DEVELOPMENT AND IMPLEMENTATION OF A DECOMMISSIONING AND CLOSURE PLAN AT THE PREMIER GOLD PROJECT

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ABSTRACT

This paper describes the development and implementation of a decommissioning and closure plan at the Premier Gold Project. The Property is located approximately 18 km north of Stewart, British Columbia, Canada and 2.4 km northeast of the BC/Alaska border. The site has been used for gold and silver mining since the turn of last century and Boliden Limited has owned and operated the site since 1988. Mining operations ceased in 1996 and the mine is proceeding through a closure phase. The main objective of the decommissioning and closure plan is to minimize the impact of tailings, contaminated water discharges, waste rock dumps and other aspects of the site on the receiving environment. The main aspects of the closure plan include decommissioning and closure of the Tailings Storage Facility (TSF), demolition of buildings, disturbed areas re-vegetation and environmental performance monitoring. The closure plan for the TSF calls for a partial wet closure and consists of tailings relocation, grouting of decants pipes and under-drain pipes through the dam, grouting of drainage pipe left through the dam, surface water management, construction of a filter berm at the toe of the tailings dam, construction of a closure spillway, overflow channel construction, diversion channel upgrade and construction of field trials for engineered covers. Decommissioning and closure of waste rock dumps included re-sloping and re-vegetation.

The paper discusses the challenges and opportunities experienced through the implementation of the closure plan together with potential avenues to generate funds to cover post closure liabilities. Finally, the paper gives a summary of the lessons learned.

INTRODUCTION

Premier Gold Project (PGP) is located approximately 20 km north of Stewart, British Columbia (B.C.), Canada and approximately 2.4 km from the B.C/Alaska, USA border (~56° 05'N, 130° 00'W). Access to the mine site is through a gravel road that goes through Hyder, Alaska. Passenger vehicles have access during the summer months and winter access is by snowmobile or snow cat.

The mineral properties surrounding PGP were discovered between 1916 and 1918. Mining and milling continued from 1921 through 1953 with intermittent mining and milling activities continuing until 1964. These activities were conducted by a number of companies that do not exist today. A new player, Boliden Limited, hereinafter called Boliden (formerly Westmin Resources Limited, and Boliden Westmin Canada Limited) came on board by commencing

exploration in 1979 and undertook open pit mining and milling operations starting in 1989. Before Boliden's involvement, the site was classified as a historical site with no closure plan and environmental protection programs. In the spirit of advancing the permitting process, Boliden agreed to take responsibility for the treatment of contaminated waters from the "old timers" mine workings and installed a Mine Water Treatment Plant (MWTP) in early 1990. The water treatment plant is now deemed to treat mine water in perpetuity.

The Premier Gold Project (PGP) was an open pit and underground gold and silver mining and milling operation. Between June 1988 and August 1992, open pit mining was primarily carried out on four different deposits including Premier, Dago, S-1 and the Province zones. Waste rock generated from the open pit mine was transported by conventional trucks to waste rock dumps adjacent to the open pits. In January 1992, mining commenced underground in an area of historic underground mining dating from 1920's through 1960's. The underground mining continued until April 1996 when low reserves and low gold prices forced activities to cease and the mine went into long term care and maintenance (LTCM) phase until 2000 when the mine was declared closed.

A revised closure plan for the site was then developed and submitted to the provincial government authorities in April 2002 and approved in April 2004. Closure of the site is currently in progress. The waste rock dumps and tailings have the potential to generate acid rock drainage (ARD).

Closure Plan Development

The first closure plan for the site was developed in 1992. The plan was not accepted by the government because it had a number of significant deficiencies including aspects such as lack of water and waste management plans, lack of sound ARD mitigative measures, lack of TSF decant system design, lack of a well defined decommissioning and closure plan for the construction diversion culvert (CSP) and culvert left in place. In addition, the 1992 closure plan did not address increased seepage through the dam and also called for a full wet closure of the TSF.

The second closure plan was submitted to the government in 1998. The government of British Columbia accepted the closure plan with major changes, mainly related to the closure of the TSF. The government did not support the concept of a full wet closure as this might compromise tailings dam stability.

A revised decommissioning and closure plan for the Premier Gold Project was submitted to the regulatory agencies in April 2002 as a follow-up to the earlier plan submitted in October 1998. Both plans give details on the closure and reclamation programs, schedules and costs. Comments from various regulatory agencies were received and the Company incorporated them when developing the revised plans. The 2002 closure plan was accepted on April 2004 and an amended permit was issued in the spring of 2004. Decommissioning and closure programs of the site are currently in progress.

The 2002 decommissioning and closure plan was developed to meet the following objectives.

- Minimize the potential impacts from acid rock drainage related to the tailings;
- Provide a self-sustaining growth of local plant species such as shrubs over waste rock dumps and other disturbed areas;
- Decommission all components of the mine-mill complex including, and not limited to access roads; waste rock piles / dumps; underground mine openings; surface opening; mill complex; buildings and structures; tailings storage facility (TSF) and its appurtenances; pipes; and other conduits;
- Provide self-sustaining water management and control structures for all relevant site components;
- Reduce erosion through sequential revegetation and reclamation of the site;
- Develop a post-closure environmental monitoring and control program to determine performance of the prescribed mitigative measures;
- Return the site to near original land use – wilderness;
- Re-integration of lands disturbed by mining into the surrounding landscape;
- Develop a contingency plan in the event that the proposed closure and decommissioning plan does not produce the expected results;
- Develop cost estimates for the decommissioning of existing components and post-closure activities.
- Maximize on the sale of non reclamation assets; and
- Select and set aside reclamation assets to minimize closure construction costs.

The major components of the closure plan are discussed below.

Tailings Storage Facility (TSF)

The original TSF design concept that was developed in 1993 called for a dry facility at closure. In 1998, the closure plan considered the incorporation of a permanent water cover to mitigate potential acid generating (PAG) materials. Several conceptual closure alternatives for the TSF were considered including “do nothing” scenario; fully flooded impoundment; flooding part of the impoundment with a beach and stabilizing upstream berm; and dry cover (no pond). These options were presented to the government with much discussion on conflicting objectives of flooding for ARD control versus a dry closure for geotechnical stability. Based on the Company’s discussions with government and other stakeholders, The Company elected to proceed with the partial flooding option – flooding part of the impoundment with a beach and stabilizing upstream berm.

Following the option study, the decommissioning and closure design considerations for the TSF allowed for a partial wet closure with the development of permanent water cover to submerge the majority of tailings to mitigate potential acid generation.

The main closure components for the TSF are as follows:

- Tailings relocation – approximately 80,000 cubic metres of tailings need to be relocated to deeper (below elevation 331.5 m) areas of the TSF to allow flooding;
- Dam section modifications;
- Relocation of tailings from immediately in front of the proposed spillway above elevation 329 m and construction of a permanent Spillway channel with invert at elevation 332.5 m;
- Grouting of decant pipes, CSP Pipe and under-drain pipes;
- Overall surface water management for closure;
- Construction of a creek overflow channel;
- Construction of an engineered cover; and
- Construction of a filter berm at the toe of the tailings dam.

Design Basis and Criteria and Other Requirements

The design basis and criteria for the decommissioning and closure of the TSF and its appurtenances are as outlined below:

- 1-in-1000-year return period earthquake;
- 1-in-1000-year return period flooding;
- Assurance against major release from pipes equivalent to 1-in-1000-year return period; and
- Control of acid drainage and metal leaching to meet downstream water quality requirements.

In addition, the Company is required to undertake the following programs:

- Conduct annual inspections of the TSF and submit reports, which will be made available to government agencies; and
- Conduct dam safety reviews of the TSF every seven years.

The requirement for dam safety review under the CDA Dam Safety Guidelines, 1999 may be met by augmenting the annual inspection every ten years to provide the information required for the dam safety review.

Dam Section Modifications

- regrading of the existing tailings beach to achieve suitable cover base layer sloping at 1% from the upstream slope to El. 332.5m at 50m from the dam;
- placing and compacting random fill on the tailings beach to form the base layer for the engineered cover;
- covering the upstream dam slope with sand and gravel, overlain in turn by coarse riprap to provide erosion protection; and
- raising the current dam crest from El. 336.0m to El. 336.3m with fill excavated from the spillway or with Mile 18 sand and gravel to provide additional flood capacity.

Water Management Program

The water management program addresses the following design elements:

a) A permanent closure spillway on the eastern perimeter of the tailings impoundment will be constructed. The spillway is sized to pass the estimated 1000-year flood event for the combined local and Cascade Creek catchments while maintaining a minimum of 1m of freeboard below the dam crest. The 1000-year flood is recommended as the inflow design flood by the Canadian Dam Association Guidelines (1999) for the upper and lower limit of low-consequence and high-consequence tailings dams, respectively.

b) The tailings in the impoundment that are not beneath the engineered cover will be submerged below a minimum of 1m of water under normal conditions and below 0.8m for a 100-year return period dry year. The water cover will ensure that these tailings remain saturated under the predicted site and climatic conditions. To achieve the 1m of cover, tailings will need to be relocated from several areas and placed into the closure pond.

c) Decommissioning of the known pipe conduits beneath the dam and the remaining decant system. Previous investigations (Klohn Crippen 2000) have located two decant pipes (200mm HDPE), an underdrain pipe (150mm HDPE) and a construction drainage culvert (900mm CSP) beneath the dam embankment. The decant and underdrain pipes were grouted as fully as possible to prevent flow through them. The construction drainage culvert was not grouted because of pipe wall corrosion and partial infilling with tailings and other materials. A filter berm, constructed on the downstream face of the dam, was identified as the most effective way of preventing uncontrolled release of tailings through the construction drainage culvert or other unknown pipes through the dam.

d) The Cascade Creek Diversion Channel (CCDC) will be maintained in perpetuity. The design flow capacity for the CCDC is $356m^3/s$ (Knight Piesold, 1988). In the event that the diversion channel becomes blocked, an overflow inlet for the Cascade Creek Diversion Channel will be constructed at the north end of the tailings impoundment, to allow routing of floodwater through the tailings impoundment and through the spillway. Tailings along this emergency routing will be covered by coarse gravel for erosion protection and may be sub-excavated to prevent erosion.

e) The North Diversion Ditch and the upper portion of the South Diversion Ditch (Indian Creek Diversion) will be decommissioned and the runoff from their drainage areas will be routed through the tailings pond.

f) The current tailings pond water quality is generally acceptable for discharge without further treatment and consequently, can be released during and following construction of spillway. However, PGP has provision for treating tailings pond water when required.

g) Ongoing maintenance of ditches along the Granduc Road that intersect the decommissioned diversions will be continued.

Engineered Cover Research for the Decommissioning of TSF Beach

An applied research program was undertaken to evaluate the long-term performance of a final cover system design for the tailings beach at the PGP site. The program included laboratory and modeling studies leading to the design and construction, instrumentation and monitoring of engineered cover test plots at the site between 2002 and 2005.

The test trials included a comparison of three dry cover systems and one control system (Geosynthetic Clay Liner (GCL) Barrier, Till Barrier, Sand and Gravel Bentonite Barrier and Control (M18 sand and gravel)) based on their estimated cost effectiveness and projected long-term durability and performance in minimizing ARD generation.

Key considerations in the implementation of an engineered soil cover to reduce ARD in a net annual water surplus site in a temperate climate are: (i) reduction of infiltration, (ii) maintenance of saturation and (iii) minimization of oxygen ingress. These factors together with the long-term integrity of the cover need to be assessed for cover selection. Other factors investigated include the effect of freeze/thaw cycles on the integrity and long-term performance of the soil cover.

The research program will provide information on the ability of soil-based cover systems to minimize acid generation and metal release from potentially acid-generating tailings. The cover materials that were investigated included local clays and tills, sand-bentonite mixtures and Geosynthetic Clay Liner (GCL).

Each cover system consisted of a base, on which the cover was constructed, a barrier to minimize oxygen diffusion and water percolation, and a protective cover to be engineered to maintain long-term integrity of the barrier system. The research will compare cover systems based on their long-term durability and effectiveness in maintaining low water percolation, low oxygen fluxes, adequate freeze-thaw resistance, and installation and maintenance costs.

Field instrumentation was installed to monitor moisture and temperature conditions in the test plots and underlying waste material together with oxygen flux, percolate water quality, and runoff quantities. Saturated-unsaturated flow modeling was performed as part of the cover design to obtain information on pressure/suction heads, water content, and degrees of saturation under simulated field conditions including evaporation, infiltration and water table fluctuations. Commercially available models such as SEEP/W, SoilCover, and UNSATH were used for this modeling.

In addition to minimizing the generation of ARD at PGP, the engineered dry cover for the tailings beach has to achieve a lowering of the phreatic line underneath the covered tailings beach to protect the long-term integrity of the tailings dam. Due to the dual design constraints of

minimizing ARD generation and lowering the phreatic line below the tailings beach, only low permeability cover systems (physical barriers) were considered for Premier.

Finally, the most suitable cover system for the PGP tailings beach will be selected based on availability of cover materials, cost, and on the basis of performance indicators such as oxygen ingress, desiccation/erosion, percolate water quantities, oxygen concentration, pore water quantity, runoff and inflow quantities and cover installation and maintenance costs.

Cover Design

The design for the engineered cover test trials included the following layers (from top to bottom):

- 0.1m growing medium;
- 0.5m sand and gravel;
- 0.15m sand cushion layer – for bedding of a geo-synthetic liner (GCL) only;
- barrier layer: 1) 0.6m sand and gravel, and bentonite; or 2) Geosynthetic clay liner (GCL) or 3) till;
- random fill;
- 1m compacted tailings (compaction may not be feasible);
- 1.5m drained tailings; and,
- random fill, only if required to make up height and only in the lowest position.

Finally, analyses will be conducted as part of the final engineered cover design assessment to confirm constructability of the engineered cover. Results and conclusions of the study will be available during the fall of 2005.

Pipe Decommissioning

As part of implementing the TSF closure plan, decommissioning of the decants, construction diversion culvert, and other drainage structures within the dam foundation is required. There are known pipe conduits that are located beneath the dam embankment (i.e. between the downstream toe and the upstream toe, and passing through the “seal zone”).

These include two 200mm nominal diameter series 100 HDPE pipes, encased in concrete beneath the upstream drainage zone leading into a 150mm nominal diameter series 100 HDPE pipe encased in concrete through the dam and one 900mm diameter CSP section in the seal zone (operable, but not used).

The 900mm diameter construction diversion culvert was originally installed during construction of the dam to function as a temporary high-level drain for runoff water that may have exceeded the capacity of the sump pumps during construction. This conduit was left in the dam at the end of the sump pumps during construction. Several attempts were made during the 1980’s construction to seal the pipe, including: driving a wooden plug approximately 9m into the

downstream end of the CSP; and two attempts at injection of cement grout plug into the CSP through a cased vertical borehole upstream of the seal zone in the dam (Knight Piesold 1990).

The under drain and the decant system's pipes were successfully grouted in the fall of 2004. The CSP was exposed and found badly corroded and deemed unfit for grouting. The CSP pipe discharge will be mitigated by the newly constructed filter berm at the toe of the dam.

Cascade Creek Diversion Channel Rehabilitation and Upgrade

Cascade Creek Diversion Channel (CCDC) will be maintained in perpetuity. The design flow for the CCDC is 356 m^3/s. In the event that the diversion channel becomes blocked, an Overflow Inlet for CCDC will be constructed at the north end of the tailings impoundment, to allow routing of floodwater through the tailings impoundment and through the spillway. Tailings along this emergency routing will be covered by coarse gravel for erosion protection.

Gabion Wall

The concern here was the longevity of the gabions as the gabion baskets have started showing signs of deterioration. Therefore, the selected approach required increasing the longevity of the right wall to over 100 years. The preferred option for right bank - gabion wall upgrade was a gabion wire mesh overlay. A PVC-coated galvanized gabion wire mesh overlay was draped on the face of the existing gabions and then shaped to conform to the existing profile before being fastened with stainless steel fixing rings. This will result in a period in excess of 125 years before the zinc galvanizing is lost or an increase of some 100 years in the total lifespan of the structure.

Left Wall

The issue of concern here was related to the wall slope stability. The rehabilitation plan focused on achieving the original objective of increasing the long-term stability of the east slope of the Cascade Creek Diversion Channel (CCDC). The program included the removal of unstable knobs and installation of six horizontal drains.

Tailings Relocation

Tailings in the impoundment that are not beneath the engineered cover will be submerged under a minimum of 1m of water. Consequently, the elevation of the spillway invert predicates the relocation of tailings from some areas of the impoundment. The water cover will ensure that these tailings remain saturated under anticipated site and climatic conditions.

The tailings relocation program will deal with tailings located mainly in the following three areas:

- Tailings that were deposited on the side slopes around the basin will be relocated from above elevation 331.5m to the deepest part of the basin below elevation 227m.
- Tailings deposited in the north end of the basin between the Granduc Road and the downstream berm of the Cascade Creek emergency overflow will be totally removed to the original ground elevation.
- All tailings from the Cascade Creek emergency overflow area to about 100m downstream shall be relocated to the deep section in the basin.

Tailings from the spillway area were successfully relocated using truck and shovel arrangement. A total of 27000 cubic metres of tailings were removed from the area immediately around the closure spillway in 2004.

For the tailings from other areas of the TSF, any one or combination of methods, such as (but not limited to) excavation, dredging, pumping, conventional excavating or grading and similar methods may be adopted.

Permanent Closure Spillway

A permanent closure spillway on the eastern perimeter of the tailings impoundment will be constructed. The spillway is sized to pass the estimated 1000-year flood event for the combined local and Cascade Creek catchments while maintaining a minimum of 1 metre of freeboard below the dam crest. This provides a margin of safety against a possible overtopping of the dam by wave action, and against local erosion of the crest due to low spots that are below the design elevation assumed to be El. 336 m). The 1000-year flood was recommended as the inflow design flood by the Canadian Dam Association Guidelines (1999) for the upper and lower limit of low consequence and high consequence tailings dams, respectively. The elevation of the lower edge of the engineered beach cover will correspond with the invert elevation of the spillway. By maintaining the normal operating pond water levels at the lower edge of the cover, the hydraulic head acting on the rock fill dam will be reduced.

Spillway Design

The spillway will be situated so as to maximize the portion built in bedrock. Side slopes through rock will be 0.5H: 1V, and in soil at 2H: 1V.

A layer of tailings overlying portions of the inlet area was removed to prevent them from washing out along the spillway. At the east access road, the road fill material will be removed and the spillway was excavated in the bedrock beneath. The remaining sections of the spillway channel in soil were armored with riprap to prevent erosion.

During future flood events, Cascade Creek Diversion may become blocked and the floodwaters will be routed through the spillway. In this situation the spillway is operating as an emergency discharge mechanism to protect the dam. Some erosion of the Granduc Road and the spillway cascade is expected. However, if this occurs, the Granduc Road will also have been eroded at the Cascade Creek overflow inlet, Cascade Creek Diversion will be blocked and repairs will be required at both locations.

Sinkholes

The sink holes observed in the TSF in mid-2001 are located in the tailings beach near the western perimeter of the impoundment between 100 m to 115 m upstream from the crest of the main dam and 50 m to 65 m upstream from the upstream toe. The dimensions of the main sinkholes measured as follows: North sinkhole – diameter = 2.5 m, depth = 2.5 m, and volume = 4.59 cubic metres; and South sinkhole - diameter = 4.3 m, depth = 1.6 to 1.7 m and volume = 8.2 cubic metres.

The hydraulic connection(s) between the sinkholes and their ultimate discharge point (if any) were not known. The distance between the sinkholes and the main dam (in absolute terms, and relative to the size of the sinkholes) indicated a low likelihood that the sinkholes were related to piping through the earthen portion of the dam, especially in light of their location relative to the decant and underdrain pipes. Because of their location, it was considered that the sinkholes are likely related to a leakage of tailings and effluent into the decant or under-drain system.

The results of a risk analysis based on the postulated hazards are presented in Table 1. The analysis considers several scenarios, and utilizes a subjective low-moderate-high rating system to assign values to the Likelihood, Consequence, and Risk involved in each of the scenarios. Risk is determined as the "product" of the Likelihood and Consequence of a Hazard. However, only a quantitative risk assessment was undertaken.

Table 1: Risk Matrix for Tailings Discharge – Premier TSF

Postulated Hazard	Likelihood of Occurrence	Consequence of Hazard	Risk
Leakage of tailings into a cavity within the impoundment	Low to Nil	Nil	Nil
Piping of tailings through main dam	Low	High	Moderate
Leakage of tailings into the underdrain pipes	High	Low or Nil	Low or Nil
Leakage of tailings into one of the decant pipes	High	Low or Nil	Low or Nil
Leakage of tailings into both of the decant pipes	High	Moderate to High[1]	High

[1] *Dependent on the total solids concentration, if any, in the effluent.*

Based on the above risk factors, the sinkholes were monitored on a regular basis and a contingent plan complete with appropriate safeguards was developed to ensure that downstream environs are protected in the event of further failure of the sinkholes.

The sinkholes were back-filled in the summer of 2004 with Mile 18 sand and gravel to reduce the risk of further movement of tailings from the TSF.

Mine Water Management and Treatment System

Water from the underground mine will continue to be directed to the appropriate treatment facility as required. The mine water treatment plant (MWTP) used to precipitate metals from the underground water will continue to be utilized as required to ensure water meets quality criteria prior to discharging to Cascade Creek.

Revegetation

The revegetation plan for the disturbed areas of Premier Gold Project focuses on the growth and development of local native species, Sitka alders. The native species has been found to be the best one for revegetation and research continues to study the propagation of different planting techniques, the growth variations in different medium, and promotion of vegetation colony establishments. Over 320,000 alder seedlings were planted on waste rock dumps between 1998 and 2002 with survival rates of between 83% and 89%.

Progressive Rehabilitation Programs

Some highlights of work completed to date include routine maintenance of Cascade Creek Diversion Channel; construction of a pipeline to convey poor quality tailings supernatant water to the MWTP for treatment; removal of debris from the Indian Creek and north tailings pond diversions; monitoring of engineered cover test plots jointly constructed by the Company and the University of Western Ontario; 6-level portal rehabilitation and upgrade; decommissioning and closure of 4-Level portal and related structures; monitoring of sinkholes developed within the tailings storage facility; construction of a filter berm (partially completed); decommissioning and closure of the TSF decant system; decant system grouting; demolition of the reclaim system building; grouting of underdrain pipes; decommissioning and closure of a 900 mm CSP culvert. Other activities conducted include Cascade Creek Diversion Channel (CCDC) upgrade – right gabion wall and left rock wall; construction of closure spillway (partially completed); relocation of sludge from the sludge settling pond into the Tailings Storage Facility; lime silo upgrade; sale of non reclamation assets; revegetation of disturbed areas using local plant species – alders; continued collection and treatment of mine water; demolition of surface buildings and decommissioning of surface infrastructure; closure of surface openings; development of site-specific water quality objectives for closure; development of a post-closure environmental monitoring and control program; and provision of reclamation for long-term care and maintenance.

Decommissioning and Closure Progress

Table 2 gives details on how the closure objectives are met.

Table 2: Assessment of Decommissioning and Closure Progress in Relation to Projected Objectives

OBJECTIVE	APPROACH AND STATUS
Minimize the potential impacts from acid rock drainage related to the tailings	• Comprehensive ARD characterization program undertaken (ABA, Kinetic Testing and use of In situ Lysimeters) • Test plots constructed in 2002 and are being monitored for performance with a goal to select appropriate ARD Control technology
Provide a self-sustaining growth of local plant species such as shrubs over waste rock dumps and other disturbed areas	• Seed mixture developed in the early stages • Assessment undertaken in 1996/97 and it became evident that revegetation using grass would not work • Shifted towards using local tree species – Sitka Alders in 1998. This initiative has been successful and yielded positive results • Planted > 320K alders at PGP to date
Decommission of the mine-mill complex including, and not limited to access roads; waste rock piles / dumps; surface openings; mill complex; buildings and structures; tailings storage facility (TSF) and its appurtenances; pipes; and other conduits	• Re-vegetated waste rock dumps using alders: >320,000 Alders Planted • Decant system was grouted in 2004 • Surface openings decommissioned in 2003 • Waste rock dumps re-sloped and re-vegetated • Under drain pipes grouted in 2004 • Filter berm construction completed in 2005
Provide self-sustaining water management and control structures for all relevant site components	• Closure spillway construction completed in 2005 • Fuse plug spillway constructed in 2004 • Run off diversions maintained

Reduce erosion through sequential re-vegetation and reclamation of the site	• Planted sitka seedlings and grass for erosion control and depict end land use – wilderness
Develop a post-closure environmental monitoring and control program to determine performance of the prescribed mitigative measures	• Various post-closure monitoring programs have been developed including but not limited to aspects such as water quality, vegetation metal uptake, plant growth performance, geochemical characterization, water flows, waste rock dump stability, TSF performance indicators and influent quality to the Mine Water Treatment Plant (MWTP) • MWTP inputs and outputs including related by-products.
Return the site to near original land use – wilderness	• Planted local plant species to depict a near original land use • Requires further effort
Re-integration of lands disturbed by mining into the surrounding landscape	• Where possible re-sloped the dumps to depict surrounding landscape attributes • Requires further effort
Develop a contingency plan in the event that the proposed closure and decommissioning plan does not produce the expected results	• Site will continuously evaluate the post closure data to determine performance and identify areas for continual improvement • Contingency plans exist for the TSF, MWTP and the re-vegetation programs
Develop cost estimates for the decommissioning of existing components and post-closure activities	• Cost estimates were developed for capital and post closure activities • Overall closure cost for the site is estimated to be CAD 19.4 Million ➢ Approximately $ 6.9 Million for capital items and $ 12.50 Million for Long Term Care and Maintenance

Maximize on the sale of non reclamation assets	• Non reclamation assets were decommissioned according to established procedures • Equipment list was developed and appraisals were done for all major pieces of the assets • Website was developed to market the assets • Some equipment were consigned to an equipment dealer
Select and set aside reclamation assets to minimize closure capital costs	• Reclamation assets were set aside for the closure and decommissioning of site components • Equipment were rented to contractors at rates slightly lower than the Blue Book Rates • Surplus non reclamation assets will be sold once construction work is completed

Post-closure Programs

Some of the post closure obligations include but are not limited to the following:

- The Granduc road will be left open and Boliden Limited ("the Company") will not be responsible for the maintenance of the road;
- The Big Missouri Road will be reclaimed to a single lane route or may be assigned for other land uses and decommissioned at the end. However, the Long Lake Joint Venture Power Project plans to use the Big Missouri Road for penstock route alignment;
- Care and maintenance of the re-vegetated areas;
- The existing mine water treatment plant (MWTP) will remain in place; and
- Implement the post-closure monitoring and maintenance programs for chemical, biological and physical components to assess the success of remediation measures.

Land Use and Capability

Premier Gold Project supports wilderness capability primarily due to the limiting topography, soil and forestry capabilities. Due to steep topography, excessive snow depths, prolonged winter climatic conditions and isolation from large population centres, the primary end land-use purpose for the Premier Gold mine site is wilderness. The planned post-mining land objective is to support native plant species with adequate bio-density and bio-diversity for wilderness habitat. To date,

the Company has planted >300,000 Sitka alder seedlings on waste rock dumps and other disturbed areas. Vegetation will provide cover and forage for resident and transient mammals. Therefore, the planned final land use is wilderness habitat.

Opportunities to Generate Revenue to Cover Some of The Post-closure Liabilities

Depending on prevailing market conditions, a well-developed non-reclamation asset recovery plan will maximize residue value to cover some reclamation liabilities. An asset recovery plan must include among other things major equipment shutdown and maintenance procedures and an asset sale plan. Equipment shutdown procedures will ensure that the equipment is shutdown and maintained in an appropriate manner for continued operation if the mine reopens or sale to a potential purchaser. A list of all assets was developed for the marketing and inventory tracking purposes. A list included specifications such as equipment identification number; motor rated power/voltage, size, other important descriptors, minimum and maximum expected prices. In-house personnel and an equipment broker using information from purchase orders taking into consideration current market conditions and equipment condition did pricing jointly. In addition, comparable prices were obtained from equipment dealers. As an alternative to the use of internal resources, the Company may engage the services of equipment dealers to undertake the equipment appraisal. Generally, equipment dealers have contacts and understand the current market conditions and have a wide network of other dealers and are constantly receiving enquiries for equipment. Retaining an equipment dealer for asset appraisal may take the following forms of agreement – one time fee for service to undertake the appraisal or commission based agreement with a goal to oversee the sale of the equipment. Typical commission rates range between 10% and 15% of the sale price. Depending on the prevailing market conditions, retaining an equipment dealer may maximize the bottom line.

Potential Non-traditional Post-closure Revenue-generating Opportunities

To generate revenue to cover for post-closure liability or reduce closure costs, some companies are aggressively looking at non-traditional ways including the ones outlined below:

- Evaluate the potential for other land uses such as opportunities for hydro power development;
- Collaborate with other land users to take advantages of potential synergies of common interest;
- Investigate the use of building structures and facilities to service the community of interest to reduce demolition costs;
- Investigate the use of some site components for recreational activities such as skiing, hiking and park development;
- Investigate the feasibility of marketing of non-acid generating waste material for construction of civil works.

Lessons Learned

Some of the lessons learned when developing a closure plan for this site include the following:

- Experience gained from environmental planning for LTCM has indicated a number of suggestions for future plans:
  - Ensure that all mixed chemicals and reagents are used up in the process before closing the milling process whenever possible;
  - Ensure that appropriate regulatory agencies are involved and kept well-informed of all aspects of closure related to their areas of control;
  - Ensure that all relevant permits are obtained;
  - Develop an environmental operating plan for closure; and
  - Review the environmental operating plan for the site on a timely basis.

- There are several known pipes through the dam (e.g. CSP culvert, decant pipes and underdrain pipes) and possibly other unknown pipes. Deterioration of these pipes may cause high seepage through the dam by allowing piping in and around the pipes even if they are plugged. Designing the TSF for closure would have minimized the risks associated with the pipes.

- Well-designed tailings deposition program would have minimized or eliminated the need for tailings relocation and engineered cover for the beach.

- Designing the Creek Diversion channel for closure would have minimized the need to re-stabilize the channel for closure and render it maintenance free. The channel left wall failed twice resulting in significant expenditures for scaling and installation of horizontal drain holes.

- Well-planned reclamation research would have accelerated the re-vegetation program. The Company used traditional approaches to re-vegetate the waste rock dumps by means of grass. For eight years this approach did not produce expected results. Trial tests conducted thereafter using local alders produced successful results and hence the Company changed its reclamation strategy, focusing in local species particularly Sitka alders.

- Setting aside reclamation assets immediately after a decision to shutdown the mine, helped to reduce closure costs at this site. Since the site is remotely located it is very costly to rent equipment from major centres due long delivery distances resulting in high mobilization and demobilization costs. Well-maintained reclamation assets will assist in day-to-day activities that can be done using in-house personnel.

- Select the LTCM human resources carefully to ensure existence of required competency and skills to meet the site challenges. Well-selected crew for the long term care and maintenance

is a tangible asset for the short and long term performance of the site. In addition, use in house staff as much as possible in order to nest the experience in house for future projects.

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