	Internal Channel Monitoring	Monitoring Report	2016	2017
6	Closure Criteria	Closure Criteria Report	2017	2017

8.8 COST

Total expected costs are $200,000 to $300,000.

8.9 REFERENCES

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9. Processed Kimberlite Weathering

9.1 UNCERTAINTY

9.1.1 Engineering Question

What are the weathering characteristics of processed kimberlite and how do these physically and chemically affect plant growth and water quality?

9.2 RESEARCH OBJECTIVE

Fine processed kimberlite (FPK) weathers when exposed to air, wet/dry cycles, and freeze thaw, and the particle size of the older deposits of the FPK reduces over time. Weathering changes the properties of the FPK, increasing its moisture retention capacity but reducing its resistance to wind and water erosion, thus affecting vegetation growth (BHPB 2007). The proposed reclamation plan of the LLCF is a rock and vegetation cover over processed kimberlite. To address the uncertainty of weathering effects on processed kimberlite and the sustainability of a vegetation cover the objective of this research is to:

- Determine the long-term weathering of processed kimberlite and effects on vegetation growth in the LLCF and the maintenance of water quality.

9.3 RESEARCH PLAN

9.3.1 Tasks Completed or Initiated

No research has been completed at this time. However data and information currently available that will assist the research work is listed below.

1. Revegetation Research

Revegetation research projects on processed kimberlite have been completed from 2000 to 2007. These studies include analysis of the physical and chemical properties of processed kimberlite, and the types of plants the research has indicated are best suited for growth on serpentine soils, similar in chemistry to the processed kimberlite found in the LLCF.

2. Processed Kimberlite Properties

The physical and chemical properties of kimberlites were studied by Dianne Joan Howe (1997), who looked specifically at the physical and chemical properties of kimberlites, and by Lucy Porritt (2008) who studied the volcanology and sedimentology of the EKATI Kimberlites (2008).

3. Tailings Characterization

A Tailings Characterization Study was completed by EBA in 1998 and looked at standard geotechnical classification testing (particle size distribution, plasticity and mineralogy) available for Panda and Fox tailings, as well as the properties of tailings sediments produced by freeze - clarification, and the thermal properties frost heave potential of the deposited tailings (EBA 1998).

4. Processed Kimberlite Mineralogy

Andrew Rollo in 2003 chemically and mineralogically defined the components of the mineral-water system that exists within the LLCF, and used major element water chemistry to determine the minerals and processes controlling the water chemistry observed. Both solid and water samples were collected from the processed kimberlite containment facility, from 2000 to 2002, in order to define and characterize the chemical and physical components of the system (Rollo 2003).

9.3.2 Short-Term Tasks (to be started/continued in the next three years)

1. Literature Review

Review existing published literature on the weathering of processed kimberlite or other similar materials in northern climates.

2. Freeze/Thaw Durability

Freeze/thaw cyclic testing of a processed kimberlite sample to assess the degree and rate of physical disintegration of the sample after repeated freeze/thaw cycles.

3. Wet/Dry Durability

Slake durability testing to assess the degree and rate of change of particle durability with moisture change on representative samples of processed kimberlite.

4. Water Quality

In parallel with slake testing, the effects processed kimberlite weathering has on water quality will be assessed using shake flask test, with representative samples of processed kimberlite.

5. Initial Vegetation Assessment

Desktop assessment of likely effects of weathering on vegetation growth as a guide to design of the field trials to be conducted in Task 6.

6. Vegetation Growth Trials

Vegetation testing on processed kimberlite as part of the Cell B reclamation pilot study.

9.3.3 Long-Term Tasks (2014 and following)

7. Continue to Monitor Vegetation Growth Trials

Continue to monitor the vegetation testing on processed kimberlite to gain a longer insight to the plant species growth in processed kimberlite.

9.4 FINDINGS OF RESEARCH COMPLETED

9.4.1 Research Summary Results

No research has been completed at this time.

9.4.2 Application of Lessons Learned

No research has been completed at this time.

9.4.3 Data and Information Gaps

No data and information gaps have been identified at this time. The first task, literature review will be used to identify initial gaps in information.

9.5 REMAINING SCOPE TO BE COMPLETED

9.5.1 Detailed Work Scopes (next three years)

Table 5.1-5i provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Literature Review

Review existing published literature on the weathering of processed kimberlite or other similar materials in northern climates. This should include information on testing and monitoring techniques.

Task 2. Freeze-Thaw Durability

Undertake freeze/thaw testing on samples of process kimberlite to assess the physical breakdown of the material under successive freeze/thaw cycles. This test work will be undertaken within a controlled laboratory environment. The total number of freeze/thaw cycles required to produce a measurable breakdown of the sample will be assessed during the test work based on the degree to which the sample breaks down during successive cycles. A minimum of two samples of processed kimberlite will be tested under both dry and saturated conditions, giving a total of four test samples. The degradation of the sample will either be assessed visually or using particle sizing techniques (sieve and hydrometer).

Task 3. Wet/Dry Durability

Two samples (same samples used in Task 2 above) of processed kimberlite will be subjected to slake durability testing according to ASTM D4644 – 08 to assess the breakdown of the material when exposed to cycles of wetting and drying. Further details on the test method can be found in the ASTM referenced above.

Task 4. Water Quality

Samples processed for freeze/thaw and for wet/dry durability testing will be subjected to shake flask testing to assess the potential effect of weathering of the material on water quality. Samples of processed kimberlite not subjected to any artificial weathering will also be tested to compare to the weathered samples, and to provide a basis for evaluating the potential effects of weathering to water quality.

Task 5. Initial Vegetation Assessment

Based on the findings of Tasks 1, 2 and 3, an initial (desktop) assessment of the likely effects of processed kimberlite weathering on vegetation growth will be developed. This initial assessment will guide, in part, the advanced field study described in Task 6.

Task 6. Vegetation Growth Trials

The northern portion of Cell B of the LLCF (approximately 60 ha) has been identified for a large-scale LLCF Reclamation Pilot Study for various reclamation operations on processed kimberlite, commencing in approximately 2013. Advanced vegetation studies will be included that attempt to provide an assessment of the effects of different stages of processed kimberlite weathering in vegetation growth. The study design will be based on available kimberlite and the work from Tasks 1 through 5.

9.5.2 Conceptual Work Scopes (2014 and following)

Table 5.1-5i provides an outline and schedule of tasks to be undertaken after 2014.

Task 7. Continue Monitoring of Vegetation Growth Trials

Continue to monitor the vegetation growth trials to obtain longer term information.

9.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on the weathering characteristics of processed kimberlite and how these physically and chemically affect plant growth and water quality in the LLCF mine component is linked to:

- Research on vegetation percent (%) cover and surface stability for the LLCF.
- Research on permafrost growth in processed kimberlite in the LLCF.
- Research and modeling of the long term LLCF water quality.
- Research on the construction of stable internal drainage channels in the LLCF.
- Research on the final landscape of the LLCF that is safe for human and wildlife use.
- Research on processed kimberlite surface stability in the LLCF.

The potential changes to processed kimberlite in the LLCF will affect growth and maintenance of vegetation and possibly water quality. Studies on weathering will begin before the pilot study for vegetation growth in 2013 so that this information can assist in determining what changes may occur and the plant species best suited for the long-term cover. Results from the water quality studies will be used for input into the LLCF water quality research.

9.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-5i. Processed Kimberlite Weathering

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short Term Research Tasks (within next 3 years)				
1	Literature Review	Reference List	2011	2011
2	Freeze/thaw testing	Report	2012	2012
3	Wet/Dry Durability	Report	2012	2012
4	Water Quality	Report	2012	2013
5	Initial Vegetation Assessment	Report	2012	2013
6	Vegetation Growth Trials	Report	2013	2014
Long Term Tasks (2014 and following)				
7	Continue to Monitor Vegetation Growth Trials	Report Update	2015	2018

9.8 COST

Total expected costs are $200,000 to $250,0000.

9.9 REFERENCES

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10. Long-Term Channel Bank Stability

10.1 UNCERTAINTY

What is required to ensure the long-term stability of channel banks and prevent any negative impacts on water quality and aquatic habitats in the surrounding area post-closure?

10.2 RESEARCH OBJECTIVE

Channels will be constructed, modified and in some cases re-established at various sites at EKATI for mine closure. Examples of new channels are between Panda and Koala pit lakes, and from Sable pit lake to Two Rock Lake. The Panda Diversion Channel may need modification in the canyon section to ensure maintenance of channel flow after mining operations. Other channels such as the Koala to Kodiak stream, and King Pond to Cujo Lake stream will need to be re-established. This research also covers external channels that will manage flow around the LLCF, as well as the new channel to be constructed through the breached Outlet Dam at LLCF closure. In all cases the channel banks will have to be constructed in such a way that the banks are geotechnically stable, and surface erosion is controlled. The purpose of this research plan is to develop an understanding of the variables affecting long-term channel bank stability and evaluate the alternatives to prevent or mitigate anticipated adverse impacts from instabilities. Additionally, it is necessary to establish measurable criteria for stabilization to meet closure objectives. Objectives of this research plan are to:

- Determine stability of channel banks at mine closure to reduce the potential of negative effects on aquatic habitats.
- Develop measurable criteria to meet the closure objective of channel bank stability.

10.3 RESEARCH PLAN

10.3.1 Tasks Completed or Initiated

No research has been completed at this time. However there is a significant amount of data and information currently available from the PDC and Grizzly Stream construction, remediation and inspections work that will assist the future research tasks. Some of this work is listed below.

1. PDC channel bank assessment completed by EBA 2005. The assessment identified areas where stabilization of the PDC would be required (EBA 2005a).
2. PDC stabilization plan. Draft design report completed by EBA in 2007.
3. Pigeon Stream Diversion design plan (EBA 2006). A design for the Pigeon Stream Diversion has been completed. The design comprises a shallow channel constructed through ice-rich permafrost. The diversion is much shallower than the PDC to mimic natural streams found in the EKATI Lease Area.
4. Grizzly Creek remediation design, construction record and visual performance records. A remediation of Grizzly Creek (discharging into the PDC) was completed after permafrost degradation and thaw settlement occurred following initial channel construction in 1997 (Dillon 1999 and EBA 1999c). To date, Grizzly Creek has performed well and in accordance with design.
5. Visual inspections of the PDC by EBA in 2003, 2004, 2006, and 2008, as part of the operations management of the channel and long term monitoring for closure and reclamation. BHP Billiton has also completed several internal inspections of the channel (regular scheduled photos have

also been taken from 2003 through 2007). To date, two areas of the PDC have been noted to be potentially at risk of failure. One is the rock canyon section and the other is where the channel is excavated through glacial till.

6. A spatial imaging survey of the canyon reach was completed in the fall of 2007. The survey was completed as part of a trial to assess the applicability of spatial imaging for mining operations at EKATI. The survey developed a 3D model of the canyon reach and provided survey data with a greater level of detail than prior conventional surveys.

10.3.2 Short-Term Tasks (to be started/continued in the next three years)

No short-term tasks have been identified prior to 2014.

10.3.3 Long-Term Tasks (2014 and following)

See Section 5.2 for more detailed description of the research.

1. Plan Showing Post Closure Drainage Channels

Identify areas where channels will be constructed or re-established at mine closure, or have been impacted by mining operations and will remain in operation following closure. Compile construction records and survey data for each of the channels, including channel geometry and subsurface soil conditions.

2. Hydrologic Assessment

Complete hydrologic assessment to estimate the expected flow through the channels. The assessment will utilize meteorological and stream flow data from other gauged streams to estimate the flows in the design channel.

3. Use PDC Bank Stabilization as an Example for Channel Bank Stability

Use the PDC bank stabilization as an example for channel bank stability. The draft PDC stabilization design cuts a bench through the canyon reach (bedrock controlled) and through the till soil lobe to the south. The PDC stabilization will likely precede other channel stabilizations and can therefore serve as a case study.

4. Test Laser Equipment to Monitor Bank Movement

Survey the stabilized portions of the PDC after this work is completed. Once the initial survey is complete, subsequent surveys will be required to see if any change in channel banks has occurred over time. This information will assist in developing measurable closure criteria for bank stability.

5. Channel Transect Surveys

Identify channel transect survey locations in the PDC to assess changes to the channel cross-section over time. Transects would be set up at select locations along the channel and surveyed at regular intervals to assess if any channel aggradation or degradation was occurring. This information will also assist in developing measurable closure criteria for bank stability.

6. Monitor Performance of Pigeon Diversion

Monitor performance of the Pigeon Stream Diversion and Grizzly Stream. Both of these channels pass through a significant amount of ice-rich permafrost. The slope and materials stability in the diversion could provide valuable insight into effective channel stabilization measures.

7. Develop Measurement Approach for Stability

Develop a measurement approach for channel bank stability in new channel construction and existing channels. Currently, land stability is monitored using visual observation by a professional geotechnical engineer as part of the engineer's geotechnical inspections (e.g., PDC), and this method may extend into closure.

10.4 FINDINGS OF RESEARCH COMPLETED

10.4.1 Research Summary Results

No research has been completed at this time.

10.4.2 Application of Lessons Learned

The reports and information summarized in Section 3.1 of this research plan will be used to monitor long-term channel bank stability. Historic inspections provide an indication of the stability of existing channels over time, which can be extrapolated to new channel construction. At the time of closure, sufficient historic data should be available to predict the long-term channel bank stability of remaining operational channels, including those that would need to be constructed.

10.4.3 Data and Information Gaps

No data and information gaps have been identified at this time.

10.5 REMAINING SCOPE TO BE COMPLETED

10.5.1 Detailed Work Scopes (next three years)

No short-term tasks have been identified prior to 2014.

10.5.2 Conceptual Work Scopes (2014 and following)

Table 5.1-5j provides an outline and schedule of conceptual tasks to be undertaken beyond 2014.

Task 1. Plan Showing Post-Closure Drainage Channels

Identify remaining operational channels at time of closure (including those that would need to be constructed) and prepare map denoting locations. These will include the two diversion channels (Panda and Pigeon), channels that will be re-established between pit lakes and external watersheds, external channels associated with the LLCF, and channels that will be cut through breached dams and dikes to external watersheds. Reference respective construction records for the existing channels. Compile and append construction records to drawings as appropriate. Construction records should denote channel geometry and subsurface soil conditions which will be required to evaluate channel bank stability.

Task 2. Monitor Performance of Pigeon Diversion

A design for the Pigeon Stream Diversion has been completed. The design was engineered for no long-term maintenance. This channel can be used as a case study for future stabilizations or channel construction. The Pigeon Diversion channel is shallow and consists of more ice-rich soil material than the Panda Diversion Channel. This contrast will allow for better assessment of long-term stability in remaining operational channels based on ongoing observations and successful mitigation employed.

Task 3. Hydrologic Assessment

Examine meteorological data for the area to determine surface water volumes expected for an appropriate design event. Additionally, examine local flow data from surrounding gauged streams to estimate expected flows within remaining operational channels.

Using information compiled from above, calculate expected flow volumes within the channels that are to remain post-closure and ensure that these flows can be accommodated.

Task 4. Use PDC Bank Stabilization as Example for Channel Bank Stability

A draft stabilization design has been prepared for the PDC, through the canyon reach and through a portion of the moraine to the south. Observations from the constructed stabilization will be used to assess the effectiveness of these measures, and then applied to other channels. Soils within the PDC channel range from predominately rock to sections of predominant till, including areas of ice rich soils. Such conditions will be similar to that expected in other areas around the mine site.

The PDC should be inspected and monitored regularly with findings recorded consistently to allow for comparison over time. Any instability within the PDC should be investigated, with the results lending towards potential improvements in channel design for improved stability.

Task 5. Test Laser Equipment to Monitor Bank Movement

Laser measuring equipment should be tested on the PDC to monitor bank movement, with the aim to more accurately monitor and quantify stability within operational channels. Laser equipment may provide more detail than traditional survey techniques, thereby enabling better interpretation of bank movement.

Task 6. Channel Transect Surveys

At select locations along channels, conduct transect surveys to establish cross-section geometry. Monitor cross-section geometry over time and observe changes, paying particular attention to degradation leading towards critical slip surfaces within channel banks. If such instability is observed, flatten bank slopes to increase stability. Investigate slope failures to determine cause, implement additional stabilization as appropriate and adjust channel design for future channel construction/channel upgrades.

Task 7. Develop Measurement Approach for Stability

Develop a measurement approach for channel bank stability in new channel construction and existing channels. Currently, land stability is monitored using visual observation by a professional geotechnical engineer as part of the engineer's geotechnical inspections (e.g., PDC), and this method may extend into closure.

10.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on channel bank stability in the Dams, Dikes and Channels mine component is linked to:

- Research on vegetation and surface stability for the same mine components.

Assessments of channel bank stability began early in the mining operations phase with the construction of the PDC. Learnings from the PDC will be used in the Pigeon Diversion construction. The majority of the remaining channel construction will take place after mining operations cease in many of the mine site components, and will include construction of channels to re-establish flow from pit lakes, and when dams and dikes are breached.

10.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-5j. Long-term Channel Bank Stability

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Long Term Tasks (2014 and following)				
1	Plan showing post-closure drainage channels	Report	2014	2014
2	Monitor performance of Pigeon Diversion	Performance Report	2014	2017
3	Hydrologic Assessment	Hydrologic Assessment Report	2015	2015
4	Use PDC bank stabilization as example for channel bank stability	Annual inspection report	2015	2015
5	Test laser equipment to monitor bank movement	Evaluation Report	2016	2016
6	Channel transect surveys	Survey Cross Sections	2016	2016
7	Develop quantifiable measurement approach for stability of land surfaces adjacent to new channel construction and existing channels.	Evaluation Report	2017	2017

10.8 COST

Total expected costs are $200,000 to $300,000.

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11. Geotechnical Stability of Dams and Dikes Infrastructure

11.1 UNCERTAINTY

The stability of remaining dams and dikes that ensures no negative impacts post-closure?

11.2 RESEARCH OBJECTIVE

The ICRP outlines the Panda Diversion Dam as the only dam that will remain operational at mine closure. All other dams and dikes will be breached and their slopes stabilized (Refer to Section 5.6.5.1 of the ICRP). The closure objective for the Panda Diversion Dam (and other dams or dikes that may in the future be determined as remaining operational after mine closure) is that the dam infrastructure is stabilized. The research objective is to evaluate the geotechnical stability of dams and dikes and to predict their anticipated behaviour during design life post-closure and the consequences of possible failure (note that LLCF dikes are included within the PKCA Mine Component). Specific objectives of the research are:

- Determine the design life for the dams and dikes that will remain post-closure.
- Establish geotechnical stability objective/s for the post-closure dams and dikes.
- Determine the work required to stabilize dams and dikes to meet the closure objective.
- Assess the consequences of dam or dike failure after mine closure.
- Develop measurable criteria to meet the closure objective of geotechnical stability of remaining dikes and dams.

11.3 RESEARCH PLAN

11.3.1 Tasks Completed or Initiated

No research has been completed at this time. However data and information currently available that will assist the research work is listed below.

1. As-Built Plans

Panda Diversion Dam as-built plans are available. They are kept on record at BHP Billiton and were submitted to the INAC Inspector when the dam was constructed.

2. Design Reports

Design reports for dams and dikes at EKATI are available.

3. Hydrology

Water levels for the Upper Panda Lake are available. The water level is monitored as part of the annual geotechnical inspection and the Panda Diversion Channel monitoring.

4. Panda Diversion Channel Geotechnical Report

Panda Diversion Dam overtopping documentation is contained in the 1999 annual geotechnical report (EBA 1999b). There was a short-term overtopping of the Panda Diversion Dam in June of 1999 due to a temporary blockage of the diversion channel with snow and ice. The chronology of events and the overtopping event's impact on the dam performance is documented in the inspection report. The performance of the dam was not affected by the overtopping event.

5. Panda Diversion Dam Option Assessment

Panda Diversion Mine Reclamation Option Assessment. This includes the concept plan for a spillway around the dam. In 2005, a concept level design was developed for the Panda Spillway. The purpose of the spillway was to act as an overflow during freshet if the PDC was blocked by snow or ice.

11.3.2 Short-Term Tasks (to be started/continued in the next three years)

No tasks have been identified prior to 2014.

11.3.3 Long-Term Tasks (2014 and following)

1. Compile Record Dataset

Compile and review construction record documentation for all post-closure dams and dikes.

2. Seepage and Stability Analyses

Complete seepage and stability analysis of all post-closure dams and dikes. Assess the performance through geotechnical inspection records.

3. Risk Assessment

Complete a risk assessment for dam failure.

4. Develop Closure Criteria

Develop measurable criteria to meet the closure objective of geotechnical stability of remaining dikes and dams.

5. Assess Stabilization Needs

Determine the work requirements for any stabilization measures for post-closure dams and dikes.

6. Monitoring Program

Continue monitoring the performance of dams and dikes through geotechnical inspections and update the closure criteria as required.

11.4 FINDINGS OF RESEARCH COMPLETED

11.4.1 Research Summary Results

No research has been completed at this time.

11.4.2 Application of Lessons Learned

No research has been completed at this time.

11.4.3 Data and Information Gaps

No data and information gaps have been identified at this time.

11.5 REMAINING SCOPE TO BE COMPLETED

11.5.1 Detailed Work Scopes (next three years)

No tasks have been identified prior to 2014.

11.5.2 Conceptual Work Scopes (2014 and following)

Table 5.1-5k provides an outline and schedule of tasks to be undertaken after 2014.

Task 1. Compile Record Database

Compile and review construction record documentation for the Panda Diversion Dam. These documents are available and will be used to develop representative geotechnical cross-sections through the dam for seepage and slope stability analyses.

Task 2. Seepage and Stability Analyses

Complete seepage and stability analysis of the Panda Diversion Dam in thawed condition based on the sections developed during Task 1.

Task 3. Risk Assessment

Complete a risk assessment for dam failure. Assess the consequences of dam failure and controls necessary to maintain dam performance and safety for downstream users and protection of the environment.

Task 4. Develop Closure Criteria

Conduct a literature review of currently practiced dam assessment methods. Using this information, develop assessment methods which are suitable and relevant to the dams and dikes at EKATI Diamond Mine. Development of the stability criteria for dams and dikes should include information on overtopping, and spillway concept plan.

Task 5. Assess Stabilization Needs

Determine the work requirements for any stabilization measures for post-closure dams and dikes.

Task 6. Monitoring Program

Continue monitoring the performance of dams and dikes through geotechnical inspections and update the closure criteria as required.

11.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

The Panda Diversion Dam will remain operating after mine closure. Research on measurable criteria for the stability of this dam will be completed prior to mining cessation of the Beartooth, Panda, and Koala mines in 2020.

11.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-5k. Geotechnical Stability of Dams and Dikes Infrastructure

Research Task #	Project Tracking (*Reporting*, *Modeling*, *Field Work*, *Engineering Designs*)	Deliverables	Research Start	Research Finish
Long-Term Tasks (2014 and following)				
1	Compile Record Dataset	Report	2015	2015
2	Seepage and Stability Analyses	Report	2015	2015
3	Risk Assessment	Risk Assessment	2016	2016
4	Develop Closure Criteria	Report	2016	2016
5	Assess Stabilization Needs	Report	2016	2018
6	Monitoring Program	Report	2015	2018

11.8 COST

Total expected costs are $200,000 to $250,000.

11.9 REFERENCES

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EBA Engineering Consultants Ltd. 1999b. Annual Water License Geotechnical Inspection (1999), EKATI Diamond Mine. Report submitted to BHP Billiton Diamonds Inc., July 1999. EBA Project No. 0101-94-11580.020.

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12. Geotechnical Stability of Esker Quarry Sites

12.1 UNCERTAINTY

What measurable criteria will be used to meet the closure objective of “Esker Quarry sites are stabilized to prevent permafrost degradation, and the physical stability of the quarry is maintained”?

12.2 RESEARCH OBJECTIVE

BHP Billiton quarried esker materials from the Airport Esker for the early development of the EKATI Diamond Mine (namely for the Old Camp pad, EKATI Airstrip and some auxiliary roads). More recently quarry material was also used for shotcrete (spray concrete) construction in the Koala North and Panda Underground mines. The reclamation plan for the Airport Esker is to stabilize the remaining landforms, and ensure positive drainage for channels and streams that cut through the esker (Refer to Section 5.7.9.6 of the ICRP). The reclamation objective for the Airport Esker is to stabilize the quarry to prevent permafrost degradation. The objective of this research plan is to:

- Develop measurable criteria that meet the closure objective of “Esker Quarry sites are stabilized to prevent permafrost degradation.”

12.3 RESEARCH PLAN

12.3.1 Tasks Completed or Initiated

No research has been completed at this time. However data and information currently available that will assist the research work is listed below.

1. Airport Esker Geotechnical Assessment

A geotechnical assessment of the Airport Esker, completed by EBA in 1995, included borehole information and geophysical survey. The airport esker was found to contain discrete bodies of massive ground ice up to 5 m thick (EBA 1995). Melting of these massive bodies of ground ice during quarrying of the esker resulted in slope instability and permafrost degradation, i.e., development of small thermokarst lakes and thermal erosion features.

2. Topographic Survey

Historical topographic survey information provides the topography prior to disturbance.

3. Quarry Management Plan

A Quarry Management Plan was completed by BHP Billiton in 1997. The Airport Esker had substantial volumes of quality granular construction material, relatively proximal to the project area, and was a source of granular construction material during the exploration and development stage. In more recent years, the esker material was used as a source of aggregate used for the production of shotcrete in the Koala North and Panda Underground Mines.

4. Fred's Channel Remediation Work

Fred's Channel is located on the Airport Esker and was remediated in 2002. The channel slope was armoured and minor modifications were made to the channel alignment. A small retention pool was created to allow suspended sediments to settle out, and rock weirs were installed within the channel to help decrease the velocity of the water before it entered a shallow pool just upstream of the delta. To minimize erosional effects on overland flow, portions of the residual esker on either side of the constructed channel were partially armoured with coarse waste rock. Crushed granite armour was also placed in areas where thaw settlement had occurred. Fred's Channel continues to perform well and in accordance with the design.

5. Landsat Imagery

Annual Landsat or SPOT imagery of Airport Esker provides yearly visual reference on quarry work.

12.3.2 Short-Term Tasks (to be started/continued in the next three years)

See Section 5.1 for more detailed description of the short-term research tasks.

1. Literature Review

Complete a literature review to identify what reclamation activities have been completed at other mine sites or esker quarry sites with similar materials and ice conditions as the Airport Esker.

2. Review Existing Information

Review the assessment of the original Airport Esker Evaluation, Quarry Management Plan, and any stabilization work completed to date.

3. Physical Assessment

Complete a physical assessment of the Airport Esker once quarry work has been completed.

4. Evaluate Stability Methods

Evaluate various methods to measure esker stability.

12.3.3 Long-Term Tasks (2014 and following)

5. Development Closure Criteria

Develop measurable criteria for closure of esker quarry sites, based on the data collected in the above tasks.

12.4 FINDINGS OF RESEARCH COMPLETED

12.4.1 Research Summary Results

No research has been completed at this time.

12.4.2 Application of Lessons Learned

No research has been completed at this time.

12.4.3 Data and Information Gaps

No data and information gaps have been identified at this time.

12.5 REMAINING SCOPE TO BE COMPLETED

12.5.1 Detailed Work Scopes (next three years)

Table 5.1-5l provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Literature Review

Complete a literature review to identify what reclamation activities have been completed at other mine sites. Part of this review would include review of government or regulatory guidelines for reclamation of esker quarry sites.

Task 2. Review Existing Information

Review the assessment of the original Airport Esker Evaluation, Quarry Management Plan, and any stabilization work completed to date.

Task 3. Physical Assessment

Complete a physical assessment of the Airport Esker once quarry work has been finished. This esker was one of the original quarry sites used for mining operations. The task will comprise analysis of historical aerial photography and satellite imagery in conjunction with visual observations of the esker condition, which includes slope instability, drainage paths, thermal erosion features, thermokarst and other permafrost features.

Task 4. Evaluate Stability Methods

Evaluate various methods to measure esker stability. One potential method that could be employed is repeated surveys concurrent with annual visual inspections. Surveys could be completed using either conventional means or LiDAR.

12.5.2 Conceptual Work Scopes (2014 and following)

Task 5. Develop Closure Criteria

Develop measurable criteria for closure of esker quarry sites based on the data collected in the above tasks.

12.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on the quantitative measurement for geotechnical stability of esker quarry sites in the Buildings and Infrastructure mine component is linked to:

- Research on bank stability and erosion for all channels disturbed through mining operations and the establishment of measurable closure criteria for bank stability in the Dams, Dykes and Channels mine component.
- Research on the geotechnical stability of remaining dam and dyke infrastructure and the establishment of measurable closure criteria for geotechnical stability in the Dams, Dykes and Channels mine component.

12.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-5l. Geotechnical Stability of Quarry Sites - Buildings and Infrastructure

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short Term Research Tasks (within next 3 years)				
1	Literature Review	Literature Review	2011	2012
Long Term Tasks (2014 and following)				
2	Review Existing Information	Desktop Evaluation	2013	2013
3	Physical Assessment	Report	2013	2013
4	Evaluate Stability Methods	Report	2013	2014
5	Develop Closure Criteria	Report	2014	2014

12.8 COST

Total expected net present value costs are $150,000 to $200,000.

12.9 REFERENCES

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13. Camp Pad and Laydown Stability

13.1 UNCERTAINTY

What measurable criteria will be used to meet the closure objective of “Camp Pads, laydown areas, sumps, roads and airstrip are stabilized”?

13.2 RESEARCH OBJECTIVE

The reclamation activities planned for camp pads, laydown areas, sumps, roads and airstrip is to remove buildings and equipment, complete remediation requirements for site contamination, stabilize areas with potential for erosion and instability, and reclaim sites to a condition that is safe for people and wildlife use. More detailed reclamation plans for these mine components are provided in Section 5.7.9 of the ICRP. Pads, laydown areas and roads will be progressively reclaimed when they are no longer useful for mining operations (e.g., Old Camp) and learnings from the stabilization works at these sites will be used for successive areas as they come available.

The purpose of the research is to develop a means of measuring stability of the above mine components and develop closure criteria that can be used to measure success of the reclamation objectives. The objectives of this research plan are:

- Determine landscape work required to stabilize areas after infrastructure has been removed and environmental site assessments have been completed.
- Review site closure plans and assess the locations and types of instability that may occur after reclamation activities.
- Develop closure criteria that can be used to monitor performance of stabilizing work and measure the success of meeting the closure objective.

13.3 RESEARCH PLAN

13.3.1 Tasks Completed or Initiated

No research has been completed at this time. However data and information currently available that will assist the research work is listed below.

1. Original ground topography is available site wide in the form of 5 m contours interpreted from aerial photographs. One-metre contour data is available for portions of the site.
2. Site-specific meteorological data for the EKATI mine site has been collected since 1995.

13.3.2 Short-Term Tasks (to be started/continued in the next three years)

See Section 5.1 for more detailed description of the research tasks.

1. Infrastructure Inventory

Compile an inventory of camp pads, laydown areas, sumps, and roads constructed at the mine site and associated subsurface works.

2. Compile Original Ground Topography

Compile a base set of drawings showing the original ground topography for the sites identified in Task 1.

3. Hydrology Assessment

Complete surface hydrology assessment.

4. Identify Stabilization Areas

Identify areas requiring stabilization at closure.

5. Review Old Camp Pad Stability

Review stability of Old Camp after reclamation activities have been completed, and use this site as a test of use and effectiveness of criteria.

13.3.3 Long-Term Tasks (2014 and following)

See Section 5.2 for more detailed description of the research.

6. Develop Measurable Criteria

Based on the learnings from Old Camp reclamation, develop measurable criteria for remaining camp pads, laydown areas, sumps, roads and airstrip.

13.4 FINDINGS OF RESEARCH COMPLETED

13.4.1 Research Summary Results

No research has been completed at this time.

13.4.2 Application of Lessons Learned

No research has been completed at this time.

13.4.3 Data and Information Gaps

No data and information gaps have been identified at this time.

13.5 REMAINING SCOPE TO BE COMPLETED

13.5.1 Detailed Work Scopes (next three years)

Table 5.1-5m provides an outline and schedule of tasks to be undertaken during the next three years.

Task 1. Infrastructure Inventory

Compile an inventory of camp pads, laydowns, sumps and roads constructed at the minesite, and associated subsurface works. This should include locations, dimensions and thicknesses. Much of this information is already surveyed on a regular basis by BHP Billiton and is included in infrastructure drawings. The subsurface works should include culverts, water lines or other utilities.

Task 2. Compile Original Ground Topography

Compile original ground topography. Much of this information is already available in 5 m contours, and in 1 m contours intervals in some locations. Where insufficient original ground survey data exists, additional survey will be required.

Task 3. Hydrology Assessment

Complete surface hydrology assessment. This task involves identifying the catchment areas that contribute runoff to each of the areas and assessing the hydrologic regime.

Task 4. Identify Stabilization Areas

Identify stabilization work required at each pad and laydown location. This includes the methods and materials required to stabilize remaining land surfaces.

Task 5. Review Old Camp Pad Stability

Review stability of the Old Camp pad. Learnings from the reclamation of the Old Camp area will assist in the closure plan for camp pads and laydowns. Old Camp pad will be inspected and monitored as part of this task to identify which stabilization measures have been most effective.

13.5.2 Conceptual Work Scopes (2014 and following)

Table 5.1-5m provides an outline and schedule of tasks to be undertaken after 2014.

Task 6. Develop Measurable Criteria

Develop site-specific measurable criteria for assessing camp pad and laydown stability. Develop procedure for measuring stability (e.g., erosion, settlement). Typically erosion is measured through visual assessment by or under the direction of a professional geotechnical engineer and this method may continue into the future.

13.6 LINKAGES TO OTHER RESEARCH AND LOM PLAN

Research on camp pads and laydown stability is linked to:

- Research of vegetation cover and surface stability for camp pads and laydown areas in the Buildings and Infrastructure Mine Component.
- Research of Traditional Knowledge inclusion in reclamation planning for the EKATI mine components.

Preliminary research on the stability of camps pads and laydown areas will be conducted during the mining operations phase when smaller laydown areas are no longer required. Research on measurable closure criteria for camp pad surface stability can start once closure objectives have been identified and approved by applicable regulatory agencies. Most of the camp pads and laydown areas will remain in operation until the later part of the LOM Plan, with the Old Camp Pad and associated laydown areas one of the few sites of appreciable size to be useful as a test for stability and measurement for stability success. Early research will focus on compiling infrastructure inventories, topographic and hydrologic information, and designing conceptual final landscapes for these infrastructure components.

13.7 PROJECT TRACKING AND SCHEDULE

Table 5.1-5m. Camp Pad and Laydown Stability - Buildings and Infrastructure.

Research Task #	Task	Project Tracking (*Reporting, Modeling, Field Work, Engineering Designs*)	Research Start	Research Finish
Short Term Research Tasks (within next 3 years)				
1	Infrastructure Inventory	Report	2011	2011
2	Compile Original Ground Topography	Report	2012	2012
3	Hydrology Assessment	Report	2012	2013
4	Identify Stabilization Areas	Desktop Evaluation	2013	2013
5	Review Old Camp Pad Stability	Field Work, Monitoring, Report	2013	2013
Long Term Tasks (2014 and following)				
6	Develop Measurable Criteria	Report	2014	2017

13.8 COST

Total expected costs are $150,000 to $200,000

13.9 REFERENCES

BHP Billiton Diamonds Inc. 2000 through 2007. Environmental Agreement and Water License Annual Report. EKATI Diamond Mine, Yellowknife, NT.

Rescan. 2000 through 2007. Aquatic Effects Monitoring Program (AEMP) Annual Report. Prepared for BHP Billiton Diamonds Inc. by Rescan Environmental Services Ltd.

Appendix 5.1-6

Post-Closure Monitoring

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Appendix 5.1-6. Post-Closure Monitoring

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1. INTRODUCTION

After reclamation activities are completed EKATI mine components will be monitored to measure the success of reclamation against closure objectives. Although monitoring programs and schedules have been tailored to individual closure criteria, they use similar parameters, methods, QA/QC protocols, and evaluation as the current operational monitoring programs. Monitoring periods in closure have been set at 5 or 10 years with the flexibility of modification to these durations (reduced or extended) dependent on reflected trends and results.

The majority of the post-closure monitoring program is expected to use as its foundation the current operational monitoring programs at EKATI. This system includes a combination of environmental monitoring, audits, and inspections to measure and manage actual environmental performance against our operational plans and regulatory requirements. Most of these monitoring programs undergo modifications based on both legal requirements and lessons learned from operational changes to the mine plan, and ongoing environmental performance. The operational programs will be adapted to the closure programs in the progressive reclamation and final closure phases, with the primary purpose of monitoring the success of reclamation activities in meeting identified closure objectives, through the use of measurable closure criteria. Review and modification of these programs will continue through closure, eventually scaling down and combining as the closure operation declines.

2. POST-CLOSURE MONITORING OBJECTIVES

The monitoring program for closure has been designed to detect changes in physical stability, increasing or decreasing trends in chemical stability and significant wildlife effects or changes in vegetation that effect biological stability. Monitoring programs are used to demonstrate the following:

- Sites are stable or trending towards the desired outcome, and there are no significance trends leading to a need for any responses or implementation of contingencies.
- Observed variables are the result of natural variations (*e.g.*, seasonal influence) or natural disturbance and sites or factors have demonstrated resilience to these natural influences.
- There are no significant residual effects. Any residual effects are consistent with those outlined in the predicted environmental effects listed in Table 7.3-1 of the main text.

3. POST-CLOSURE MONITORING PROGRAMS

The following is a list of the expected post-closure monitoring programs used to measure performance of reclamation activities:

- Aquatic Effects Monitoring Program (AEMP);
- Surveillance Network Program (SNP);
- Geotechnical Inspections;
- Air Quality Monitoring Program (AQMP);
- Wildlife Effects Monitoring Program (WEMP);
- Vegetation Monitoring Program (VMP);
- Health, Safety, Environment and Community (HSEC) and ISO 14001 audits;
- Inspections for Mine Health and Safety Act;

- Seepage Monitoring Program; and
- Archaeology Monitoring Program.

The reclamation monitoring program is organized in Tables 5.1-6a to 5.1-6m under parameters, location, evaluation and response thresholds, as well as monitoring periods. Locations are those sites specific to reclamation activities. All of the closure monitoring programs will focus on reclamation of individual mine components (e.g., Panda Open Pit), with the exception of the WEMP and AQMP programs. The WEMP and AQMP programs will be treated as site-wide programs because of the ubiquitous nature of wildlife use and air distribution across the EKATI Claim Block. Unlike mine component specific monitoring programs, the WEMP and AQMP will assess reclamation performance criteria over the whole minesite. For these two programs the current operational programs will be extended into the reclamation phase, with expected review and modifications to these programs as necessary.

4. QA/QC MONITORING PROTOCOLS

Parameters and methods for reclamation monitoring in the monitoring tables generally follow current operational monitoring programs. Quality Assurance (QA) and Quality Control (QC) protocols will guide the reclamation monitoring program to ensure that the program is defined and appropriate (QA), and mechanisms are in place to quickly identify problems in the data generation process that require correction (QC). The definitions for QA and QC of the monitoring programs at EKATI are summarized as follows:

- **Quality Assurance (QA)**. An integrated system of management activities involving planning, implementation, documentation, assessment, reporting and quality improvement to ensure that the monitoring process is adequate and appropriate for reclamation success at EKATI.
- **Quality Control (QC)**. The overall system of technical activities that measures the attributes and performance of the monitoring program to meet the stated requirements established by BHP Billiton, including identification of problems in the data collection and generation process that require correction.

The management system for the reclamation monitoring QA/QC protocol mirrors the overall BHP Billiton organizational structure for reclamation research planning. Figure 4.8-1 in the main text summarizes the management structure for the environmental functions at the EKATI Diamond Mine. The Senior Environment Advisor for Closure is responsible for the operations and implementation of reclamation monitoring QA/QC protocols. This includes ensuring that Standard Operating Procedures (SOPs) for monitoring programs are implemented in a consistent, timely and reliable manner, and that all monitoring programs have a QA/QC protocol. The ECCP Manager approves all final monitoring plans and QA/QC protocols.

Monitoring protocols for EKATI Environmental programs during operations will be phased into monitoring protocols for reclamation, in line with the monitoring programs. Operational QA/QC protocols are identified within the current QA/QC Plan, SOPs, and various external use QA/QC protocols by BHP Billiton's contractors for sampling analysis and data management. Table 5.1-6n provides an overview of the QA/QC Protocols and SOPs for the current monitoring programs at EKATI, which are likely to be phased into reclamation monitoring.

Table 5.1-6a. Closure Monitoring and Performance – Open Pits

Indicator(s)	Method(s)	Location	Evaluation	Response Thresholds
AIR				
1. Fugitive Dust	Total suspended particulate sampling	TSP 2 (Grizzly Lake), and TSP 3 (Cell B LLCF)	Comparison with Canadian Ambient Air Quality Standards.	Exceedance of Canadian Ambient Air Quality Standards.
LAND				
1. Slope stability	Geotechnical Inspections	High walls, berms and channel banks. Sable, Pigeon, Beartooth, Panda, Koala, Fox, and Misery.	Check for slope stability (e.g., Signs of significant erosion, subsidence, slope failures, surface instability)	Evidence of significant highwall movement and or potential inter-bench failure, or channel bank slumping which has the potential to dam stream flow.
2. Percent vegetation cover	Inspections and monitoring of transects at reference and reclamation sites	Pads, pit lake perimeter and channel banks. Reference sites.	Identify plant types, and cover percentage. Record temporal and spatial cover growth/decline.	Increasing trend toward loss of vegetation cover.
WATER				
1. Lake levels and stream discharge	Aquatic Effects Monitoring Program (AEMP)	Source lakes and source lake outlet streams (locations to be confirmed).	Comparison with baseline and monitoring for change over time	Evidence of negative trend from baseline conditions.
2. Stream flow	Aquatic Effects Monitoring Program (AEMP)	Outflow streams from pit lakes (to be confirmed).	Measurement of stream flow, consistent or intermittent.	Prolonged period of no flow between pit lakes and downstream watershed.
3. Field: pH, Flow, Conductivity and Temperature Lab: Metals, Nutrients and general water quality indicators.	Surveillance Network Program (SNP) Aquatic Effects Monitoring Program (AEMP)	SNP Locations: SNP-1616-14 (Panda) SNP-1616-15 (Koala) SNP-1616-39 (Misery) SNP-1616-45 (Fox) SNP-0008-Pi1 (Pigeon) SNP-0008-Sa1 (Sable) SNP-0008-Be1 (Beartooth) AEMP Closure Locations to be confirmed.	Comparison with baseline and monitoring for change over time. Discharge water quality at pit lake discharge points meets water licence criteria. Conductivity, Temperature Chains and water quality at various depths, for pit lake stratification.	Increasing trends towards exceedance of discharge criteria.

(continued)

Table 5.1-6a. Closure Monitoring and Performance – Open Pits (completed)

Indicator(s)	Method(s)	Location	Evaluation	Response Thresholds
WILDLIFE				
1. Wildlife habitat, movement, safety, abundance, mortalities, incidents, breeding, distribution, density, diversity.	Wildlife Effects Monitoring Program (WEM)	Current Study Area	Changes in habitat availability, biophysical environment, interaction with traffic, success of deterrent efforts, number of mortalities and incidents, caribou abundance, distribution, interaction and behaviour, grizzly bear habitat use, wolf breeding success, wolverine population and distribution, density and diversity of breeding birds, falcon nesting and re-productivity.	Negative effects compared to conditions identified during 1995 EIS.
HEALTH & SAFETY				
1. Safe working procedures/ practices.	Safety meetings, OH&S, HSEC Risk Registry upkeep and reporting. Compliance with *Mine Health and Safety Act* and Regulations	EKATI Minesite	Safety evaluation conducted during safety meetings (PASS), incident investigations (ICAMs), Mines inspections and reporting.	Identification of unsafe working conditions, injury or fatality to people/person at the minesite.
COMMUNITY				
1. Incorporation of TK into closure.	Annual site tours and visits to the Communities. Annual BHP Billiton HSEC audit.	EKATI minesite and communities.	Effects on caribou and other VECs, discussions on monitoring results, continued opportunities and effectiveness of TK, have targets been met, HSEC audit to ensure compliance with Sustainable Development Policy.	Audit failure against agreed action at start of closure.
2. Archaeological sites	Record of archaeological sites kept and monitored during reclamation activities (e.g., Quarrying of esker materials) to ensure sites are not disturbed.	EKATI Claim Block	Monitoring of reclamation activities against identified sites.	Disturbance of Archaeological site/s.
OPERATIONS				
1. Operations, Procedures, and Reporting.	Annual Reports, Audits.	NWT and Corporate	Maintenance of compliance, certification (e.g., ISO 14001), and audit scoring.	Non-compliance, loss of certification, audit failure.

Table 5.1-6b. Closure Monitoring Frequency – Open Pits

Monitoring Program	Closure Monitoring Period Years									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Geotechnical Inspections (Land)	A	A	A	A	A	A	A	A	A	A
Vegetation Sampling and Inspection (Land)	A	A	A	A	A	A	A	A	A	A
SNP (Water)	BA	BA	BA	BA	BA	A	A	A	A	A
AEMP (Water)	S	S	S	S	S	S	S	S	S	S
Health & Safety	C	C	C	C	C	C	C	C	C	C
Traditional Knowledge Monitoring (Community)	A	A	A	A	A	A	A	A	A	A
Archaeological Sites (Community)	C	C	C	C	C	C	C	C	C	C
Operations	C	C	C	C	C	C	C	C	C	C

BA = Bi-Annual.
A = Annual.
S= Seasonally (3 times in open water season & 1 time in winter).
C = Continuous.
Pit Lake 10 year water quality monitoring period commences in individual pit lakes with verification of acceptable water quality.

Table 5.1-6c. Closure Monitoring and Performance – Underground Mines

Indicator(s)	Method(s)	Location	Evaluation	Response Thresholds
AIR				
N/A	N/A	N/A	N/A	N/A
LAND				
1. Slopes, drainages, surface stability of adit/raises plugs and seals.	Geotechnical Inspections.	Underground adit portal, vent raises Koala/Panda Underground Mine.	Check for slope stability (e.g., erosion, subsidence, slope failures, surface stability, collapse).	Evidence of instability and movement/failure outside of forecast cave zone.
WATER				
(Contribution of ground water to pit lake water quality (See Open Pits WATER 3 in Table 49))	N/A	N/A	N/A	N/A
WILDLIFE				
N/A	N/A	N/A	N/A	N/A

(continued)

Table 5.1-6c. Closure Monitoring and Performance – Underground Mines (completed)

Indicator(s)	Method(s)	Location	Evaluation	Response Thresholds
HEALTH & SAFETY				
1. Safe working procedures/ practices.	Safety meetings, OH&S, HSEC Risk Registry upkeep and reporting. Compliance with *Mine Health and Safety Act* and Regulations.	EKATI Minesite	Safety evaluation conducted during safety meetings (PASS), incident investigations (ICAMs), Mines Inspections and reporting.	Identification of unsafe working conditions, injury or fatality to people/ person at the minesite.
COMMUNITY				
N/A	N/A	N/A	N/A	N/A
OPERATIONS				
1. Operations, Procedures, and Reporting.	Annual Reports, Audits.	NWT and Corporate.	Maintenance of compliance, certification (e.g., ISO 14001), and audit scoring.	Non-compliance, loss of certification, audit failure.

Table 5.1-6d. Closure Monitoring Frequency – Underground Mines

	Closure Monitoring Period Years									
Monitoring Program	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Geotechnical Inspections(Land)	A	A	A	A	A	A	A	A	A	A
Health & Safety	C	C	C	C	C	C	C	C	C	C

A = Annual.
C = Continuous.

Table 5.1-6e. Closure Monitoring and Performance – Waste Rock Storage Areas

Indicator(s)	Method(s)	Location	Evaluation	Response Thresholds
AIR				
1. Fugitive Dust	Total suspended particulate sampling.	TSP 2 (Grizzly Lake), and TSP 3 (Cell B LLCF).	Comparison with Canadian Ambient Air Quality Standards.	Exceedance of Canadian Ambient Air Quality Standards.
LAND				
1. Slopes, drainages, surface stability.	Geotechnical Inspections. Permafrost Monitoring.	Waste Rock Storage Area Slopes: Panda/Koala WRSA Misery WRSA Fox WRSA Pigeon WRSA Sable WRSA WRSA Permafrost Monitoring Locations: Panda/Koala WRSA Misery WRSA Fox WRSA Pigeon WRSA Sable WRSA	Check for slope stability (e.g., erosion, subsidence, slope failures, surface stability), Comparison with baseline and monitoring for change over time.	Instability of side slopes, Increasing temperature trend.
2. Percent vegetation cover.	Inspections and monitoring of transects at reference and reclamation sites.	Topsoil and lake sediment/glacial till storage sites. Reference sites.	Identify plant types, and cover percentage. Record temporal and special cover growth/decline.	Increasing trend toward loss of vegetation cover.
3. Surface stability at quarry sites.	Surface inspections.	Airstrip Esker.	Changes in surface stability, thermokarst erosion, unstable channel banks.	Erosion of fines into streams and lakes.
WATER				
1. Field: pH, Conductivity & Flow. Lab: ICP Dissolved Metals, Nutrients, major ions, general water quality indicators.	Waste Rock Seepage Monitoring Program (WROSMP).	Seepage locations to be determined for Closure Monitoring.	Comparison with agreed criteria and monitoring for change over time.	Degradation of seepage water quality, significant pH change, volume of flow increases measurably.
WILDLIFE				
1. Wildlife movement and safety.	Wildlife Effects Monitoring Program (WEMP)	WRSA (access ramps).	Evidence and frequency of use of WRSA.	Negative effects compared to conditions identified during 1995 EIS.

(continued)

Table 5.1-6e. Closure Monitoring and Performance – Waste Rock Storage Areas (completed)

Indicator(s)	Method(s)	Location	Evaluation	Response Thresholds
HEALTH & SAFETY				
1. Safe working procedures/practices	Safety meetings, OH&S, HSEC Risk Registry upkeep and reporting. Compliance with Mine Health and Safety Act and Regulations.	EKATI Minesite.	Safety evaluation conducted during safety meetings (PASS), incident investigations (ICAMs), Mines Inspections and reporting.	Identification of unsafe working conditions, injury or fatality to people/person at the minesite.
COMMUNITY				
1. Incorporation of TK into closure.	Annual site tours and visits to the Communities. Annual BHP Billiton HSEC audit	EKATI Minesite and communities.	Effects on caribou, discussions on monitoring results, continued opportunities and effectiveness of TK, have targets been met, HSEC audits to ensure compliance with Sustainable Development Policy.	Audit failure against agreed action at start of closure.
OPERATIONS				
1. Operations, Procedures, and Reporting.	Annual Reports, Audits.	NWT and Corporate.	Maintenance of compliance, certification (e.g., ISO 14001), and audit scoring.	Non-compliance, loss of certification, audit failure.

Table 5.1-6f. Closure Monitoring Frequency – Waste Rock Storage Areas

Monitoring Program	Closure Monitoring Period Years									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Geotechnical Inspections (Land)	A	A	A	A	A	A	A	A	A	A
Geotechnical Inspections (Permafrost)	BA	BA	BA	BA	BA	BA	BA	BA	BA	BA
Vegetation Sampling & Inspection (Land)	A	A	A	A	A	A	A	A	A	A
WROSMP (Water)	BA	BA	BA	BA	BA	BA	BA	BA	BA	BA
Health & Safety	C	C	C	C	C	C	C	C	C	C
Traditional Knowledge Monitoring (Community)	A	A	A	A	A	A	A	A	A	A
Operations	C	C	C	C	C	C	C	C	C	C

BA = Bi-Annual.
A = Annual.
C = Continuous.

Table 5.1-6g. Closure Monitoring and Performance – Processed Kimberlite Containment Areas (Phase 1 and LLCF)

Indicator(s)	Method(s)	Location	Evaluation	Response Thresholds
AIR				
1. Fugitive Dust	Total suspended particulate sampling	TSP 2 (Grizzly Lake), and TSP 3 (Cell B LLCF)	Comparison with Canadian Ambient Air Quality Standards.	Exceedance of Canadian Ambient Air Quality Standards.
LAND				
1. Slope/surface stability	Geotechnical Inspections	Channel banks, dike weirs, Outlet Dam channel, at LLCF. Phase 1 Channel banks (if required).	Check for slope stability (e.g., Signs of significant erosion, subsidence, slope failures, surface instability)	Evidence of significant channel movement and or potential inter-bench failure, or channel bank slumping which has the potential to dam stream flow.
2. Percent vegetation cover	Inspections and monitoring of transects at reference and reclamation sites	Channel banks. Reference sites.	Identify plant types, and cover percentage. Record temporal and spatial cover growth/decline.	Increasing trend toward loss of vegetation cover.
WATER				
1. Stream flow	Aquatic Effects Monitoring Program (AEMP)	Outflow stream from LLCF at Outlet Dam Channel.	Measurement of stream flow, consistent or intermittent.	Prolonged period of no flow between Cell E and Leslie Lake.
2. Field: pH, Conductivity & Flow. Lab: Metals, Nutrients & general water quality indicators.	Surveillance Network Program (SNP) Aquatic Effects Monitoring Program (AEMP)	AEMP Closure Location – Leslie Lake and Slipper Lake and Stream. SNP Locations – to be determined.	Comparison with baseline and monitoring for change over time. Water quality at Outlet Dam Channel meets water licence criteria.	Increasing trends towards exceedance of water quality criteria.
WILDLIFE				
1. Wildlife habitat, movement, safety, abundance, mortalities, incidents, breeding, distribution, density, diversity.	Wildlife Effects Monitoring Program (WEM)	Current Study Area	Changes in habitat availability, biophysical environment, interaction with traffic, success of deterrent efforts, number of mortalities and incidents, caribou abundance, distribution, interaction and behaviour, grizzly bear habitat use, wolf breeding success, wolverine population and distribution, density and diversity of breeding birds, falcon nesting and re-productivity.	Negative effects compared to conditions identified during 1995 EIS.

(continued)

Table 5.1-6g. Closure Monitoring and Performance – Processed Kimberlite Containment Areas (Phase 1 and LLCF) (completed)

Indicator(s)	Method(s)	Location	Evaluation	Response Thresholds
HEALTH & SAFETY				
1. Safe working procedures/practices.	Safety meetings, OH&S, HSEC Risk Registry upkeep and reporting. Compliance with Mine Health and Safety Act and Regulations	EKATI Minesite	Safety evaluation conducted during safety meetings (PASS), incident investigations (ICAMs), Mines inspections and reporting.	Identification of unsafe working conditions, injury or fatality to people/person at the minesite.
COMMUNITY				
1. Incorporation of TK into closure.	Annual site tours and visits to the Communities. Annual BHP Billiton HSEC audit.	EKATI minesite and communities.	Effects on caribou and other VECs, discussions on monitoring results, continued opportunities and effectiveness of TK, Have targets been met, HSEC audit to ensure compliance with Sustainable Development Policy.	Audit failure against agreed action at start of closure.
2. Archaeological sites.	Record of archaeological sites kept and monitored during reclamation activities (e.g., Quarrying of esker materials) to ensure sites are not disturbed.	EKATI Claim Block	Monitoring of reclamation activities against identified sites.	Disturbance of Archaeological site/s.
OPERATIONS				
1. Operations, Procedures, and Reporting.	Annual Reports, Audits.	NWT and Corporate	Maintenance of compliance, certification (e.g., ISO 14001), and audit scoring.	Non-compliance, loss of certification, audit failure.

Table 5.1-6h. Closure Monitoring Frequency - Processed Kimberlite Containment Areas (Phase 1 and LLCF)

Monitoring Program	Closure Monitoring Period Years									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Geotechnical Inspections (Land)	A	A	A	A	A	A	A	A	A	A
Vegetation Sampling and Inspection (Land)	A	A	A	A	A	A	A	A	A	A
SNP (Water)	BA	BA	BA	BA	BA	A	A	A	A	A
AEMP (Water)	BA	BA	BA	BA	BA	A	A	A	A	A
Health & Safety	C	C	C	C	C	C	C	C	C	C
Traditional Knowledge Monitoring (Community)	A	A	A	A	A	A	A	A	A	A
Archaeological Sites (Community)	C	C	C	C	C	C	C	C	C	C
Operations	C	C	C	C	C	C	C	C	C	C

BA = Bi-Annual.
A = Annual.
C = Continuous.

Table 5.1-6i. Closure Monitoring and Performance - Dams, Dikes and Channels

Indicator(s)	Method(s)	Location	Evaluation	Response Thresholds
AIR				
1. Fugitive Dust	Total suspended particulate sampling	TSP 2 (Grizzly Lake), and TSP 3 (Cell B LLCF)	Comparison with Canadian Ambient Air Quality Standards.	Exceedance of Canadian Ambient Air Quality Standards.
LAND				
1. Slopes, drainages, surface stability.	Geotechnical Inspections.	All dams, dikes and diversion channels (etc., PKCA dikes, dams and channels).	Check for slope stability (e.g., erosion, subsidence, slope failures, surface stability, collapse).	Evidence of instability and movement/failure.
2. Percent vegetation cover.	Inspections and monitoring of transects at reference and reclamation sites	Channel banks. Reference sites.	Identify plant types, and cover percentage. Record temporal and spatial cover growth/ decline.	Increasing trend toward loss of vegetation cover.
WATER				
1. Stream flow	Aquatic Effects Monitoring Program	Outflow from Cell E, and from Phase 1 (if required)	Comparison with baseline and monitoring change over time.	Evidence of negative trend from baseline conditions.

(continued)

Table 5.1-6i. Closure Monitoring and Performance – Dams, Dikes and Channels (continued)

Indicator(s)	Method(s)	Location	Evaluation	Response Thresholds
2. Field: pH, Conductivity and Flow. Lab: Metals, Nutrients and general water quality indicators.	Surveillance Network Program (SNP) Aquatic Effects Monitoring Program (AEMP)	SNP Locations – to be determined.	Comparison with baseline and monitoring for change over time. Water quality criteria have been met.	Increasing trends towards exceedance of water quality criteria.
WILDLIFE				
1. Wildlife habitat, movement, safety, abundance, mortalities, incidents, breeding, distribution, density, diversity.	Wildlife Effects Monitoring Program (WEMP)	Current Study Area	Changes in habitat availability, biophysical environment, interaction with traffic, success of deterrent efforts, number of mortalities and incidents, caribou abundance, distribution, interaction and behaviour, grizzly bear habitat use, wolf breeding success, wolverine population and distribution, density and diversity of breeding birds, falcon nesting and re-productivity.	Negative effects compared to conditions identified during 1995 EIS.
2. Stream flow, water temperature, fish movement, grayling fry density, habitat complexity and nutrient inputs.	Panda Diversion Channel Monitoring Program	Panda Diversion Channel	Increase in fish habitat use in, and fish passage through the channel. Evaluation program over 10 years (1999- 2008) as part of BHPB fish habitat compensation.	Loss of fish habitat and decline in fish numbers recorded in the channel.
HEALTH & SAFETY				
1. Safe working procedures/ practices.	Safety meetings, OH&S, HSEC Risk Registry upkeep and reporting. Compliance with Mine Health and Safety Act and Regulations.	EKATI Minesite	Safety evaluation conducted during safety meetings, incident investigations (ICAMs), Mines Inspections and reporting.	Identification of unsafe working conditions, injury or fatality to people/person at the minesite.
COMMUNITY				
1. Incorporation of TK into closure.	Annual site tours and visits to the Communities. Annual BHP Billiton HSEC audit.	EKATI minesite and communities.	Effects on caribou and other VECs, discussions on monitoring results, continued opportunities and effectiveness of TK, have targets been met, HSEC audit to ensure compliance with Sustainable Development Policy.	Audit failure against agreed action at start of closure.

(continued)

Table 5.1-6i. Closure Monitoring and Performance – Dams, Dikes and Channels (completed)

Indicator(s)	Method(s)	Location	Evaluation	Response Thresholds
2. Archaeological sites.	Record of archaeological sites kept and monitored during reclamation activities (e.g., Quarrying of esker materials) to ensure sites are not disturbed.	EKATI Claim Block	Monitoring of reclamation activities against identified sites.	Disturbance of Archaeological site/s.
OPERATIONS				
1. Operations, Procedures, and Reporting.	Annual Reports, Audits.	NWT and Corporate.	Maintenance of compliance, certification (e.g., ISO 14001), and audit scoring.	Non-compliance, loss of certification, audit failure.

Table 5.1-6j. Closure Monitoring Frequency – Dams, Dikes and Channels

Monitoring Program	Closure Monitoring Period Years									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Geotechnical Inspections (Land)	A	A	A	A	A	A	A	A	A	A
Vegetation Sampling and Inspection (Land)	A	A	A	A	A	A	A	A	A	A
SNP (Water)	BA	BA	BA	BA	BA	A	A	A	A	A
AEMP (Water)	BA	BA	BA	BA	BA	A	A	A	A	A
Health & Safety	C	C	C	C	C	C	C	C	C	C
Traditional Knowledge Monitoring (Community)	A	A	A	A	A	A	A	A	A	A
Archaeological Sites (Community)	C	C	C	C	C	C	C	C	C	C
Operations	C	C	C	C	C	C	C	C	C	C

BA = Bi-Annual.
A = Annual.
C = Continuous.

Table 5.1-6k. Closure Monitoring and Performance – Buildings and Infrastructure

Indicator(s)	Method(s)	Location	Evaluation	Response Thresholds
AIR				
1. Fugitive Dust	Total suspended particulate sampling.	TSP 2 (Grizzly Lake), and TSP 3 (Cell B LLCF).	Comparison with Canadian Ambient Air Quality Standards.	Exceedance of Canadian Ambient Air Quality Standards.
LAND				
1. Surface stability at camp pads/laydown pads.	Surface inspections.	All camp pads, laydown pads, ore storage pads, building pads. Identified roads.	Erosion control, indication of slumping.	Erosion of fines into adjacent water bodies, ground failure.
2. Surface stability at quarry sites.	Surface inspections.	Airstrip Esker.	Changes in surface stability, thermokarst erosion, unstable channel banks.	Erosion of fines into streams and lakes.
3. Percent vegetation cover.	Inspections and monitoring of transects at reference and reclamation sites.	Camp pads, ore storage pads, laydown pads, roads.	Identify plant types, and cover percentage. Record temporal and special cover growth/ decline.	Increasing trend toward loss of vegetation cover.
WATER				
1 Field: pH, Conductivity and Flow. Lab: ICP Dissolved Metals, Nutrients, major ions, general water quality indicators.	Ore Storage Pad Seepage Monitoring	Seepage locations to be determined for Closure Monitoring.	Comparison with agreed criteria and monitoring for change over time.	Degradation of seepage water quality, significant pH change, volume of flow increases measurably.
WILDLIFE				
1. Wildlife movement and safety.	Wildlife Effects Monitoring Program (WEMP)	Current Study Area	Changes in habitat availability, biophysical environment, interaction with traffic, success of deterrent efforts, number of mortalities and incidents, caribou abundance, distribution, interaction and behaviour, grizzly bear habitat use, wolf breeding success, wolverine population and distribution, density and diversity of breeding birds, falcon nesting and re-productivity.	Negative effects compared to conditions identified during 1995 EIS.

(continued)

Table 5.1-6k. Closure Monitoring and Performance – Buildings and Infrastructure (completed)

Indicator(s)	Method(s)	Location	Evaluation	Response Thresholds
HEALTH & SAFETY				
1. Safe working procedures/practices.	Safety meetings, OH&S, HSEC Risk Registry upkeep and reporting. Compliance with Mine Health and Safety Act and Regulations.	EKATI Minesite.	Safety evaluation conducted during safety meetings (PASS), incident investigations (ICAMs). Mines Inspections and reporting.	Identification of unsafe working conditions, injury or fatality to people/person at the minesite.
COMMUNITY				
1. Incorporation of TK into closure	Annual site tours and visits to the Communities. Annual BHP Billiton HSEC audit	EKATI Minesite and communities.	Effects on caribou, discussions on monitoring results, continued opportunities and effectiveness of TK, have targets been met, HSEC audits to ensure compliance with Sustainable Development Policy.	Audit failure against agreed action at start of closure.
2. Archaeological sites	Record of archaeological sites kept and monitored during reclamation activities (e.g., Quarrying of esker materials) to ensure sites are not disturbed.	EKATI Claim Block	Monitoring of reclamation activities against identified sites.	Disturbance of Archaeological site/s.
OPERATIONS				
1. Operations, Procedures, and Reporting.	Annual Reports, Audits.	NWT and Corporate.	Maintenance of compliance, certification (e.g., ISO 14001), and audit scoring.	Non-compliance, loss of certification, audit failure.

Table 5.1-6l. Closure Monitoring Frequency – Buildings and Infrastructure

Monitoring Program	Closure Monitoring Period Years									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Geotechnical Inspections (Land)	A	A	A	A	A	A	A	A	A	A
Vegetation Sampling and Inspection (Land)	A	A	A	A	A	A	A	A	A	A
Seepage Monitoring	BA	BA	BA	BA	BA					
Health & Safety	C	C	C	C	C	C	C	C	C	C
Traditional Knowledge Monitoring (Community)	A	A	A	A	A	A	A	A	A	A
Archaeological Sites (Community)	C	C	C	C	C	C	C	C	C	C
Operations	C	C	C	C	C	C	C	C	C	C

BA = Bi-Annual.
A = Annual.
C = Continuous.

Table 5.1-6m. Closure Monitoring Frequency – Site Wide Monitoring Programs

Monitoring Program	Closure Monitoring Period - Years & Frequency 2020 to 2030
AQMP (Air)	(i) High Volume Air Sampling – Every 6 weeks during open water season. (ii) Continuous Air Monitoring – Weekly. (iii) Snow Core Sampling – Every 3 years. (iv) Lichen Sampling – Every 3 years.
WEMP (Wildlife)	(i) Caribou Survey – Weekly during open water season. (ii) Landfill Survey - Daily during decommissioning. (iii) Grizzly Bear, Wolf and Wolverine Surveys – Annual. (iv) Upland Breeding Birds – Annual. (v) Falcons – Annual.

Table 5.1-6n. QA/QC for Reclamation Monitoring

Monitoring Program	Program Components	QA/QC	General Protocols
General	Environment Operations Monitoring Programs	QA/QC Plan	Prepared in accordance with Class A Water Licences. Annual updates. Includes sample handling and data management for the following sampling procedures: water quality, limnology, benthic invertebrates, sediment, zooplankton, fish laboratory analysis and data reporting.
	External Laboratory Analysis	QMS	ALS Laboratory Group Uses Quality Management System (QMS) national standards. External Requirements include periodic audits and assessments, ISO/IEC 17025:2005. Tasks: Training and qualifications, sample management, test procedures, holding times, storage, contamination control, setting detection limits, blanks management, data and record management (*e.g.*, sample history).
AIR	High Volume Air Sampling	SOP	Preparation: Identification of operational hazards, tools required, training / knowledge and licences required. Tasks: Equipment preparation, sampling procedure, laboratory procedures, calculation and data entry, calibration procedures, and documents and records management.
	Continuous Air Monitoring	Preliminary Stage	Tasks: weekly data and equipment checks by Environment staff; quarterly calibrations of equipment. Annual review and reporting.
	Snow Core Sampling	SOP	Preparation: Identification of operational hazards, tools required, training / knowledge and licences required. Tasks: Equipment preparation, sampling locations, sampling preparation and procedure, data recording, laboratory sample preparation, shipping procedures, and documents and records management.

(continued)

Table 5.1-6n. QA/QC for Reclamation Monitoring (completed)

Monitoring Program	Program Components	QA/QC	General Protocols
	Lichen Sampling	SOP	Preparation: Site selection, plot establishment, operational hazards, tools required. Tasks: Collection and processing of lichen tissue, post field storage, preparation and analysis of samples, data analysis and interpretation, replicate samples.
LAND	Seed Collection and Processing	SOP	Preparation: Identification of field hazards, tools required. Tasks: timing of seed collection, where to collect seed, collection methods, drying, cleaning and storage of seed, documents and records management.
	Vegetation Monitoring	SOP	Still to be developed for reclamation sites.
	Geotechnical Inspections	Annual Inspection	Preparation: Identification of field / operation hazards, tools required. Inspections completed by Professional Engineer. Tasks: Annual (July) inspection of LLCF, Phase 1, collection ponds, and KPSF and report submitted to WLWB as required under the water licence. Inspection includes observations for physical distress, settlement, cracking, seepage, erosion, permafrost thaw.
WATER	SNP	SOP	Preparation: Identification of operational hazards, the tools required, training and knowledge and licences required. Tasks: Sampling schedule, analytical requirements, instrument calibration, bottle selection and labelling, sampling, sample preservation, sample record database and chain of custody, shipping samples, sample shipment confirmation, and documents and records management.
	AEMP	Various SOPs	(i) In-house (EKATI) laboratory analysis SOPs for: pH, turbidity, dissolved oxygen, TSS, stream flow. All SOPs. (ii) ALS Laboratory QA/QC Protocols. (iii) Rescan Environmental Services Data Management and Report Protocols.
WILDLIFE	WEMP	Various SOPs for Field Work	Grizzly Bear Monitoring, Nest Monitoring, Caribou Snow Track Monitoring, Caribou Aerial Surveys. All SOPs. Preparation: hazard identification, tools. Tasks: Annual training, survey frequency, data collection procedures, data entry, data management and recording.
HEALTH and SAFETY	General	HSEC, ISO14001.	HSEC: Significant incidents, monthly and six-monthly reporting. HSEC annual company targets.
COMMUNITY	Archaeology	Permits	Class 1 or 2 Work Permit required. Compliance with NWT Archaeological Sites Regulations, and Mackenzie Valley Land Use Regulations.

5. ADAPTIVE MANAGEMENT

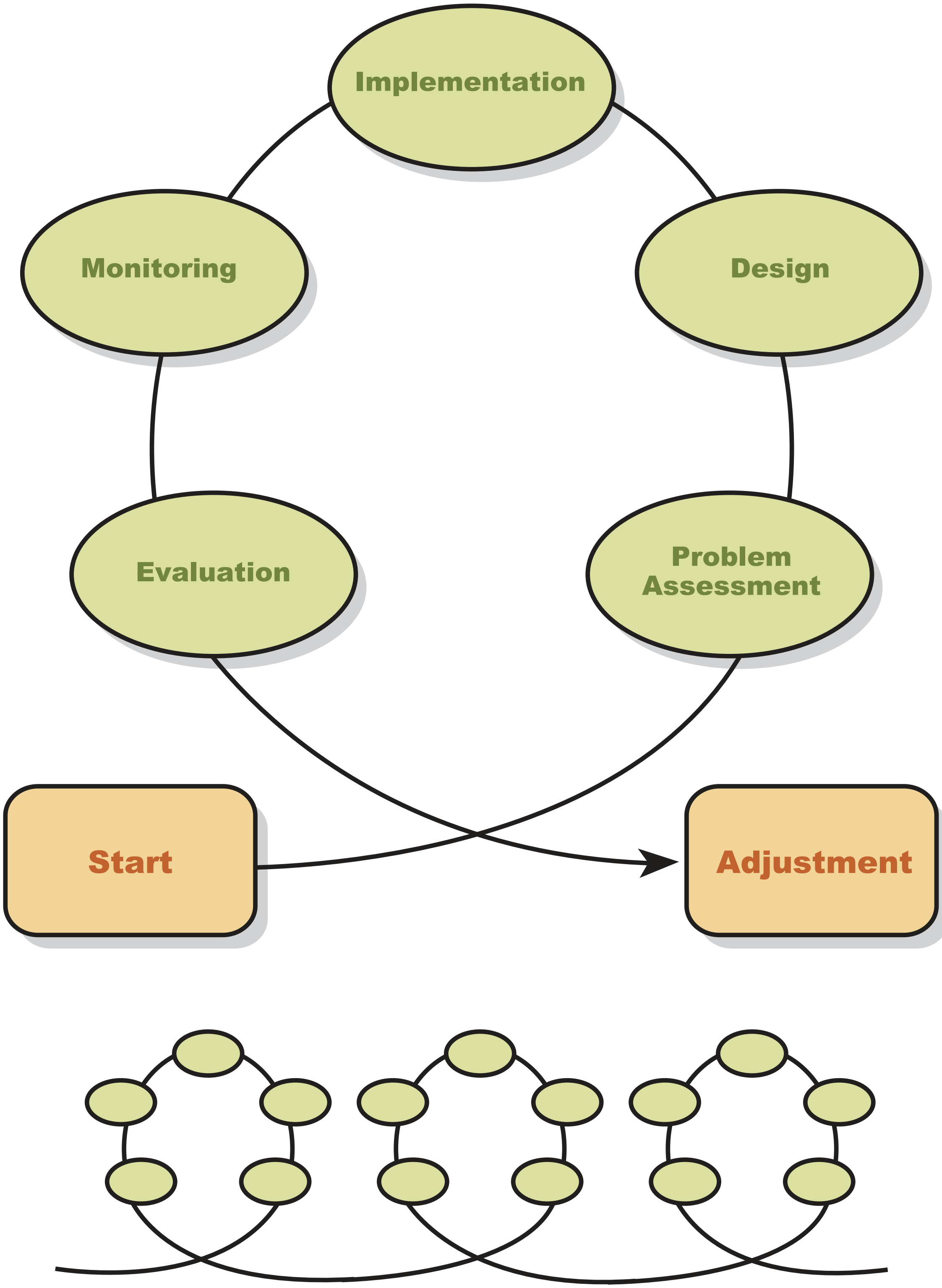
BHP Billiton has applied the principles of adaptive management at EKATI since mine development began in 1997. Through adaptive management, new technologies and practices have been implemented to protect the environment in areas influenced by mine activities. This approach will continue through the reclamation of mine components. An adaptive management plan will be in place during reclamation as a tool to evaluate results from the monitoring program and assist in the decision making and potential adjustments to the reclamation activity, closure criteria, or monitoring program to ensure that closure objectives are achieved. Response thresholds have been included in the Closure Monitoring to identify trends when closure criteria will be exceeded, and the potential for closure objectives not being met. The refinement of the Adaptive Management Plan for post closure will continue with future updates of the ICRP, with input from the EKATI Diamond Mine Watershed Adaptive Management Plan (BHP Billiton 2007) currently under review by the WLWB. The conceptual outline of the adaptive management cycle of continual improvement and adjustment that will be central to ensure closure objectives is presented in Figure 5.1-6a. The steps that will be used in adaptive management are:

- problem assessment;
- design;
- implementation;
- monitoring;
- evaluation; and
- adjustment.

The first step in the cycle is to assess the problem and to generate testable hypotheses or management practices. Management practices are designed based on the hypotheses and implemented if possible. A monitoring program is required to determine the effectiveness of the management actions. The results of the monitoring are evaluated to determine whether the predicted outcomes were accurate, and to gain knowledge about how activities could improve the outcome of management actions. From the knowledge gained, adjustments to the management practices are initiated to improve the overall performance of the system. These steps are repeated as the project progresses.

6. MONITORING PERIODS

Monitoring periods (of 5 and 10 years) are selected based on reasonable and currently used time periods that are sufficient in duration to detect any trends or changes in monitoring parameters, and to provide clear indication toward achieving closure objectives. The timeframe for monitoring specific mine area components will vary depending on the point in time when the closure activity is completed. For example not all of the annual monitoring will begin during the same year, for the majority it will begin in individual mine components when the reclamation activities are complete. In the case of pit lakes water quality, monitoring will coincide with completion of flooding and initial verification of acceptable water quality. Monitoring periods for mine site components have been included in Tables 5.1-6b, 5.1-6d, 5.1-6f, 5.1-6h, 5.1-6j, and 5.1-6l. The period of monitoring may also be modified by duration (reduced or extended) dependent on reflected trends and results.



Source: Adapted from Margoluis & Salafsky (1998) and Nyberg (1999).

Figure 5.1-6a

The Adaptive Management Cycle

7. REPORTING

During closure operations the monitoring plan will be reviewed and updated through performance assessment. A Performance Assessment report will be completed every five years after the closure of individual mine components up until the end of operations. Starting in 2020, at the conclusion of mining operations, and every five years thereafter, a comprehensive performance assessment will review, update and report on closure criteria for all mine components, any ongoing residual and/or environmental risks, the monitoring plan, and financial security estimates.