Reclamation and Closure

Activities in 2005

As we noted in last year's annual report, the current closure plan for Ekati is seriously out of date. Major changes in the mine's operations are in the works, and substantive upgrading of the closure plan is now due. When BHPB received its new water licence last fall, the Mackenzie Valley Land and Water Board (MVLWB) established a separate process for the Ekati Mine closure plan review. This requires the company to submit a revised Interim Closure and Reclamation Plan (closure plan) by January 15, 2007.

To aid in the process, the MVLWB established a working group of regulators and affected Aboriginal organizations, to review BHPB's proposed terms of reference for developing its closure plan, and to review the draft plan once submitted. The Wek'èezhìi Land and Water Board (WLWB) will then hold a public hearing on the revised closure plan prior to its approval.

The working group met to discuss terms of reference for conducting the closure planning work. BHPB has also initiated a community consultation process, and held a partial first round of meetings with two of the Aboriginal communities (Kugluktuk and Lutsel K'e) about closure concerns.

A number of outstanding issues remain to be addressed before an acceptable closure plan is prepared. One of the issues is what to do with the open pits at closure. To answer this question, BHPB has commenced investigations focused on ten research tasks related to pit *reclamation*. In December 2005 the company reported on the results of the first two tasks (literature survey of pit lake restoration; and information gap analysis). Following our review of those reports we commented to the MVLWB that the issue of re-establishing viable aquatic ecosystems in the case studies examined seemed not to be fully explored, and that, while five information gaps were identified in the task two report, how these related to determining the viability of pit lake *reclamation* options was unclear. Both reports were limited, in our view, by not clearly or meaningfully relating the results to the possible *reclamation* objectives for the pits.

To better prepare ourselves for involvement in BHPB's closure planning exercise, the Agency commissioned four experts to work through closure principles and concepts with us, and to take a preliminary look at some closure options for key mine components. We made these experts available to our Aboriginal Society Member staff for an extra day.

View of Ekati from a helicopter

Agency's Assessment

Last year we recommended that BHPB develop a workable closure plan within one year, that decisions about closure options be based on results of research investigations described in a closure research plan, and that a collaborative consultation process similar to the Long Lake Containment Facility (LLCF) *tailings* management exercise be used. A closure plan is in the process of being developed and a consultation process has been initiated, although the Agency, and others, have some concerns over the timing and the manner in which the consultation is being conducted. We are also still waiting for a proper closure research plan (as required by the water licence) to be available so that we, regulators and the Aboriginal communities can have a comprehensive picture of what the information needs for closure are, and how they are being addressed.

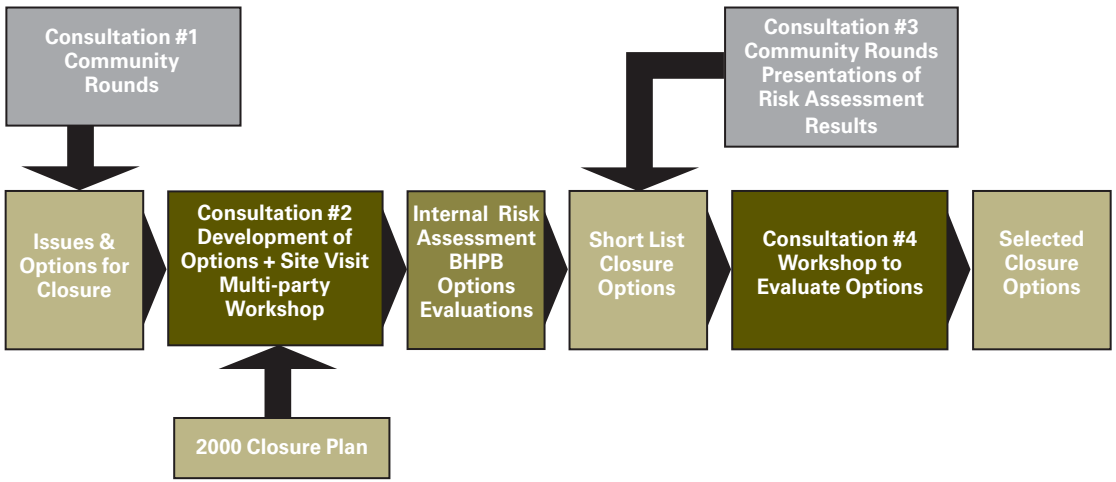
The Process

We are pleased to report that a serious process now appears to be in place for the development of a closure plan at Ekati. The WLWB's initiative to establish a working group of regulators and Aboriginal organizations to help BHPB with this exercise is to be commended. The initial meeting and round of reviews were constructive, and BHPB took seriously the issues raised when finalizing the terms of reference for the closure plan development.

With respect to the involvement of the affected Aboriginal Peoples in the closure planning process, we have some concerns about BHPB's intended approach to involving the communities in this work. The initial round of consultation for some of the communities met with only partial success—low turnout in one and foreshortened discussions in another indicate that meaningful consultation may not have been achieved. Other communities are yet to be consulted, and the company needs to invest more effort in getting an effective dialogue going with the affected Aboriginal Peoples.

To this end, we have written BHPB suggesting that more community engagement is necessary earlier in the process, rather than later. BHPB's current plan is to identify its closure options through an internal review process, and then have community representatives involved in the final selection of preferred closure options for the various mine components. In our view (see Figure 1), the communities should have a role in identifying the array of potential options for evaluation at the start of the process, and not be limited to selecting one from the handful of options that BHPB has already developed and evaluated internally.

Figure 1: Closure and Reclamation Plan Consultation Process Proposed by the Agency



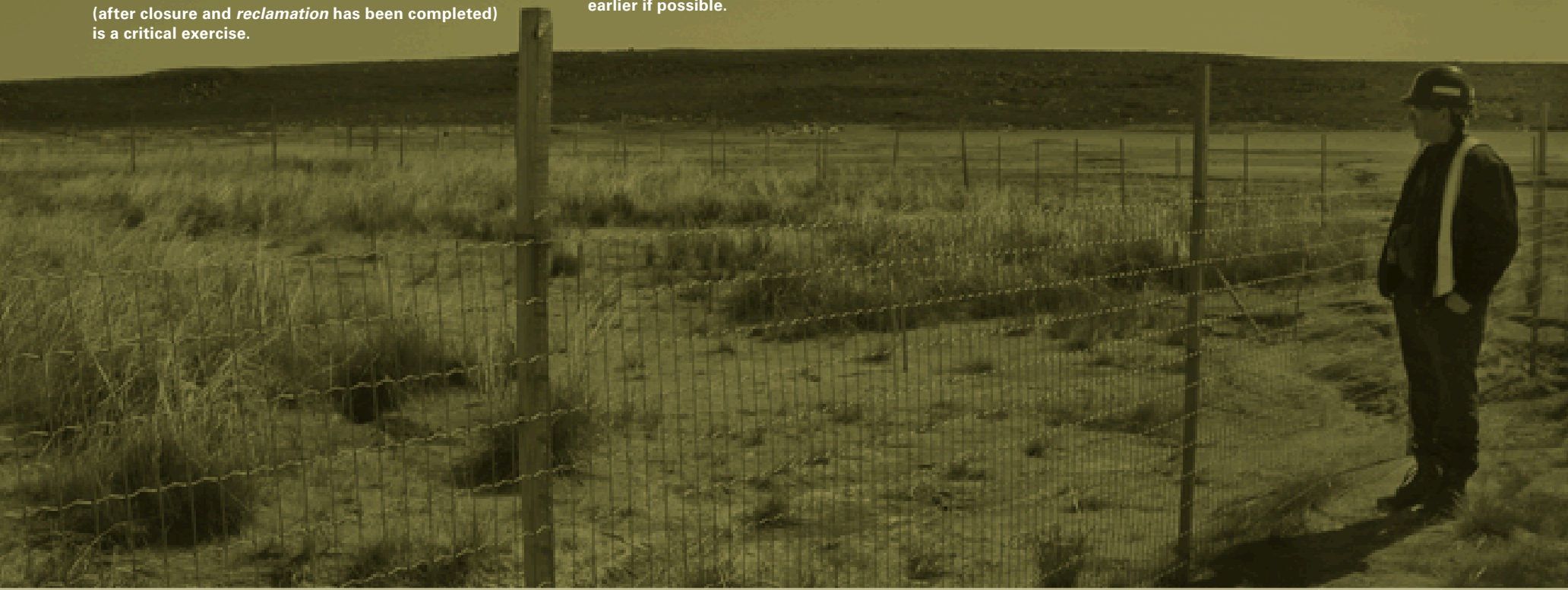
The Issues

Additionally, there are several technical issues that need substantial work from BHPB before an acceptable closure plan can be prepared.

The first of these relates to the LLCF. A large portion of the cells in the facility will contain highly mobile, unconsolidated clay slurries that are extremely challenging to manage. BHPB has not yet presented a way

Key closure recommendations made by the Agency to BHPB over the past year

- early and effective consultation with the Aboriginal communities in development of the closure plan.
- use of external expert assistance at key stages and for complex issues related to closure planning.
- expansion of BHPB's internal risk assessment process to a more collaborative and multi-disciplinary approach.
- a clear statement of closure objectives for each mine component is required.
- significant research is yet required, and a comprehensive *reclamation* research plan as required by the water licence is still outstanding.
- a more comprehensive assessment of the potential for metal uptake by plants on reclaimed surfaces and toxicological effects to plant eaters is required.
- the environmental assessment of residual effects (after closure and *reclamation* has been completed) is a critical exercise.
- reclaimed roads should be 'caribou-friendly' and provide for natural plant regrowth and drainage.
- waste rock piles should be 'caribou-friendly' and should not produce harmful drainage.
- open pits should be reclaimed to provide biologically productive shallow lakes, safe passage for fish, and acceptable downstream water quality.
- storage of waste rock or *processed kimberlite* in deep portions of pits should be done if surface water quality can be maintained.
- *tailings* impoundment should be 'wildlife-friendly', stable and erosion-proof, and not produce deleterious drainage downstream. Permanent dams should be avoided.
- extra fine *processed kimberlite* should be siphoned off and sent to a pit, either at the end of mine life or earlier if possible.
- closure plan needs to consider the possibility that the winter road is not available for *reclamation* purposes, thereby significantly increasing closure costs and challenges.
- computer models for estimating *reclamation* liabilities must be transparent and in an 'auditable' format.
- the burden of proof lies with BHPB to adequately demonstrate the effectiveness of closure measures it proposes, particularly the reliance on permafrost to prevent acid mine drainage and *metal leaching*.
- many past failures have been caused by overly optimistic professional judgement and faulty assumptions in computer models rather than scientific evidence—the need for solid information is emphasized.



in which these slurries can be contained indefinitely, and in which the wet zones around the edges of the slurry ponds can be effectively reclaimed with either vegetation and/or rock cover.

Unfortunately, the company's recently submitted revision of its management plan for the Long Lake Containment Facility (LLCF) did not adequately address closure issues (see the section on *tailings* and wastewater management page 7). In our view this is inappropriate. At the start of the *tailings* management evaluation back in 2005 the Agency clearly set out its expectations that any new management plan needed to be accompanied by viable closure options. We have adopted the principle of *'designing for closure'* and, in our view, this means that in modifying or designing new operations at the site, closure considerations must be incorporated in the new approach.

As a result of this deficiency, we believe that the new *tailings* management plan should not be approved until the necessary information was incorporated in a revised plan.

Another issue relates to the prediction of drainage quality from the waste rock dumps at closure. While BHPB is convinced that the waste rock storage facilities are freezing internally, and that harmful drainage will not be a problem in the long-term, our independent expert reviews of the company's waste rock monitoring program reveal that there are serious questions that remain unanswered, and that management implications of some results are not being identified by BHPB. Some of these unaddressed issues have important implications for closure.

The most recent Waste Rock Seepage survey provides no discussion of the long-term behaviour of the vast volumes of coarse *kimberlite* rejects that will be encapsulated in the granite waste dumps. These could present mine drainage problems in the future.

Some of the biotite schist waste rock layers at Misery are not freezing to the same degree as the granite waste rock, and therefore may not offer the same long-term protection as the granites do. The leaching of nickel from *kimberlites* and black clay may be a long-term concern, and more tests are required to get a better understanding of this potential at closure.

The question of how to best reclaim the open pits is still under investigation. BHPB and reviewers have identified a number of research questions, and a program to get the needed information is being carried out. We are concerned about the pace of this review, since the apparent date for completion of the work may not coincide with the target date for this version of the closure plan. The Agency's current view is that the closure objective for the pits should be the establishment of lakes that would provide, at a minimum, safe habitat and passage for fish.

As we go to press, BHPB's annual environmental report is not available, substantially delayed compared to previous years. Among other things, this means we cannot evaluate the company's efforts in conducting *reclamation* research or undertaking *progressive reclamation* of completed mine components.

Despite the substantial early commitments to *progressive reclamation* of the project, and given the lack of *progressive reclamation* last year, it is our impression that there is no current substantive *reclamation* work being carried out at Ekati.

We are also concerned that *reclamation* research is at a standstill. The revegetation studies formerly underway in cell B were abandoned in 2004 pending the outcome of the re-assessment of operations in Long Lake. Under the proposed operational plan, the company will resume depositing *tailings* in cell B for some years, thereby continuing to limit the revegetation and *reclamation* work there. We have written again to the WLWB urging that approval of BHPB's new Wastewater and Processed Kimberlite Management Plan provide for the early completion of *tailings* placement in cell B so that the *reclamation* activities can be restarted at the earliest possible time. ■

Recommendation

2. BHPB should develop closure objectives, options and criteria and assess risk collaboratively with all interested parties in accordance with the advice offered by the Agency and the Interim Closure and Reclamation Plan (ICRP) working group members.

Aquatic Effects Monitoring

BHPB's Aquatic Effects Monitoring Program (AEMP) is a requirement under its water licence and the Environmental Agreement. The AEMP is designed to detect any changes that the project has on 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 measurements above licence limits for regulated water quality parameters in 2005.

Outline of Monitoring

The monitoring frequency is every year for water quality, hydrology, *limnology*, lake *benthos*, stream *benthos*, every three years for sediment quality and every five years for fish communities. BHPB monitors *phytoplankton* and *zooplankton* annually in August.

2005 was the eighth year of post-baseline data collection within the Koala drainage, and the fifth of post-baseline monitoring within the King-Cujo to Lac du Sauvage drainage at the Misery site. Monitoring also occurs within three reference lakes and outflow streams (see Figure 2).

Winter sampling under ice (lakes only) occurred in April after discharge of water from the LLCF had ceased.

Winter dissolved oxygen concentrations were measured monthly (except Kodiak and Cujo lakes which were measured weekly). Open water sampling occurred during July, August and September, after discharge had resumed. Sampling of streams included water quality, stream *benthos*, and stream flow.

Inputs to the Aquatic Receiving Environment

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

Water was discharged from the Long Lake impoundment in October to December 2004, June and September 2005.

Due to temporary shutdown of mining at Misery in April 2005, water was discharged into Cujo Lake from King Pond in only two months—October 2004 and September 2005.

Results

Our review of BHPB's AEMP for 2005 has been somewhat hampered by the fact that, as we went to press, we still had not received the full 2005 monitoring report from the company. Consequently, the discussion below is based

Fish Palatability Monitoring

The new 2005 water licence for Ekati contains a provision for BHPB to conduct fish palatability monitoring in water bodies downstream of the mine with participants from the Aboriginal communities. This activity, also used at the Diavik and Snap Lake diamond mines, is intended to involve Aboriginal Peoples in monitoring of changing environmental conditions in the waters affected by the mining operations.

Due to the presence of small fish populations in the downstream water bodies at Ekati, the Agency is concerned that palatability monitoring could have an adverse effect on the populations. Fish are currently sampled from lakes downstream of Ekati every five years as part of BHPB's Aquatic Effects Monitoring Program. We believe that palatability monitoring should be linked to this program or, alternatively, should take a more regional approach to monitoring of fish in Lac de Gras. The Snap Lake Environmental Monitoring Agency has a Traditional Knowledge panel with expertise related to fish palatability which could provide assistance to BHPB. The Diavik Diamond Mine also has an ongoing fish palatability monitoring program that could be considered by BHPB.

Fish tasting at the Diavik Mine

EMAB

Upward Trends in Water Chemistry Variables in LLCF Cell E

In winter of 2003/04, water at the outlet of the *tailings* impoundment showed a significant increase in concentrations of some water quality variables (although nothing above licence limits), with some variables showing the highest concentrations to date. The Agency is pleased with the proactive manner in which BHPB notified stakeholders of this unexpected occurrence.

BHPB's subsequent investigation into the cause of the spikes in water chemistry suggests that these were probably due to pumping of water from cell E in winter 2003/04 (the first time water has been released from LLCF throughout the winter). This under-ice pumping meant that there was little dilution of water containing elevated chemical concentrations in cell D and E (reduced dilution attributed in part to the "ice exclusion" process). Ice makes up about 30% of cell E volume in winter thus remaining unfrozen water would contain a higher concentration of chemicals. The existence of a "chemocline" (stratification of lake water due to chemical composition that prevents mixing) was also found within cell E in winter and contributed to the poorer quality effluent. The higher TDS and chloride concentrations discharged into the LLCF were attributed to additions of mine water seeping into underground mine operations at Ekati (underground water is saline and the major source of chloride, sodium and calcium pumped to the LLCF).

Understanding the ability of the LLCF to contain and allow for settling and clarification of mine water is especially critical at this point in mine life, as the cause of the spikes may have implications for the future management of *processed kimberlite tailings*. To this end, BHPB is using a computer model to determine the physical and chemical processes affecting water quality in the LLCF on a monthly basis. Hopefully, the model will be able to predict water quality at the impoundment discharge point well into the future so effluent from the LLCF can be properly managed by BHPB.

solely on a summary report provided by BHPB. This means that some aspects of the AEMP that we have been tracking over the years, such as the decline in *zooplankton (cladocera)* abundance in Koala watershed lakes, and winter water quality in Leslie, Moose and Cujo Lakes, have not been possible to review here.

Koala Watershed

The concentration of molybdenum in water downstream of the mine continued to rise sharply. Molybdenum and *nitrate*,

Figure 3: Mining effects on water quality flowing through the Koala and King – Cujo Watersheds

	Parameters elevated in Koala watershed Long Lake Containment Facility ⇒ Lac de Gras					Parameters elevated in Cujo watershed: King Pond ⇒ Lac du Sauvage	
Parameters monitored	**Leslie**	**Moose**	**Nema**	**Slipper**	**Lac de Gras**	**Cujo**	**Lac du Sauvage**
pH	▲	▲	▲	▲	▲	▲	
Sulphate	▲	▲	▲	▲		▲	
Potassium	▲	▲	▲	▲	no baseline	▲	
Total Disolved Solids	▲	▲	▲	▲		▲	
Total Ammonia						▲	▲
Nitrate	▲	▲	▲	▲			
Nitrite							
Ortho-Phosphate						▲	
Total Phosphorus							
Aluminum							
Arsenic	▲	▲	▲	▲			
Copper							
Molybdenum	▲	▲	▲	▲			
Nickel							
Zinc							

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

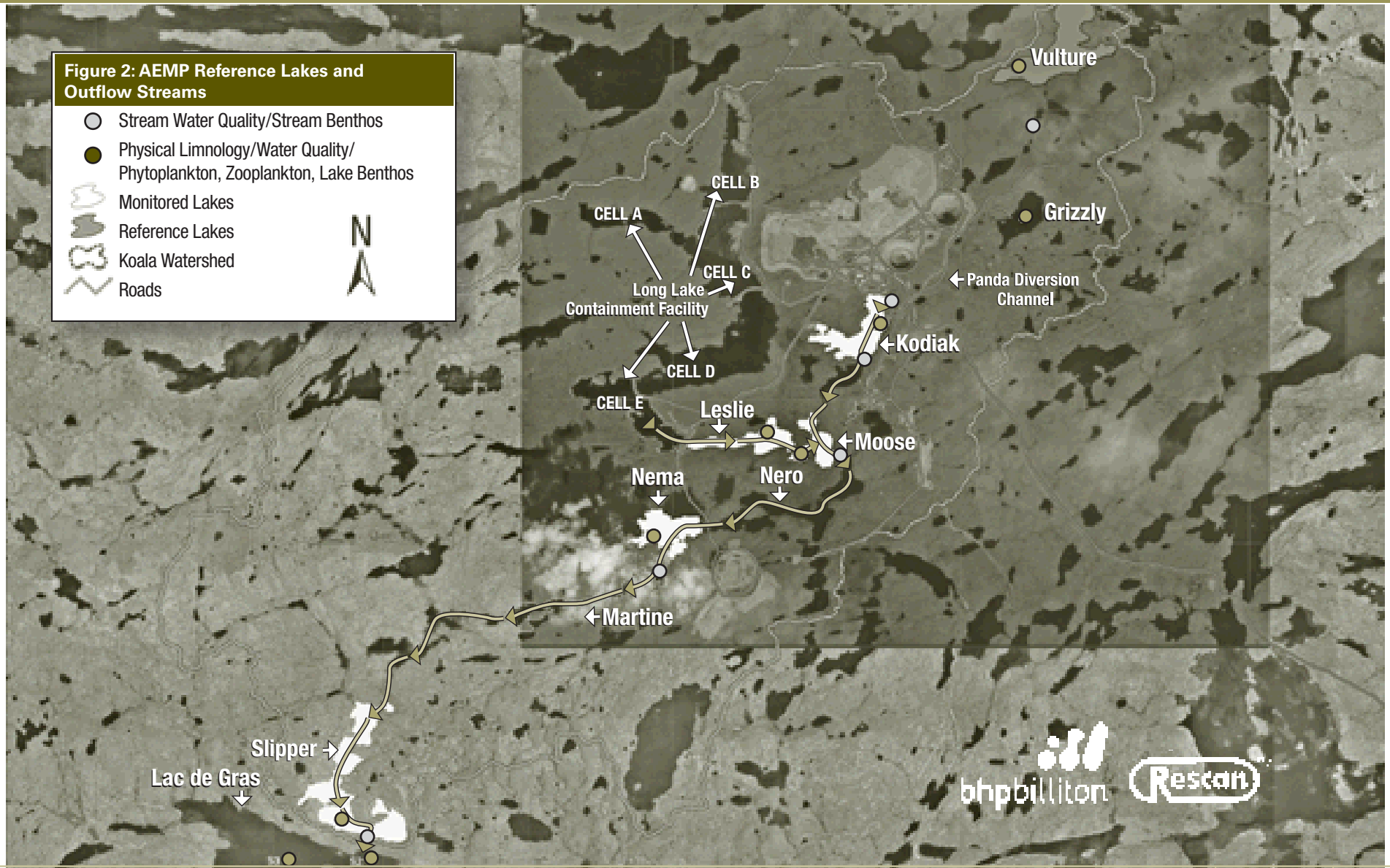


Figure 2: AEMP Reference Lakes and Outflow Streams
Stream Water Quality/Stream Benthos
Physical Limnology/Water Quality/ Phytoplankton, Zooplankton, Lake Benthos
Monitored Lakes
Reference Lakes
Koala Watershed
Roads
N
Vulture
Grizzly
CELL A
CELL B
CELL C
CELL D
CELL E
Long Lake Containment Facility
Panda Diversion Channel
Kodiak
Leslie
Moose
Nema
Nero
Martine
Slipper
Lac de Gras
bhpbilliton
Rescan

Bearclaw Lake Water Drawdown Effects

We wrote last year that Bearclaw Lake experienced an unplanned drop in water level, due to operational error during pumping out of freshet water. The only direct adverse effect on fish identified was the death of 60 juvenile burbot trapped in an inlet stream due to the lowered water level in the lake. *Phytoplankton* biomass and density in the lake increased, but this may also be attributable to *nitrate* seepage from the nearby Panda waste rock pile. The effect on shallow-water *benthos* (the most physically disturbed habitat) was difficult to assess due to lack of baseline benthic data, although average densities of shallow-water benthic invertebrates were higher than in five reference lakes. Due to an observed increase in *phytoplankton* in Bearclaw Lake, BHPB began monitoring dissolved oxygen with a plan to aerate the lake if oxygen levels reach a critical minimum level. BHPB's report also contained a linkage between fluctuations in river levels from another region to provide a relative comparison to the amount Bearclaw Lake was lowered and we do not believe this was ecologically relevant. Overall it appears that the incident has passed without causing lasting damage to fish habitat in Bearclaw Lake.

Bearclaw Lake following the drawdown of water

Recommendation

3. BHPB should, through monitoring and additional analyses of data already collected, obtain the necessary information to explain changes in zooplankton community structure in relation to water chemistry changes.

both unregulated under BHPB's water licence, are getting closer to federal guidelines for the protection of aquatic life in Leslie Lake. Molybdenum has also increased in the bottom sediments of Leslie, Moose and Nema Lakes.

Arsenic is newly elevated above baseline compared to previous years, while nickel, elevated in previous years, has declined to background levels.

Cujo Watershed

In Cujo Lake, ortho-phosphate is newly elevated above baseline compared to previous years, while copper, elevated in previous years, has declined to background levels. It is noteworthy that even though there is a significant decrease in *ammonia* in King Pond outflow, *ammonia* is still higher than in previous years in Cujo Lake.

Agency's Assessment

In last year's report, we highlighted the results of an independent review of the AEMP that was commissioned by the Agency and a steering committee made up of DIAND, DFO and EC. The final report suggested improvements to statistical methods and data handling procedures and contained advice on techniques to correlate water quality changes and effects on aquatic life. These are important findings related to improving the analysis of data gathered by the AEMP. As yet, BHPB has not responded to the results and recommendations from this review and this reduces our level of comfort that the results of the AEMP are accurate enough to conclude 'no adverse effect' is occurring downstream of the mine site. BHPB's new water licence contains a provision requiring a review of the AEMP program in 2006. This would be an ideal opportunity for BHPB to address the concerns raised in our earlier review.

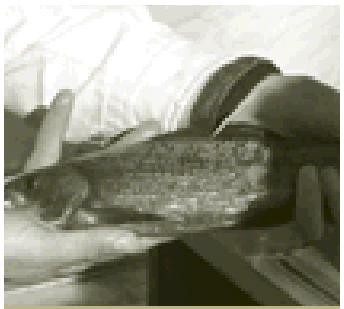
Concentrations of several water chemistry variables continue to rise downstream of the LLCF as far as the stream between Slipper Lake and Lac de Gras. Most significant are *nitrates* (up to 228 times the baseline levels in some lakes) and molybdenum (up to 113 times baseline). Whether these increases are affecting the aquatic biota is not certain, as there are no statistical correlations being done. Also, while the *zooplankton* and *benthos* are being evaluated at a whole-community level, there needs to be some work on whether there have been changes within these communities. In this regard, the Agency is disappointed that, due to not having received the full AEMP report by press time, we were not able to continue to monitor the status of the *cladoceran* portion of the *zooplankton*. This will be reported on in next year's annual report from the Agency. ■

Panda Diversion Channel

The year 2005 is the seventh consecutive year that fish habitat within the Panda Diversion Channel (PDC) has been monitored since the habitat was constructed. BHPB's annual report on the diversion channel was not available as we go to press, so our review below is based on summary information provided by the company.

The number of fish using the diversion channel in 2005 (675) decreased by 11% from 2004. However, use of the channel by fish entering from the upstream end, North Panda Lake, increased by three times the 2004 count.

The percentage of fish returning to spawn continues to increase, as 20% of 302-tagged Arctic grayling had spawned in the channel in previous years. However, total number of grayling spawning in the channel was down from the previous two years, a trend also reflected in one of the natural streams (Pigeon). The channel is still being used as a travel corridor between Kodiak and North Panda lakes, with 14% of all tagged grayling moving from Kodiak to North Panda and not returning to Kodiak.



The female/male sex ratio (0.71) was the same as last year. An estimated 10% of the Koala-North Panda grayling population spawned. But *fry* densities were the lowest in the last three years (see Figure 4).

There were no statistically significant differences in *fry* growth rates between the diversion channel and two reference streams (Pigeon, Polar-Vulture). The slight lower mean in the diversion channel and Pigeon was probably due to colder July temperatures (just as *fry* emerged from the substrate

Aerial view of the Panda Diversion Channel

Figure 4: Arctic Grayling Reproduction in the PDC in 2004 and 2005

Stream	Egg Density (#/100m^2) (2004)		Egg-to-Fry Survival (%) (2004)		Egg-to-Outmigrant Survival (%) (2004)		Fry growth rate (mm/day) (2004)	
PDC	1110	(1340)	1.4	(2.1)	0.04	(0.6)	0.6-0.7	(0.7-0.9)
Pigeon	680	(1230)	0.9	(4.0)	0.97	(3.9)	0.6-0.7	(1.0)
Polar-Vulture	230	(370)	14.0	(6.3)	0.75	(1.4)	0.7-0.8	(0.7)

into the water column) in those two streams than in Polar-Vulture. This is also probably why egg-to-outmigrant (outmigrants are those fish that are born in the channel and survive to move out of the channel at the end of the first season) survival was also lower than previous years in those two streams.

The mortality rate of grayling *fry* in July to late August was estimated at 4% per day in the channel, resulting in approximately four *fry* out of every 10,000 grayling eggs that survived the summer and entered Kodiak Lake. This is a much lower reproductive success than that of the two reference streams.

There was no significant difference among average condition (0.82 to 0.86 g/mm^3) of grayling *fry* in the three streams, but it was lower than that in 2004 (0.91 to 0.93 g/mm^3) in all streams. Total grayling production was reduced in all three streams over previous years (see Figure 5).

First-year over-wintering survival of channel-raised grayling in Kodiak Lake is estimated by BHPB at 92%, as predicted by a computer model. In the 2006 field season, captured grayling that were fin-clipped as *fry* in 2003 should provide hard data to verify this prediction, giving us the first real evidence of survival rates of grayling hatched in the channel.

Agency Assessment

As we stated last year, the fate of the Panda diversion channel at closure is still an open question. Monitoring in 2005 showed that, besides being used by grayling for spawning and rearing of *fry*, the channel is used as a travel corridor between Kodiak and North Panda lakes. In the event that the channel is decommissioned at closure, and water flow is returned to the original watercourse between North Panda and Kodiak, the pit lakes and interconnecting channels should be constructed so as not to inhibit this inter-lake movement. ■

Figure 5: Annual Arctic Grayling Fry Production (gm/m^2 per year)

Lake	2005	2004	2003
PDC	0.10	0.12	0.28
Pigeon	0.004	1.43	0.75
Polar-Vulture	0.002	0.04	0.11

Ekati visitors tour the Panda Diversion Channel fish box