

# Processed Kimberlite and Wastewater Management

## Highlights:

- 🕒 A BHP Billiton (BHPB) study shows that pore water quality is a good reflection of the long-term water quality likely to be found in the Long Lake Containment Facility (LLCF); and
- 🕒 Extra-fine processed kimberlite (EFPK) and kimberlite weathering pose significant operational and long-term challenges.

## Activities in 2007-08

BHPB continues to investigate the *geochemistry* and physical behaviour of *processed kimberlite tailings* material and effluent in the LLCF. An important contribution in 2007 was the production of two reports dealing with water quality characteristics and predictive modeling on LLCF discharge water, discussed in the Aquatic Effects Monitoring Program (AEMP) section of this report.

Another contribution was the completion of a study called the 'Quality of Pore Water Extracted from *Processed*

*Kimberlite Beach* in cell B of the LLCF' in May 2007. Samples of *tailings* solids, underwater sediments and pore water were collected and analyzed. The major conclusion from this study was that pore water concentrations of various metals could be regarded as a proxy for long-term water quality emanating from the beached *processed kimberlite* material.

In July 2007, BHPB submitted an updated Wastewater and *Processed Kimberlite* Management Plan (WPKMP). The WPKMP presented new information about the significance of *extra-fine*

*processed kimberlite* (EFPK) in the LLCF. This material comprises approximately 12% by mass, but 35% by volume, of the *processed kimberlite tailings* deposited into the LLCF. This material "behaves essentially like a heavy liquid 'flowing' to fill the pond zone." Depths of 13 m or more have been measured, and the solids content of the slurry can vary from less than 5% by weight near the surface to about 45% at the low end of the zone.

Flocculants added during processing to clarify the water in the plant induce settling of the EFPK in the pond, but thwart consolidation of the particles once on the bottom. The flocculation forms large particles, which are in grain-to-grain contact somewhat like a "house of cards", with lots of void space. The effect caused by flocculation consumes more of the available storage volume in the LLCF.

*Processed kimberlite tailings* weather when exposed to air, and break down into finer particle sizes over time. This has two implications for revegetation—first, moisture retention capacity on *tailings* beaches is increased; and second, reduced resistance of establishing plants to wind and water erosion. Beached *tailings* are also highly susceptible to erosion by water, and where water from side drainages flows across the surface, erosion is "rapid and progressive". This results in re-suspension of the *tailings* and sediment plumes in the downstream facility.

The WPKMP clarified the considerable constraints for construction within the LLCF, and observed that extending

jetties into the lower zones of the fine *processed kimberlite* (FPK) beaches to better distribute *tailings* is unlikely to be attainable. "Increasing fines, low effective shear strengths, entrained ice, and thaw effects, results in poor trafficability on the lower parts of FPK beaches further from the spigots. The loose, high moisture FPK may liquefy when subjected to cyclic or vibrating loads, thereby limiting the extent of the beach that may be safely accessed during the summer construction months." Jetties required to both support and provide reliable access to FPK delivery lines placed over the beaches are "difficult and dangerous to construct over the lower beach zones".

By approximately November 2007 all regular discharge of *processed kimberlite tailings* to cell C stopped in favour of being re-routed to cells A and B on a 4-month rotational basis. The WPKMP notes that discharges to cell C will be minimized to retain the maximum capacity there for the storage of EFPK. Cell C pond will be filled to its maximum EFPK containment by 2014. After that, most of the EFPK will flow into cell D. The WPKMP indicates that by about 2016 the upper cells A, B, and C will be unable to accept any more *processed kimberlite tailings* discharge, and the discharge pipe will be relocated to cell D for the final four years of production.

The WPKMP notes that an objective for management of the LLCF is to have water in cell E and "on the surface" of cell D remain at water licence discharge quality. Another objective is to avoid or delay



*processed kimberlite tailings* discharge to cell D and the need to construct an East Dam or Spillway Dam. Alternatives for the management of water levels and water quality in cell D are being evaluated.

A seasonal chemocline in cell D is now observed, and its stability is increasing as dissolved constituent concentrations increase below the chemocline. Potential water quality changes as a result of this are being evaluated. A number of contingency measures are described for handling future unacceptable water quality changes.

### Agency's Assessment

There is no doubt that the development of large volumes of unconsolidated and highly mobile EFPK as a component of *processed kimberlite tailings* has presented a vexing operational challenge for BHPB. BHPB has to date spent obvious effort in adapting to the required management changes needed in LLCF to deal with this, and it must be said that *tailings* management has been well conducted. This is well documented in the current WPKMP.

However, the uncertainties of effective operation and closure of the facility are apparently high. The WPKMP notes that future development of LLCF "must anticipate the volume of *extra-fine processed kimberlite* (EFPK) that will report to ponds and provide adequate pond volume in order to ensure deposition. Studies of the long-term consolidation characteristics and investigations of the nature,

behaviour, management and operation requirements for the EFPK are on-going". No further details of the research design of these studies, or the expected timelines for completion are provided.

The WPKMP also identifies a number of operational issues that are still not resolved. Details are generally vague about exactly what research is being undertaken. For example, to deal with the "numerous unknowns currently with the processing of Fox ore", or for the vegetation studies "to review potential environmental risks (metal uptake studies) and to optimize methods and practices". Fox pipe ores are being investigated, and initial results indicate that higher portions of EFPK may result. Different reagents and flocculants may be required. Investigation studies "are at this time not adequately advanced to enable revised design or operation criteria to be established for the LLCF". In other words, more operational changes to the LLCF are still to come.

More importantly, from our point of view the WPKMP is too vague about the closure implications of the LLCF operation. This is especially true for the accumulating EFPK and highly erodible *tailings* beaches. Lack of discussion on closure design is an issue that we stressed in last year's annual report when we criticized BHPB for not presenting sufficient information about closure plans for the *tailings* impoundment. Our view remains that the regulatory approval of all operating facilities should, if the design-for-closure philosophy is

to be meaningfully embraced, contain sufficient information about closure plans to demonstrate that *reclamation* and closure of the facility can be effectively attained. The company's response then was that closure issues would be dealt with in the current Interim Closure and Reclamation Plan (ICRP) and should not form part of an operational plan. Unfortunately, our review of the draft ICRP found it completely silent on the EFPK problem.

The deposition of low density and highly mobile EFPK in the LLCF is an

obvious candidate for some rigorous closure planning. The WPKMP indicates that the approach is to ensure that a water cover above the EFPK will need to be present, but few details are presented about the required thickness to prevent mobilization of the EFPK, and how the water level will be managed. An option that, from our perspective appears to have promise, is pumping the EFPK from the LLCF ponds into an empty open pit as part of closure. We have suggested this option frequently to BHPB. ■



Drill core samples at Ekati.

# Closure and Reclamation

## Highlights:

- ▶ BHP Billiton (BHPB) agreed to a mine component-specific approach for closure objectives, options and criteria;
- ▶ More work is needed on clear and measurable closure criteria;
- ▶ BHPB continues to propose pit lakes without fish or fish passage, even though all other interested parties want fish to be able to use those lakes;
- ▶ There is need for a comprehensive *reclamation* research plan linked to uncertainties that provide details on the research to be undertaken and ensures that it is done to meet critical timelines as set out in the mine plan for the closure of various mine components;
- ▶ Aboriginal organizations need additional capacity and financial support to meaningfully participate in closure planning; and
- ▶ A review of the *reclamation* research to date suggests that *processed kimberlite* should be revegetated as soon as possible due to salt build up on the surface of the Long Lake Containment Facility (LLCF).



View through the Pigeon culvert.

## Activities in 2007-08

Last year's annual report described the current review process for BHPB's revised Interim Closure and Reclamation Plan (ICRP) for Ekati. The last version of the ICRP was approved in 2002. BHPB submitted a revised ICRP in January 2007, and since that time, it has been the subject of a detailed review by a working group established by the Wek'èezhii Land and Water Board (WLWB). The regulators, government agencies, Aboriginal organizations, and the Agency have all been invited to participate in the working group. Three meetings were held during 2007-08 to review the ICRP. These meetings reviewed closure objectives, *reclamation* criteria and specific plans for underground mining, waste rock dumps, open pits, *processed kimberlite tailings* impoundment, dams, dykes, buildings and infrastructure. The review is still continuing as we go to press, and a public hearing on the revised ICRP is anticipated sometime in late 2008 or early 2009.

## Summary of Reclamation Undertaken

As we go to press, BHPB will have just submitted its annual environmental report for 2007. We therefore have little information about the company's past year of *reclamation* work. At the end of 2007, however, we received and reviewed the Revegetation Research Projects 2006 and 2007 report prepared by BHPB's consultant that synthesizes revegetation research at Ekati undertaken

to date. This report, based on 10 years of field studies and observations, should provide a helpful guide to the company in revegetating the Ekati site.

Important information arising from this report is the observed tendency of salt in the *tailings* to migrate upward to the surface of the *tailings* beaches. Concentrations of salt at the *kimberlite* surface could inhibit seed development, and the report recommends immediate revegetation of the *tailings* beaches following cessation of *kimberlite* deposition in that cell. This finding has not been transferred to BHPB's *reclamation* planning schedule as far as we can tell.

The consultant's report also notes that channel scouring in the *tailings* beaches will require special attention and erosion control measures to assist the re-establishment of plants on fragile channel margins. Windblown *kimberlite* tends to accumulate in the channels, thus retarding plant development. Revegetated beaches would presumably reduce this effect.

The report is also not able to conclude that the revegetation experimental plots established in cell B will endure without fertilization or other care and maintenance. Work to resolve this uncertainty should be undertaken on a priority basis. The consultant's report unfortunately does not describe the management implications of the results.





*Tundra vegetation adjacent to the Sable haul road.*

### Agency's Assessment

We are pleased to report that some of the substantive issues we had with the draft ICRP have been fixed, although some others are of serious concern.

Our earlier concern about the lack of component-specific closure objectives has been largely rectified, and the draft ICRP now identifies the closure objectives for each specific part of the mine (e.g., waste rock piles). Our other initial concern

was the absence of clear criteria for determining when the closure objectives had been achieved. Regulators would need to know when a specific mine component was adequately reclaimed, so that they would be able to sign-off on a "successfully reclaimed" designation. Properly defined closure criteria need to be objective, measurable, and have pre-defined tests in the field. These are critical for being able to determine, at

the end of mine life, exactly when BHPB has met its *reclamation* objectives and no longer has a liability at the site. Through the working group process, progress on *reclamation* planning principles has been made, but we are still short of having a full array of meaningful closure criteria in place for this project.

The WLWB working group process has continued to work through the draft ICRP in a very thorough manner, and the

Agency has been generally impressed with this process. Participation by regulators and government agencies in this process has been good, but Aboriginal involvement has suffered significantly from a lack of technical and financial resources for the Aboriginal organizations to engage in what is a very complex technical review. The amount of work now required to conduct due diligence on the environmental and regulatory documentation produced for the Ekati mine (not to mention other diamond mining projects in the region) is substantial, and, because of lack of resources, the Aboriginal organizations are increasingly unable to participate effectively. The working group review process for the ICRP is a special case for consideration. First, closure planning is, arguably, the single most important issue requiring resolution at Ekati for obvious reasons of long-term sustainability. Second, the Aboriginal organizations have been invited to participate by the WLWB in this process because of its significance to nearby communities.

The present arrangement with respect to providing financial resources to the Aboriginal organizations is unworkable, and the federal government needs to re-examine its funding policies in this regard.

The Agency recommends that DIAND increase the amount of resources available to potentially affected Aboriginal organizations to engage in regulatory and review processes, and particularly the closure planning process, for Ekati.

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## Recommendation

*The Department of Indian and Northern Affairs (DIAND) should increase the amount of resources available to potentially affected Aboriginal organizations to engage in regulatory and review processes, in particular the closure planning process for the Ekati Mine.*

### Pit Lake Reclamation

One issue that is still unresolved is BHPB's stated intention to install barriers at the inflow and outflows to the pit lakes to prevent fish movement in and out of the pit lakes. The Agency, and all other members of the working group, take the position that the objective of keeping fish out of the pit lakes is not consistent with the overall *reclamation* goal of creating functional ecosystems. Our position is that BHPB should do as much as possible to restore a viable aquatic ecosystem function within the pit lakes, including their use by fish.

BHPB has presented three reasons for preventing fish use of pit lakes at closure. First, the company says that at the outset of the project it received an authorization from DFO to destroy fish habitat, and that such habitat has been compensated for through a fish habitat compensation program, so that this is no longer a *reclamation* requirement. The Agency's view is that, while the lakes were compensated for through a compensation agreement, the closure goal and objectives address a different

set of environmental imperatives, namely the requirements under the water licences and *Environmental Agreement* for proper closure and *reclamation* of the mine site.

Second, BHPB states that by asking the company to create fish habitat in the pit lakes, DFO is seeking to alter the terms of the compensation agreement. The option to create fish habitat in the pit lakes is not a request from DFO, but a consensus position being advanced by all reviewers interested in achieving the stated *reclamation* goal, including DFO.

Finally, BHPB states that because it has already compensated for fish habitat loss, the creation of fish habitat in the pit lakes "goes beyond BHPB's responsibilities of returning the Ekati Diamond Mine to a viable self-sustaining ecosystem, to a more enhanced ecosystem with more fish habitat than existed originally". It is not clear why BHPB would not want to strive to return as much of the site as possible to a self-sustaining ecosystem—the richer in species diversity and the more extensive the functionality the better. Such a move would be entirely consistent

with the company's sustainability policy and overall industry best practices, and would show that the company is taking its commitment to environmental sustainability seriously.

The Agency and other reviewers continue to push the company toward changing its position on this issue, although BHPB has remained steadfast over the past year. In January, striving for a resolution, the Agency wrote to the WLWB suggesting a ruling may be necessary to ensure creation of fish habitat as a clear objective for pit lake *reclamation*. As we go to press, an agreement-in-principle between BHPB and DFO has been reached to enable fish habitat to be created in the pit lakes. The implications of this agreement are now under review and we will report on it next year.

### Reclamation Research

Two very serious issues are looming with respect to closure planning at Ekati, both relating to uncertainties in how various parts of the mine will be reclaimed.

In January 2008, as a member of the ICRP Working Group, we provided a detailed critique to the WLWB of the deficiencies of BHPB's *reclamation* research plan. Our first concern is about the lack of detail for the proposed research and how research should be linked to uncertainties around closure objectives, options and criteria. Quite simply, the necessary research on how and when these gaps will be filled must be laid out now in a comprehensive research plan leading to clear closure objectives, options and criteria. While BHPB had provided a list of future research topics, it had not provided a



View of Ursula Lake from a helicopter. It could be used as a source of water for pit lake flooding.

sufficient description of how the work would be carried out, methods to be used, data to be collected, descriptions of how the results of the research would inform *reclamation* measures, or what closure objectives or uncertainty was being addressed. We stressed that it is critical that BHPB review the linkages between the needed research tasks and closure activities, and explain how these would be successfully integrated into mine closure. In our letter to the board we included a format for the *reclamation* research plan to provide the company with a clear indication of the types of information required. BHPB subsequently agreed to revise its *reclamation* research chapter in the draft ICRP. Unfortunately, the revised work suffers from many of the same deficiencies characterizing the earlier version. The details about which

ICRP uncertainties the research would deal with, as well as what and how future research would be conducted are still largely missing.

The second critical issue is BHPB's proposed timing of the bulk of its *reclamation* research. It appears very little of the proposed research will be initiated prior to 2013, when the upper cell in the LLCF is no longer being used for *tailings* disposal and becomes potentially available for research activities. BHPB's *reclamation* schedule shows that *reclamation* work will be commenced shortly after this date. It is not clear if there will be adequate time for getting research completed in a way that can effectively help BHPB evaluate and decide on closure methods. We think that the current schedule of activities laid out by BHPB, from research to *reclamation*



View of Koala Pit from a helicopter.

## Recommendation

*BHP Billiton (BHPB) should improve its reclamation research plan to include an explicit description of the link between the research task and the related closure measure, how the research task will be carried out to deal with each of the remaining uncertainties, what data will be collected, how the results will be used to improve the Interim Closure and Reclamation Plan (ICRP) and when the results will be available to amend the ICRP. This recommendation should be targeted especially at the four key issues of concern—pits, Long Lake Containment Facility (LLCF) cover, water quality in the LLCF, and extra-fine processed kimberlite.*

implementation, is unrealistically compressed and difficult to achieve.

The end of mining is scheduled for 2020, and BHPB's corporate policy is to have a final closure plan in place two years before this date. This timeline effectively allows only five years for all remaining *reclamation* research to be completed, assuming a 2013 start date. The Agency is of the view that detailed *reclamation* research plans should now be in place for at least the key closure uncertainties, and the work largely underway and progressing to completion. What is needed in the current draft ICRP is a fully-designed research plan that will deliver, in timely fashion, the necessary information in at least the four big issues of concern—pit lakes, the LLCF cover, water quality in the LLCF impoundment, and *extra-fine*

*processed kimberlite* (EFPK).

A remaining high priority issue has to do with *reclamation* and closure of the LLCF. The draft ICRP does not identify the challenges posed by the substantial volumes of highly erodible and mobile EFPK in the LLCF, despite significant operational problems associated with this material that have necessitated alterations in the operation of the LLCF in the last few years. An array of uncertainties about the long-term behaviour of the EFPK was identified in the 2007 Wastewater and Processed Kimberlite Management Plan (WPKMP), although the ICRP so far remains silent on these issues. The ICRP does identify a series of research tasks related to the construction challenges for reclaiming the water/beach interface zones in

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the *tailings* facility, but no details are provided about what work needs to be done to reduce these uncertainties. BHPB proposes vegetation and/or waste rock covers for the interface zones, but does not explain how these measures can be implemented on such unstable surfaces.

In summary, the lack of progress on *reclamation* research, and the company's apparent intention to delay the required research until near the end of mine life is worrisome. We believe that too much important detail is being left to the "next version" of the ICRP, when it should be integral to this version.

The current water licence was issued on the recognition that a revised ICRP was to be produced at an early date. The licence stipulated the following information be provided, at a minimum:

- An update of *reclamation* research to date;



Examining processed kimberlite at the Long Lake Containment Facility.

- An explanation of how the results may affect closure planning;
- Details of further *reclamation* research that needs to be completed;
- A description of a process that ensures that the *reclamation* measures arising from research results are ecologically appropriate, viable and achievable;
- A description of how the research will incorporate objectives relating to the *reclamation* of wildlife habitat;
- A description of how metal uptake in revegetated plant communities will be monitored;
- A schedule of anticipated annual research expenditures; and
- QA/QC protocols for conducting research and monitoring research progress.

We are of the view that if this important work is delayed for another few years, then the conditions on which the current water licence was issued would not be met.

Our assessment of the current draft of the ICRP is that it does not provide the information stipulated in the water licence. Consequently, a high degree of uncertainty remains about BHPB's ability to effectively reclaim key components of the mine in a way that maximizes opportunities for achieving the overall *reclamation* goal. This could have an impact on the public hearing for the review of the revised ICRP.

In 2006, we recommended an early completion of the north end of cell B in the LLCF in order to allow enough time to carry out the revegetation research

there. This should be done, in our view, to permit the company to determine the sustainability of the vegetation, to determine its ability to revegetate on a large scale and to identify the closure criteria for LLCF revegetation. We believe this component of the *reclamation* research is likely to require many years, and an early start is essential if the revegetation is to be carried out effectively. We repeat the recommendation to complete the deposition of *tailings* in the north end of cell B to enable a timely start on that component of the *reclamation* research plan.

The Agency recommends that BHPB

should improve its *reclamation* research plan to include an explicit description of the link between the research task and the related closure measure, how the research task will be carried out to deal with each of the remaining uncertainties, what data will be collected, how the results will be used to improve the ICRP and when the results will be available to amend the ICRP. This recommendation should be targeted especially at the four key issues of concern—end use of the pits, LLCF cover, water quality in LLCF impoundment, and EFPK. ■



Vegetation growth at the Long Lake Containment Facility.



# Aquatic Effects Monitoring Program

## Highlights:

- BHP Billiton (BHPB) concluded a review of its Aquatic Effects Monitoring Program (AEMP) design and received approval to modify aspects of the 2007 and future monitoring work. BHPB is also required to conduct a number of other studies;
- No significant concerns were identified with the 2006 AEMP results and a detailed analysis of the 2007 AEMP is postponed until next year due to the late delivery of these results; and
- BHPB submitted reports that model water quality in the Long Lake Containment Facility (LLCF) so that predictions on downstream effects can be made.

BHPB's AEMP is a requirement under its water licences and the *Environmental Agreement*. The AEMP is designed to detect any changes that occur in the aquatic ecosystems downstream of the mine to enable effective environmental management.

The AEMP measures physical, chemical and biological features of the local aquatic environment that serve as indicators of change. Where appropriate, follow-up actions are to be taken by BHPB to minimize or correct any adverse effects that have been identified. In addition to monitoring the aquatic environment, BHPB is required to control water effluent quality and volumes at a number of regulated stations specified by its water licence.

There were no values above water licence limits for regulated parameters in 2007.

## Outline of Monitoring

The monitoring frequency for water quality, *hydrology*, *limnology*, lake *benthos*, and stream *benthos* is yearly;

every three years for sediment quality; and every five years for fish communities. BHPB monitors *phytoplankton* and *zooplankton* annually in August.

The year 2007 was the tenth year of post-baseline data collection within the Koala drainage and the seventh year of post-baseline monitoring within the King-Cujo to Lac du Sauvage drainage at the Misery site. Monitoring also occurs in three reference lakes and outflow streams (Figures 1 and 2).

Winter sampling under ice (lakes only) occurs in April when no water is being discharged from the Long Lake Containment Facility (LLCF). Winter dissolved oxygen concentrations are measured monthly except at Kodiak and Cujo lakes, which are measured weekly.

Open water sampling occurs during July, August and September after discharge has resumed. Sampling of streams includes water quality, stream *benthos*, and stream flow.

## Inputs to the Aquatic Receiving Environment

Processed *kimberlite*, treated sewage and *pit water* are discharged into the upper cells (cell A, B and C) of the LLCF. Water released from the LLCF enters the receiving environment of the Koala watershed through Leslie Lake, flowing downstream through Moose Lake, and eventually entering Lac de Gras (see Figure 2).

Water totalling 8,696,000 m<sup>3</sup> was pumped from cell E to Leslie Lake from June to November 2007. Water totalling

137,000 m<sup>3</sup> was discharged into Cujo Lake from King Pond in June and July, and from October to December.

As in previous years, the delivery date of BHPB's 2007 AEMP Summary Report meant that it could not be reviewed in time for inclusion in this Agency annual report. The principle documents available for review were:

- 2006 AEMP Summary Report;
- AEMP Plan for 2007-09;
- LLCF Water Quality Prediction Model Versions 1.0 and 2.0; and
- The *Environmental Agreement* and Water Licences Annual Report 2007.



Inside the Pigeon culvert.



## AQUATIC EFFECTS MONITORING PROGRAM

**Modifications to the AEMP**

In April 2007, the Wek'èezhii Land and Water Board (WLWB) gave conditional approval to BHPB's updated AEMP for 2007-09. The approval was contingent on BHPB fulfilling a number of requirements. In addition, the Board approved some changes to the current sampling program and stipulated a number of studies be undertaken before other requested changes could be implemented. BHPB is also required to submit studies on effects

size so a proper determination can be made on the significance of detected changes, and on the issue of whether multiple samples at the same site should be classified as subsamples or replicates. Most of the Agency's concerns were addressed, although some remain.

There was a request by BHPB to eliminate the July and September lake water samples, and focus solely on conducting sampling in August and taking triplicate samples at that time.

In the view of the Agency and the regulators, this change should not be implemented until further work has been done. The Board acknowledged these concerns in the conditional approval and required BHPB to submit information demonstrating the August-only sampling is superior or at least an equally effective indicator of long-term trends. As of August 2007, sufficient information has not been provided to warrant a change in sampling frequency.

**2007 AEMP**

A number of changes to the AEMP were made in 2007: the addition of triplicate samples in August; the elimination of shallow zone samples for lake *benthos*;

the addition of slimy sculpin (on a trial basis) as an indicator species for fish tissue metal concentrations; and a new statistical analysis, calculation of Minimum Detectable Differences.

In 2007, the primary finding of the AEMP was reported to be that "there are no known negative effects of the mining activities on the aquatic community in the Koala and King-Cujo watersheds". In Appendix J of the *Environmental Agreement* and Water Licences Annual Report 2007, it is reported that the concentrations of a number of water quality parameters were found to have increased significantly in the lakes and streams downstream of the LLCF discharge point (Koala Watershed and Lac

**Figure 1: Mining effects on water quality flowing through the Koala and King – Cujo Watersheds**

	Parameters elevated in Koala watershed Long Lake Containment Facility 					Parameters elevated in King-Cujo watershed King Pond  Lac du Sauvage	
Parameters monitored	Leslie	Moose	Nema	Slipper	Lac de Gras	Cujo	Lac du Sauvage
pH	▲	▲	▲	▲	▲	▲	
Sulphate	▲	▲	▲	▲	▲	▲	
Potassium	▲	▲	▲	▲	▲	▲	
Total Dissolved Solids	▲	▲	▲	▲	▲	▲	
Chloride	▲	▲	▲	▲	▲	▲	
Total Ammonia	▲	▲	▲	▲		▲	
Nitrate	▲	▲	▲				
Arsenic	▲	▲				▲	
Molybdenum	▲	▲	▲	▲	▲	▲	
Nickel	▲	▲	▲	▲		▲	

 Flow from effluent source to ultimate receiving lake in watershed  
 ▲ Levels elevated above baseline.

**2006 AEMP**

The Agency reviewed the 2006 AEMP report and provided comments to the WLWB and BHPB in November 2007. Generally, the AEMP report continues to be of high quality. The graphs of historical trends for all 48 measured water quality variables are a welcome addition. A significant result was that 2006 marked the first time that BHPB's monitoring has shown that its mine effluent has had a negative effect on aquatic biota, primarily the decline of the *cladocera* (zooplankton) population in Moose Lake due to water quality changes. The Agency hopes that BHPB continued to monitor *cladocera* in 2007.

There were a number of comments from the Agency on the 2006 AEMP

results that were provided for BHPB's consideration. These are:

- Elevated sulphate levels in Kodiak Lake and increasing levels downstream of the LLCF may be an issue;
- Molybdenum levels in Leslie and Moose Lakes are approaching Canadian Council of Ministers of the Environment (CCME) guidelines;
- The contribution of barium and antimony to the change in water quality of lakes downstream from the LLCF should be evaluated; and
- Concern exists regarding the *nitrate* levels under ice in winter in Leslie Lake.

de Gras) compared to reference lakes and streams. These parameters include: pH; sulphate; total dissolved solids; chloride; potassium; total *ammonia*; *nitrate*; total arsenic; total molybdenum; and total nickel. The distance downstream that these increases were noted varies from parameter to parameter (see Figure 1).

The chemical composition of water discharged from the LLCF remained below the discharge limits of the water licence. With the exception of *nitrate*, the concentrations of water quality variables discharged from the LLCF were also below the CCME guidelines for the protection of freshwater aquatic life. The *nitrate* CCME guideline is currently in interim form and a final guideline is in preparation by Environment Canada for expected release in 2008.

With one exception (*nitrate*) the same parameters were also found to increase in the King-Cujo Watershed and Lac du Sauvage downstream from the King Pond Settlement Facility (KPSF). The distance downstream that these increases were noted varies from parameter to parameter (see Figure 1).

In the King-Cujo watershed, the chemical composition of water released from the KPSF was reported to be below the discharge limits of the water licence and CCME guidelines.

The summer of 2007 was the first year since 2002 that fish in the AEMP lakes have been sampled. The 2007 *Environmental Agreement* and Water Licence Annual Report states that compared with 2002, the catch-per-unit of effort for trout and whitefish

was lower in Cujo Lake and most AEMP lakes in the Koala watershed as well as reference lakes. This is most likely due to significant sampling mortality in 2002. Also, average size and age of fish species sampled in 2007 increased over 2002 fish, possibly due to low recruitment

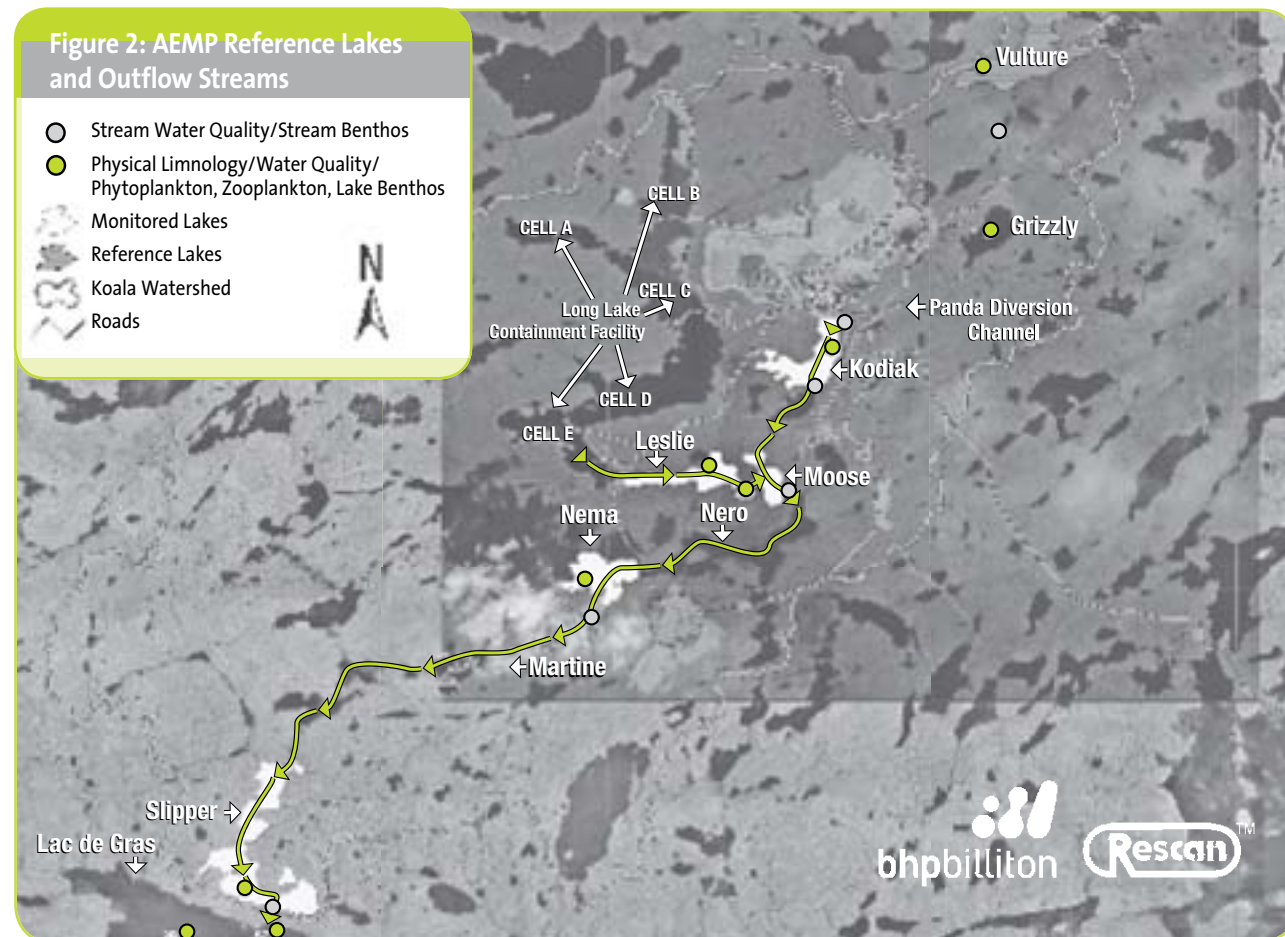
of younger fish caused by fewer adult spawners in the population.

BHPB would like to use slimy sculpins as a surrogate species in future fish monitoring to avoid the problem of sampling-induced changes to fish population structure in these small lakes.

The scientific validity of this proposal is still being assessed.

It is suggested that fish in Leslie Lake may have been subjected to trace amounts of hydrocarbons, but BHPB doubts that the LLCF is the source as there have not

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# LLCF Water Quality Models

In spring 2008, BHPB submitted two long-awaited reports on LLCF Water Quality Prediction Models (Version 1.0 and Version 2.0) to the WLWB.

Version 1.0 contained a description of the model and how it was built, a list of parameters to be addressed, some preliminary predictions based on data available in 2005, and a sensitivity analysis of the model. This report identified two main areas of concern, uncertainties in groundwater flow rates and the associated chloride loadings into the LLCF, and the higher concentrations of metals in the Fox Pit ore and the potential impacts of processing this ore.

For chloride, the model predicts that Tier 1 water quality guidelines (180 mg/L) will be exceeded for about 15 years beginning in September 2008 and peaking in 2020. For metals, cadmium, copper, lead, molybdenum and nickel will be above water licence limits or CCME guidelines for the protection of aquatic life. In all cases, the limits would first be exceeded in 2006 or 2007, peaking in 2014 or 2015, except for cadmium, which would peak in 2010.

The highest magnitude increase above guidelines is projected to be for cadmium. As early as 2010, water quality is projected to reach cadmium concentrations (680 ng/L) that we believe will likely reduce crustacean zooplankton abundance, especially cladocera, and may be harmful to fish in cell E (disrupt kidney function). Cadmium is not currently evaluated in the AEMP and thus there may not be an early warning of this potential biological problem. In cell E, the only licensed variable that is projected to exceed licence limits is nickel.

Version 2.0 provided information on the updates made to Version 1.0

of the model incorporating changes to the mine plan, water management concepts and field data from 2006 and 2007. The prediction of chloride and nitrate concentrations was the focus of the water quality modeling efforts during this period. The chloride concentrations produced by the model closely resembled data from 2005 to 2007. The model was then run as a life-of-mine simulation using the current best estimates of key input parameters. Maximum chloride concentrations were predicted to be between 300 and 370 mg/L in open water and between 405 and 520 mg/L under ice (see Figure 3).

In 2007, nitrate concentrations in cell E, Leslie Lake and Moose Lake rose just above the interim CCME guidelines for protection of freshwater aquatic life (2.93 mg/L). In the LLCF, the model predicts concentrations in the range 5.8 to 6.9 mg/L during open water and 7.9 to 9.9 mg/L during the winter, peaking in 2019. It is anticipated that this situation will need to be re-evaluated in light of any new guidelines that become available.

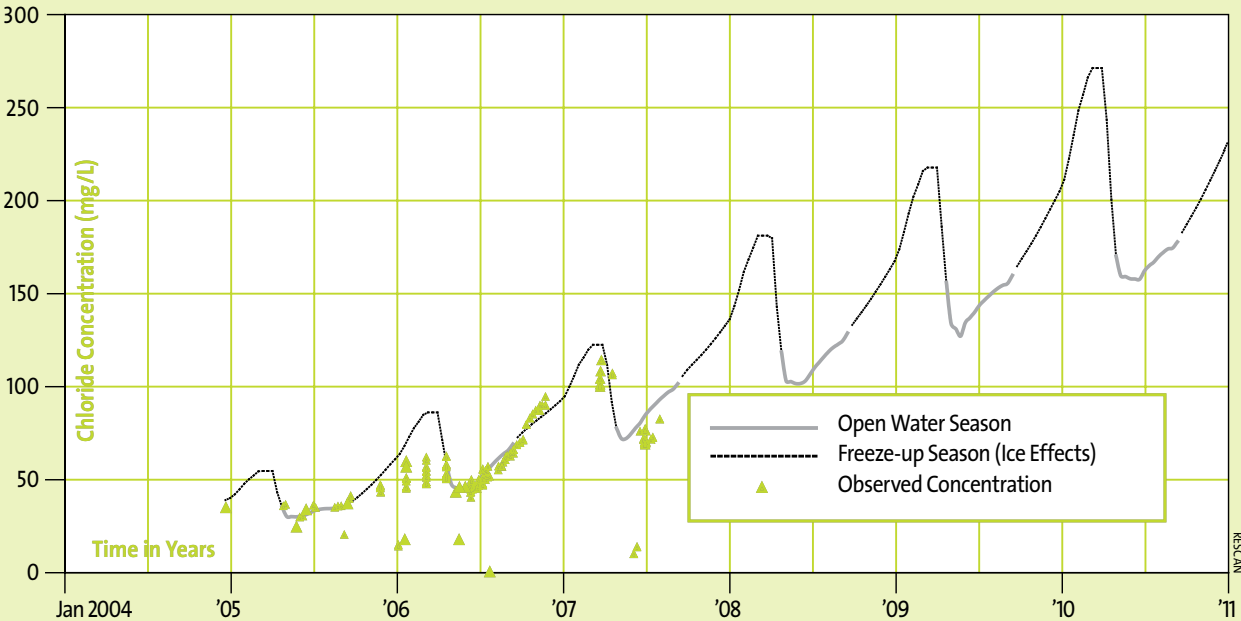
## Agency Assessment

The Agency has some concerns with the approach used in the LLCF Water Quality Prediction Models. Using a mass

balance model has some shortcomings. It can address physical processes but will be less successful in addressing any chemical reactions occurring within the LLCF. While the list of parameters of interest appears reasonably comprehensive, predictions have not been provided for all these parameters. *Extra-fine processed kimberlite (EFPK)* is given only a cursory treatment and efforts need to be made to address this material. On the other hand, moving to a model using monthly time steps to predict seasonal change is a positive development.

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Figure 3. Predicted and Observed Chloride Concentrations in Cell E - Short Term Predictions





## LLCF Water Quality Model *Continued from previous page*

Version 2.0 addressed a number of the shortcomings identified in the earlier version. It used data from January 2006 to September 2007 to confirm predictions made in the earlier model and to refine the model itself. The technical refinements, modifications of key processes and flow pathways, appear to have improved the model. The comparison of observed chloride levels for 2005 to 2007 with the predictions for the period from 2005 to 2011 (Figure 4) made using historical data appear to reflect the physical processes in the LLCF. This, in turn, adds confidence to the accuracy of the long-term prediction for the period from 2005 to 2030 (Figure 4).

Version 2.0 concentrated on chloride and *nitrate* and did not attempt to address the full range of variables considered important in managing the LLCF and its effluent in the long term. We assume that the full range of variables will be addressed in future reports, but making accurate predictions may prove challenging, given the use of a mass balance model.

Predicting *nitrate* concentrations presents a different challenge. Given that the primary source of *nitrate* loads is residues from explosives, it is hard to obtain reliable estimates of *nitrate* loading to the LLCF. To obtain estimates of the *nitrate* loads, the water quality model was used in “reverse mode”, resulting in an estimate of 40 tonnes/yr. Short-term and long-term predictions were compared with observed *nitrate* values for the period from 2005 to 2008. While there is greater variation between observed and predicted values for *nitrate* compared with chloride, the general trends appear to be realistic.

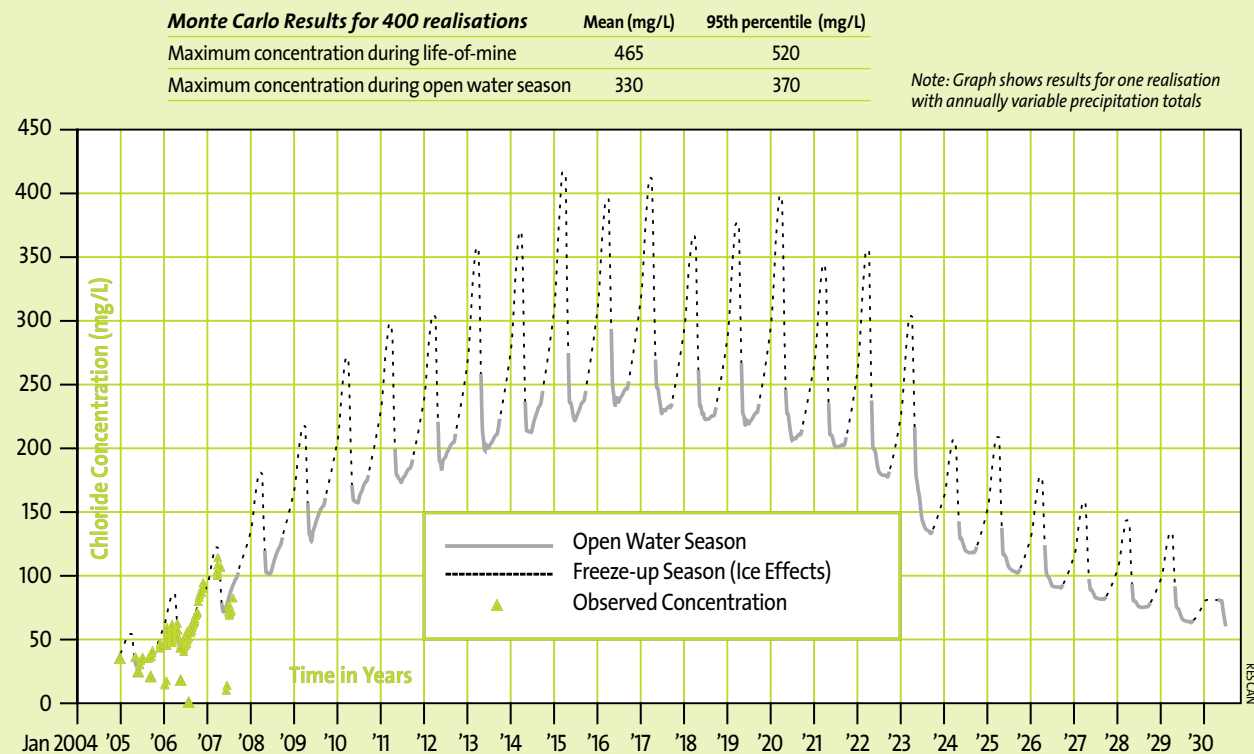
On a positive note, the model appears to have provided some clarity around the trend in increasing molybdenum concentrations noted in recent years. It appears that the source of the molybdenum to the LLCF was the processing of the Misery ore. Given that processing of this ore was completed in the fall 2007, BHPB anticipates that the increasing trend should reverse beginning in 2009.

Future work will need to link the uncertainties identified in the modeling to the Interim Closure and Reclamation Plan (ICRP). Some attention needs to be paid to understanding and predicting chemical interactions occurring within the LLCF and to the implications of large volumes of EFPK.

Finally, the high level of chloride predicted for the LLCF underlines the importance of establishing site-wide

limits for chloride in effluent and/or the receiving environment. Work is progressing toward setting a criterion for chloride in discharge from the Two Rock Sedimentation Pond in the context of the Sable Pigeon Beartooth Expansion Licence renewal. However, this work needs to be expanded to develop a site-wide criterion that is protective of aquatic life.

Figure 4. Predicted and Observed Chloride Concentrations in Cell E - Long Term Predictions



## AQUATIC EFFECTS MONITORING PROGRAM

been any significant hydrocarbon spills in the LLCF. As well, the study showed no evidence of tainting. The Agency will examine this issue more closely in next year's annual report once we have the full 2007 AEMP from the company.

## Other Studies and Activities

A special study to analyze variability in water quality, sediment quality and counts of benthic organisms in two lakes in the Koala Watershed was undertaken. The study was designed to answer four questions:

- How far apart do samples (water and sediment) have to be spaced to be considered independent replicates?
- Do errors in categorizing multiple same-site samples as replicates or subsamples bias the data analysis?
- What proportion of total variation is sampling variation or process variation?
- Will altering the AEMP sampling protocol to increase distance between sampling stations improve the precision of the AEMP?

Moose Lake and Slipper Lake were chosen for the studies. The conclusions reached in the report were:

## Adaptive Management

## Background on Adaptive Management

BHPB states that it is committed to and that it has been using the principle of adaptive environmental management in managing environmental effects at Ekati. This approach can be effective at dealing with surprise events and uncertainty in predicting impacts. The major purpose of the Watershed Adaptive Management Plan (WAMP) should be to reassure the WLWB, Aboriginal communities and affected peoples that the actual effects on the Koala and King-Cujo watersheds are being determined and that they are being appropriately managed. This will generally be done by monitoring the project effects, evaluating what the monitoring data show, and adapting the environmental management strategies to incorporate what we learn. The AEMP is responsible for the monitoring

and evaluation and so is an essential component of the Ekati WAMP.

In adjusting predictive models and management actions as development proceeds, the objectives should be periodically reviewed as more is learned about how the aquatic system works, to ensure they still reflect overall goals and values of Aboriginal communities and regulators. The Adaptive Management Plan should indicate clearly how this is all to be done. The manner in which this should take place is illustrated conceptually in Figure 5, taken from Nyberg, B. 1999. An Introductory Guide to Adaptive Management for Project Leaders and Participants. BC Ministry of Forests, Victoria, BC. January 1999.

It should be noted that in adaptive environmental management one does not wish to monitor everything, only those things that affect Valued

Ecosystem Components (VEC) that respond to management action, and about which there is a knowledge gap or sufficient uncertainty that could lead to identifying important impacts.

In evaluating results and adjusting mine management, there is great value in regular collaborative reviews, such as the annual Ekati environmental monitoring workshops. The purpose is to improve adaptive management to better respond to observed or potential environmental changes and to focus on residual uncertainties.

## BHPB's Watershed Adaptive Management Plan

As a requirement of the water licence, BHPB submitted a WAMP for the watersheds affected by the mine to the WLWB in November 2007. There are several key documents referenced in the WAMP, including a risk assessment for molybdenum that the Agency expects to analyze to review the WAMP.

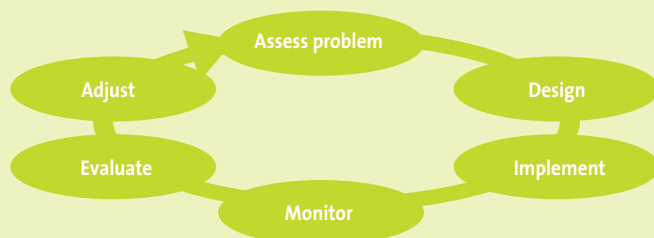
The WAMP proposes numerical thresholds for contaminants of concern identified in the water licence (total arsenic, cadmium, chromium, copper, lead, molybdenum, phosphorus, zinc, chloride, nitrite and *nitrate*, total dissolved solids, total suspended solids, turbidity, Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX) and for two additional parameters

(aluminum and nickel). A threshold is the concentration of a substance at which some ecological impact is expected. BHPB's proposed trigger for management action is when statistical predictions give an early warning that a threshold will be exceeded in any AEMP lake within three years. The proposed thresholds are calculated using a site-specific Hazard Quotient, which is computed to provide confidence that at least 95% of all species in the lakes and streams downstream of *tailings* ponds at Ekati will be protected.

The Agency is working with the Environmental Monitoring Advisory Board (EMAB) in jointly reviewing Ekati's and Diavik's adaptive management plans.

We will be suggesting principles and a framework for evaluating adaptive management plans as part of our review. We will be using the results of the LLCF Water Quality Prediction Model and other key information to inform our review, as the model predicts future values for these water quality variables. Also, the Agency believes there may be a need for more analysis of mitigation options when concentrations that trigger management action are reached. We will have a more thorough discussion of the WAMP in next year's annual report.

Figure 5: Adaptive Management Cycle



## AQUATIC EFFECTS MONITORING PROGRAM

- Water samples should be collected at least 300 m apart but the ideal spacing distance for sediment and *benthos* is not known;
- Sampling method is not a significant source of bias in the current AEMP;
- The majority of uncertainty in the AEMP is the result of process error rather than sampling error; and
- Altering the AEMP sampling protocol to increase the distance between sampling locations will not significantly improve the precision of the AEMP.

The Agency participated in a meeting about AEMP guidelines being developed by DIAND on January 25, 2007. There we offered comments and advice on:

- Protocols for discarding suspect data;

- Need for protocols for assessing *cumulative effects* on a single water body;
- Documenting Traditional Knowledge (TK) contributions to AEMP;
- Need for AEMP linkages to adaptive management; and
- Need for regular collaborative reviews.

### Agency Assessment

The Agency is unable to fully evaluate the 2007 AEMP report as it was unavailable at the time of writing. A full review of the 2007 AEMP will be provided in the next Agency annual report. ■



Pigeon Stream above the Pigeon culvert.

### Panda Diversion Channel

2007 marked the ninth year of monitoring the Panda Diversion Channel (PDC).

As the 2007 PDC monitoring report was unavailable at the time of writing. We have only a brief summary of the highlights of the monitoring results contained in BHPB's *Environmental Agreement* and Water Licenses Annual Report. This is unfortunate, as we had hoped to report on the attempts to recover fin-clipped grayling. These now sexually mature fish were marked as juveniles (by clipping the adipose fin) in the PDC in 2003. They should now be turning up in the PDC if they survived in Kodiak Lake.

Fewer adult grayling used the PDC compared to last year. However, the PDC continues to provide good fish habitat for spawning, rearing, feeding and inter-lake migration, with production of grayling *fry* falling within the range of production estimates of two reference streams. As was the case the previous year, *fry* produced in the PDC appear to be physiologically equipped for overwintering in Kodiak Lake, judging by lipid content in their bodies. Lipid content of PDC out-migrant *fry* was no different than those in the most productive reference stream.

### Nero-Nema Stream Fish Habitat Compensation

A new monitoring program will be initiated next year (2008) at Ekati – annual monitoring of the effectiveness of new enhanced grayling habitat in Nero-Nema Stream. On the road to the Fox Pit, part of the bridge support over this stream encroaches on the main channel, destroying 456 m<sup>2</sup> of fish habitat. To compensate for this, in 2005-07 BHPB created what it hopes will be high-quality spawning

habitat for grayling by placing clean gravel in various locations in the stream, with the goal of increasing the production and survival of grayling *fry*. The substrate will be monitored to ensure the stability of the new spawning habitat. In 2009, two years after creation of this new habitat, spawning grayling will be monitored in the stream to determine density of spawners and *fry* production.



# Air Quality Monitoring

## Highlights:

- ▶ **The Agency commissioned and distributed an independent review of BHP Billiton's (BHPB's) Air Quality Monitoring Program (AQMP);**
- ▶ **BHPB held a collaborative technical meeting where it agreed to significantly improve snow and lichen sampling methods and analyses in 2008;**
- ▶ **BHPB agreed to further discussion on improvements to its continuous ambient air quality monitoring; and**
- ▶ **We believe that BHPB should discuss changes to its Air Quality Monitoring Program with Aboriginal communities.**

## Activities 2007-08

For the last 10 years, the Agency has been recommending to BHPB that it needs to improve its AQMP. Our current knowledge of the changes in air quality at Ekati as a result of mining activity is not comparable to our knowledge of the changes to other environmental components such as water quality and wildlife. The Agency is pleased to report this year that BHPB has committed to improving its AQMP and will be making some changes for the 2008 field season.

In 2007, the Agency commissioned an independent consultant to conduct a technical review of the 2005 Air Quality Monitoring Program report and results and the CALPUFF Air Dispersion Modeling report. The Agency provided this review to BHPB in April 2007, which identified some fundamental problems with the results presented, and with how the data were being collected and used to assess the air quality impacts of Ekati. In last year's annual report, the Agency noted these concerns and

recommended the AQMP be reviewed and revised in *consultation* with the technical experts at Environment Canada (EC) and the Government of Northwest Territories, Environment and Natural Resources (GNWT-ENR). In November 2007, BHPB responded to concerns raised by the Agency, our consultant, EC and the GNWT-ENR on these reports, and recognized that the AQMP could be improved.

In January 2008, a technical meeting was held with BHPB, the consultants (including an independent lichen specialist), GNWT-ENR, DIAND and the Agency with the objective to solicit input on how to improve methodologies for the snow core, vegetation and lichen sampling programs in time for the 2008 field season. As a result there were a number of changes to the program, including:

- The addition of new sampling locations along new transects representing a grid pattern to better establish a zone of influence;

- A new protocol for lichen sampling, plus the addition of lichen species preferred by caribou;
- An improved snow sampling methodology;
- The discontinuation of the vegetation species composition sampling that was done in 2005 as this method does not yield meaningful results; and
- An agreement to further discuss the AQMP and to determine if the continuous air monitoring station at Grizzly Lake is in the best location.

In 2007, BHPB operated two high volume air samplers, one at Grizzly Lake and the other on the west side of cell B

of the Long Lake Containment Facility (LLCF). These air samplers currently record data on a weekly basis from May to October, however BHPB is considering the recommendation to operate them year round. A continuous air quality monitoring station was installed at Grizzly Lake in 2007 to monitor the parameters of TSP, PM<sub>2.5</sub>, NO<sub>x</sub> and SO<sub>2</sub>, throughout the year, supplemented by the high volume air samplers in warmer weather. In 2007, this station was not properly calibrated, and the data collected were not reliable and will not be used. The appropriateness of the location of the station is under review and is yet to be determined.



Natural vegetation at Ekati.

In 2007, dust fall monitoring was initiated along the Fox, Misery and Sable roads for the purposes of quantifying dust fall resulting from haul traffic. Dust deposition was measured at 30, 90, and 100 metres downwind of the road and 30 metres upwind and at two background sites. Measurements were conducted during the months of June, July and August and the dust was sampled for metals and particulates. The results of this monitoring are expected in 2008.

In 2008, BHPB will continue with its comprehensive snow and lichen sampling surveys. This sampling program is conducted on a three-year cycle with the previous surveys being conducted in 1998, 2001 and 2005.

### Agency Assessment

The Agency is pleased with the progress that is finally being made to improve the AQMP, and with the collaborative review process involving the Agency and others with technical expertise. To further improve the AQMP, the Agency recommends that BHPB now involve Aboriginal people with Traditional Knowledge (TK) expertise, through a non-technical workshop to ensure that the program addresses Aboriginal concerns, particularly with regards to dust and its impacts to lichen and caribou. We also encourage BHPB to coordinate its AQMP with Diavik, as the influences of dust and dust deposition potentially extend beyond individual mineral claim boundaries.

The Agency's primary concern continues

to focus on the levels of suspended particulates and dust deposition around Ekati. We continue to recommend that BHPB investigate and clearly report on the potential linkages among the different monitoring programs and attempt to link dust deposition and ambient air quality effects on lichen with potential effects on caribou. We also continue to recommend BHPB add the testing and analysis of faecal pellets from caribou for possible evidence of exposure to metal uptake to the AQMP.

The Agency was happy to hear that BHPB has constructed new incinerators during 2007, but is disappointed to learn that the new, more efficient incinerators are still not in full operation. We hope that the new incinerators will be put into operation as soon as possible and a revised Waste Management Plan be submitted for review. ■



*Air quality monitoring station at Ekati.*

## Wildlife Effects Monitoring

### Highlights:

- ▶ **Small increase in the mine footprint by seven hectares;**
- ▶ **Caribou have a greater probability of being observed as distance from the mine infrastructure increases;**
- ▶ **Wolverine incidents continued to decline due to better management by BHP Billiton (BHPB);**
- ▶ **Results of 2005 and 2006 wolverine DNA sampling have been released; and**
- ▶ **A more robust technique to address mine impacts on grizzly bears is needed.**

### Activities 2007-08

BHPB's Wildlife Effects Monitoring Program (WEMP) documents wildlife impacts resulting from mining activities, and assesses the effectiveness of wildlife mitigation and management efforts. The WEMP at Ekati is in its eleventh year. As in previous years the 2007 WEMP focused on wildlife habitat, caribou, grizzly bear, wolverine, wolf, falcons, and upland breeding birds. Monitoring techniques included aerial surveys, behaviour observations, snow tracking, and a compilation of incident reports and visual observations. The mine footprint increased by 7 ha during the reporting period, and now covers 2,036 ha (20.4 km<sup>2</sup>). The caribou study area was expanded in 2006 from 2,800 km<sup>2</sup> to 6,300 km<sup>2</sup> to accommodate increases in the area covered for monitoring.

### Wildlife incidents

BHPB has worked hard to improve its waste management practices to reduce attractants at landfills, and to reduce wildlife incidents and exclude wildlife

from areas of danger (airstrip, high traffic areas). Ten vehicle-related animal mortalities were reported at Ekati in 2007 (all were ptarmigan and arctic hare); none involved large mammals or Valued Ecosystem Component (VEC) species. Thirteen non-vehicle related wildlife mortalities were observed on site, involving two caribou, three birds, and eight fox. Wolves killed one caribou and a calf died of unknown but presumed natural causes. Rabies was involved in most of the fox incidents. Incidental observations of grizzly bears (48) and wolves (34) were documented during 2007, with deterrents used for nine bear incidents (one was darted and relocated) and no wolf incidents.

### Caribou Monitoring

BHPB spends considerable effort to document caribou abundance, distribution, and behaviour relative to the mine, including incidental observations and a suite of aerial and ground-based surveys. The aerial surveys provide data to assess abundance, distribution and

## WILDLIFE EFFECTS MONITORING

habitat use relative to distance from mine infrastructure. In 2007, a total of 5,951 caribou were observed within the Ekati study area between July 7 and October 7, with peak numbers occurring in late July (based on incidental observations and the satellite collar data), and late September (aerial survey data). Unlike 2005-06, when there were no sightings of caribou between November and April,

incidental caribou sightings occurred in every month between October 2006 and October 2007, including a herd of 275 animals in mid-January 2006. Of those group sightings, the greatest herd size reported was 7,000 individuals, occurring on July 25, 2007.

Work conducted for BHPB in 2005 and 2006, and recent research by independent biologists using data from

both collared caribou and aerial survey results, have suggested that the relative abundance of caribou has declined in proximity to mine infrastructure, and that groups with calves were less likely than non-nursery groups to be found closer to mine development. Data obtained during 2007 continue to indicate that there was a greater probability of caribou being observed as distance from the mine

infrastructure increased. In contrast with the results from previous years, groups of caribou closer to mine infrastructure were more likely to contain calves than groups farther away, although the difference in mean distance was not large. Snow track surveys and road monitoring continue to suggest that higher snow banks and heavy truck traffic decrease the chance that caribou will cross a road, and that

## Ekati Wildlife and Human Health Risk Assessment

In early 2008, BHPB released the final report on the Tier 1 wildlife and human health risk assessment for metal uptake in vegetation, updating an earlier report from 2004. The objectives were to identify and assess the metals that could pose a potential risk to wildlife grazing on vegetation or eating soil at the Long Lake Containment Facility (LLCF), and to humans that consumed such wildlife. Concerns raised by the Government of the Northwest Territories (GNWT) and the Agency with the original report were largely incorporated into the updated assessment, including two chemicals

originally omitted. Acceptable risks from exposure to all chemicals evaluated except aluminum (for caribou and hare) and magnesium (for caribou, hare and ptarmigan) were predicted for a number of wildlife receptors at the individual and population level. The only metal that had unacceptable risks for human consumption of Canada geese and caribou was nickel, and that was only for caribou eating unrealistically large amounts of *processed kimberlite* (0.64 kg/day for several days).

## Agency's Assessment

- In the initial 2002 soil and vegetation sampling, half of the reference sites (areas considered not to be impacted by mining activities) included four locations at Ekati near the LLCF. One of the criteria for inclusion of a metal in the full risk assessment was that the LLCF concentrations had to be higher than the reference sites. We question whether samples taken at "reference" sites near the LLCF or adjacent to helipads and roads

can be truly considered indicative of unaffected areas. Should concentrations from reference sites be elevated beyond true background levels, then comparisons with concentrations from the LLCF could mean that some metals were screened out that should not have been;

- We think it may be wrong to use only muscle tissue in the human health assessment based solely on the eating patterns of one First Nation, the Tlicho, who it is reported do not eat organs. Some metals are known to concentrate to a greater degree in certain organs than in muscle. A great deal of sampling was conducted in the early 1990s under the Arctic Environmental Strategy program that provided concentrations of 10 heavy metals in caribou kidneys and livers. These data could be used for comparative purposes in assessing risk to wildlife and human health;
- Although there is no evidence that the LLCF is functioning as a mineral

lick for caribou, increases in salt concentrations in the medium term may result in greater attraction. BHPB should move ahead with research on the attractiveness of the LLCF soils and vegetation to wildlife;

- At least one study reports that willow bioconcentrates cadmium to a much greater degree than any other ptarmigan food. Since willow is grown on the LLCF, its cadmium content should be evaluated. Willow was not among the plants evaluated for metals content; and
- Assessing possible cumulative toxicity to Bathurst caribou from multiple exposure pathways (i.e. other mines), as recommended by the GNWT in reviewing the original risk assessment, would have enriched this study. BHPB's consultant claimed that this was beyond the scope of the study and that *cumulative effects* assessment is a responsibility of government, not BHPB.





caribou did not appear to habituate to roads in place for a long time. During 2007, the sample size of behavioural observations was too small for meaningful additional statistical analysis; a full sampling effort is expected to resume in 2008.

### Grizzly Bear Monitoring

The grizzly bear sign survey is the main monitoring program used to assess and determine the potential mine-related

effects on barren-ground grizzly bear movements and presence within the Ekati study area. The technique involves searching 500-m radius plots in wetland (spring) and riparian (summer) areas for recent bear signs. Results from 2007 concluded that there was no significant effect of distance from the mine on bear sign occurrence in riparian or wetland plots. Since 2000, the data indicate significant differences among years and different indications of a distance from mine effect, but no trend over time.

### Wolf Monitoring

Annual surveys of den sites are the main monitoring program used to assess the potential mine-related effects on wolf movements and presence within the Ekati study area. The WEMP report concludes “in 2005, the survey included all known historic dens and new dens in the Ekati study area; however, in 2006 and 2007, all

known historic dens were not surveyed, as only a partial survey was completed by [Environment and Natural Resources] ENR (Dean Cluff)”, and that “the effect of distance to the mine on occupancy and productivity cannot be calculated”. Of six historic dens surveyed by ENR, only one was productive. Twelve historic dens within the Ekati study area were not surveyed in 2007.

### Wolverine Monitoring

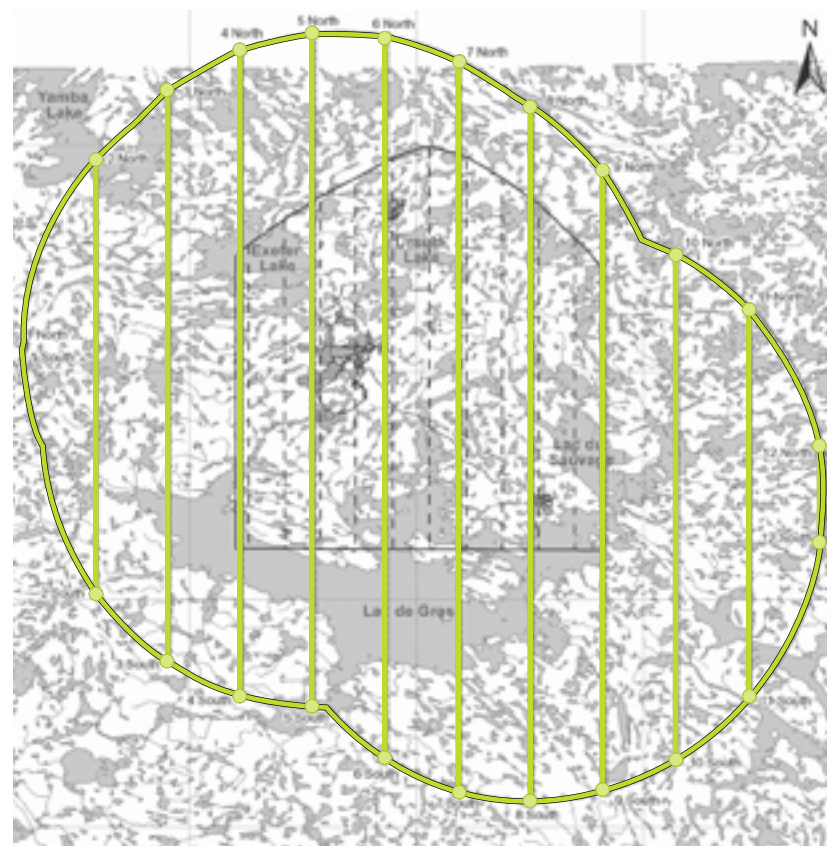
BHPB has continued with efforts to reduce incidents with wolverines, including waste management, building inspections, reinforced skirting around buildings, and use of escalating deterrents. Likely as a result of these efforts, the number of incidental wolverine observations decreased from 128 in 2005, to 23 in 2006, to 9 in 2007.



Wolverine bait station for DNA monitoring.



Grizzly bear at Ekati.



Caribou aerial survey transects at Ekati.

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## Regional Monitoring and Cumulative Effects



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Regional caribou monitoring has been a focus of the Agencies' comments for a number of years. Caribou health and the decline of the Bathurst caribou herd remain a major concern among our Aboriginal Members. The changes to the BHPB caribou monitoring program, primarily to a larger study area around mine infrastructure, will enable better mine-specific assessment of effects, and can better contribute to regional monitoring.

We are pleased that government regulators are making progress on regional and *cumulative effects* assessment and monitoring of caribou. The Agency participated in the Assessing Cumulative Effects and Barren-Ground Caribou workshop hosted by ENR in Yellowknife in February 2008, where Aboriginal Members expressed support for the proposed process to examine *cumulative effects* as a pilot project

in a portion of the Bathurst caribou herd range. This initiative is a solid step forward. The mines in the North can contribute further to this effort by making their aerial survey data available to a central storage facility (hosted by ENR) that will facilitate regional assessment and monitoring.

A regional dust monitoring program (through faecal pellet ash content, an indication of ingested dust) or lichen monitoring (to examine metals and contaminants on vegetation) or modeling of cumulative impacts on caribou are examples of programs that could be instituted in order to assess *cumulative effects* at larger scales. BHPB is expanding their dust and lichen monitoring at the mine-specific regional study area scale and Government agencies should address this issue at larger scales across the landscape.

The number of wolverine incidents has declined from 33 in 2005, to zero in 2006 and 2007.

In 2005 and 2006, BHPB and three other mining developments (Diavik, Snap Lake and Gahcho Kué) participated in a regional wolverine DNA sampling program developed and coordinated by ENR. Results of the DNA sampling program have recently been released, and showed that the technique is successful at producing reliable population and range estimates, to enable tracking of wolverine density and activity relative to mines. No wolverine snow tracking was conducted in 2005 to 2007.

**Bird Monitoring**

Surveys for upland breeding birds at Ekati continued in 2007, with no overall change in species densities. Raptors continue to nest on pit walls at Ekati, although BHPB actively deters nesting in all active pits. Raptor surveys conducted in conjunction with ENR have documented a continued decline of gyrfalcons at breeding sites relative to peregrine falcons, likely related to natural cycles and prey (ptarmigan) abundance. During 2007, occupancy of sites by peregrine falcons was high, but productivity was low, likely related to poor spring and early summer weather.



Solid waste management at Ekati.

## Agency's Assessment

Overall the Agency found the WEMP, with few exceptions, to be a comprehensive monitoring program and the report well written. The caribou aerial survey continues to be the main source of data used to examine mine-related effects on this important species. We commend BHPB for including Diavik in the distance from infrastructure calculations. During 2007, the sample size of behavioural observations was too small for meaningful analysis and we advise BHPB to conduct more behavioural observations at varying distances from mine infrastructure to ensure that sufficient samples are obtained to validate conclusions and interpretations.

The Agency also suggests that the grizzly bear sign survey plots appear limited in their ability to address objectives, and are not a strong

assessment methodology. The linkage between results obtained from the plot surveys (presence or absence of recent signs) and grizzly bear use of the plots has never been tested. We encourage BHPB to research a more robust technique to address mine impacts to grizzly bears.

It is apparent that BHPB has relied upon ENR to conduct wolf den surveys during the past two years, and that not all the historic den sites were surveyed by ENR within the Ekati study area. Therefore statements in the WEMP such as "Although den occupancy was high this year, den productivity among sites within the study area was low" cannot be justified from the monitoring data. We recommend that BHPB conduct full occupancy and productivity surveys of known wolf den sites within its study area each year.

BHPB's efforts to reduce incidents



The Helipad at Ekati.

## Recommendation

*BHP Billiton (BHPB) should, in collaboration with the Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT-ENR), recommence wolverine DNA monitoring in 2009 for continuation every second year. All cells within the BHPB study area should be sampled (varying numbers of cells were not sampled in 2005 and 2006). The snow track surveys for wolverine should be discontinued in favour of the DNA monitoring.*

and attractants to wolverines are commendable, as is their DNA inventory program conducted in 2005 and 2006. This initial 2-year inventory is designed to anchor the trend analysis in wolverine demography, with the intent that trend monitoring must be carried out by conducting DNA inventories every second year. Our understanding (from the April Overview of Environmental Agreement Annual Report) is that the snow track survey will resume in 2008/2009; there is no indication that further DNA inventories are proposed. The Agency's opinion, shared by a number of researchers and regulators in the North, is that track counts are not robust indicators of wolverine densities or relative abundance over time, and have limited value in determining mine-related effects on wolverine populations in the area. Accordingly, we recommend BHPB should, in collaboration with ENR, recommence wolverine DNA monitoring

in 2009 (since the 2008 season was missed) for continuation every second year. All cells within the BHPB study area should be sampled (varying numbers of cells were not sampled in 2005 and 2006). The snow track surveys for wolverine should be discontinued in favour of the DNA monitoring. ■







Raven nesting at Ekati.



# Regional Monitoring and Cumulative Effects

## Highlights:

-  A draft terms of reference and budget for Multi-Project Environmental Monitoring Agency (MPEMA) was completed although BHP Billiton (BHPB) has withdrawn from the MPEMA process;
-  GNWT held a *cumulative effects* workshop where there was agreement to develop a pilot project using the Bathurst caribou herd;
-  Wolverine hair sampling for DNA has good potential for regional monitoring and management; and
-  Slave Geological Province Plan of Action for the Environmental Management Framework (formerly known as CEAMF) is to be updated in 2008.

## Multi-Project Environmental Monitoring Agency

The Agency has been supportive of the concept of a MPEMA since the establishment of a second diamond mine monitoring body in 2000. With three diamond mines currently operational and the potential for more mines, there has been interest in the creation of MPEMA over the past five years. Given

the progress over the course of the year in setting terms of reference and a potential budget for MPEMA, it appears that 2008 may be the year when the parties involved make a decision.

BHPB has concerns with the lack of involvement of the Kitikmeot Inuit Association and Diavik in negotiating MPEMA and the proposed conceptual organization. BHPB has formally withdrawn from the MPEMA process.

Therefore, it is apparent that two of the key industry participants (BHPB and Diavik) are not interested in proceeding with MPEMA at this point, casting considerable doubt on its future.

## Opportunities for Regional Wildlife Monitoring

Due to the overlapping wildlife study areas and close proximity between Ekati and Diavik, the Agency has long been of the view that some collaboration between the wildlife monitoring programs of both companies is needed, particularly for wide ranging species like caribou and wolverine. For the Agency perspective on caribou monitoring and aerial survey work please see the Wildlife Effects Monitoring Program (WEMP) section of this report.

For wolverine, DNA-based hair monitoring has been found to be successful in developing population estimates and trends that enable tracking of wolverine density and distribution.

This method is superior to the snow track surveys in providing meaningful, consistent data for monitoring and managing human activities in relation to wolverine. No wolverine survey work was conducted in 2007 and 2008 and the Agency believes that further DNA sampling is required (see the WEMP section of this report).

## Cumulative Effects Monitoring

In February 2008, DIAND hosted a workshop on the Cumulative Effects Assessment and Management Framework (CEAMF) where it was decided to change the name to the Environmental Management Framework (EMF) to better reflect the broad scope of the work to be undertaken. It was mentioned that the 2002 Slave Geological Province Regional Plan of Action would be updated. A draft of this report is due early in the summer of 2008. We will continue to monitor developments in EMF in relation to the Ekati project.

Also in February 2008, the Department of Environment and Natural Resources (ENR) hosted an Assessing Cumulative Effects and Barren-Ground Caribou workshop in Yellowknife. ENR is attempting to develop computer models that would help improve understanding of cumulative impacts on the Bathurst caribou herd. Among other objectives, ENR wants to determine thresholds for development that may trigger declines in the caribou population. ■



Caribou near Ekati.