Proceedings of the 23rd Annual British Columbia Mine Reclamation Symposium in Kamloops, BC, 1999.
The Technical and Research Committee on Reclamation

ENVIRONMENTAL MANAGEMENT CONSIDERATIONS FOR A MINE SITE UNDER LONG-TERM CARE AND MAINTENANCE

Linda Zurkirchen

Boliden Westmin (Canada) Limited Premier Gold Project, Stewart, British Columbia, Canada

David M. Mchaina

Boliden Limited
Suite 1500 West Tower, 3300 Bloor Street West
Etobicoke, Ontario, Canada

ABSTRACT

Environmental planning for a mine site under long-term care and maintenance (LTCM) plays a key role in ensuring organized and efficient use of limited resources. The objective is to minimize operating and maintenance costs and future environmental liabilities.

Significant environmental aspects must be identified during the planning phase to minimize environmental liabilities and risks associated with major site components.

Some of the major aspects considered during the planning phase for LTCM include, risk assessment, environmental audit, chemical and reagent inventory, development of a decommissioning and closure plan, geochemical characterization of waste rock dumps and tailings, review of environmental monitoring data and reclamation programs and permit requirements, mixed chemical and reagent destruction program, government consultation, emergency preparedness and internal and external communication protocols.

This paper discusses the environmental management considerations for a mine site that is currently under long-term care and maintenance together with lessons learned during the implementation of the plan.

BACKGROUND

The mine and mill site of discussion in this paper is the Premier Gold Project (PGP), located approximately 20 km north of Stewart B.C. and approximately 2 km from the B.C. / Alaska border. Gravel road access to the Premier Gold Project is from Stewart, B.C. through Hyder, Alaska. Passenger vehicles have access during summer months and during winter months if snow clearing is contracted. During long term care and maintenance winter access is by snowmobile or snowcat.

The Premier Gold Project 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: Premier, Dago, S-I and Province. Waste rock generated from the open pit mining activities was transported by conventional rock 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 the 1960's. Underground mining continued until April 1996 when low reserves and gold prices forced activities to cease.

A lime treatment facility with twin settling ponds is in continual operation for treatment of elevated zinc concentrations in the influent resulting from metal leaching within the underground mine workings.

The milling process used cyanidation and carbon-in-leach (CIL) technology for gold and silver extraction. Prior to discharge to the tailings pond, carbon-in-leach tailings were treated with the INCO SO2/Air process to destroy residual cyanide.

The tailings storage facility was operationally designed for sub-aerial deposition. Therefore, due to the high surface runoff from direct precipitation, the supernatant pond level needs to be kept to a minimum through continual effluent discharge to the environment. Closure plans for the tailings storage facility consist of sub-aqueous tailings disposal due to the acid potential of the tailings.

Premier Gold Project entered into LTCM with some pre-planning, as is the case for most operations in long-term care and maintenance. Lack of ore reserves and low gold and silver prices forced Premier Gold Project to cease operations, however potential sale of the property restricted decommissioning of equipment and materials. Therefore, the property, while still a permitted turn-key operation and responsible for two liquid effluent discharges, entered into long term care and maintenance for an undetermined length of time. The human resources required to maintain the property under this status are four full time maintenance workers and one environmental co-ordinator. Two maintenance workers per shift work a one week in, one week out schedule, while the environmental co-ordinator works regular days and as required, primarily from an office in Stewart, B.C..

ENVIRONMENTAL MANAGEMENT CONSIDERATIONS FOR LONG-TERM CARE AND MAINTENANCE

In order to sufficiently address the major environmental aspects associated with the property, a clear understanding should be developed regarding boundaries and limits in the following areas:

- Environmental Programs
- Liabilities
- Risks
- Budget
- Resources

Major environmental aspects and long-term care and maintenance plans within these limits can then be defined.

At the Premier Gold Project, the environmental planning for long-term care and maintenance occurred as an effect of the shut-down of mining and milling operations. For certain items planning is a dynamic process and is still underway. Major environmental aspects characterizing the Premier Gold Project included:

- Environmental audit
- Risk assessment
- Development of the decommissioning and closure plan
- Ongoing monitoring programs and permits
- Government consultation
- Emergency preparedness and response plans
- Internal and external communication protocols

Environmental Audit and Risk Assessment

The environmental planning commenced with a brief environmental audit focusing on long-term care and maintenance status. The audit was performed on the Premier Gold Project by the environmental co-ordinator with verbal consultation from the past mine manager and corporate environmental engineer. As most deficiencies were identified in the formal audit of the previous year and mining and milling activities had been minimal since that audit, it was deemed that a formal audit was not required at the time. Together with the audit, a risk assessment was conducted to assist in prioritizing work and development plans. Only those aspects of relatively high risk are discussed. The long-term care and maintenance audit confirmed some known outstanding deficiencies from the previous year such as the requirement for an updated decommissioning and closure plan including:

- Geochemical characterization of waste rock dumps and tailings.
- Engineering design of closure of the tailings storage facility.
- Updated reclamation plans.

New deficiencies identified due to the property status of long-term care and maintenance included:

- Outdated emergency preparedness plans & training.
- Internal & external communication plans & protocols.

In addition, items were identified as potential risks or problem areas (irresponsibility was not transferred to the remaining human resources):

- Chemical and reagent inventories and locations.
- Hazardous and waste material storage and disposal.
- Monitoring programs and permit requirements.
- Treatment system operating procedures.

The audit was utilized to develop environmental plans for the deficient items as well as those items identified as potential risks.

ENVIRONMENTAL PLANNING

The environmental planning for the property focussed on, but not limited to the following eight components identified in the audit. The environmental plan for each component was developed maximizing the available resources and minimizing future environmental liabilities.

1.0 Development of the Decommissioning and Closure Plan

All items identified in the environmental audit were critical aspects of the decommissioning and closure plan. A plan to address the deficient items in the environmental audit was developed and in some cases implemented, prior to finalizing the decommissioning and closure plans.

2.0 Geochemical Characterization of the Waste Rock Pumps and Tailings

The geochemical characterization of the waste rock dumps had been initiated during mining activities, but had not been completed. Outstanding items for completion included a geological report of the waste rock characteristics, kinetic testing of the waste rock and interpretation of the data. Premier Gold Project followed BC ARD Task Force Guidelines to complete the characterization. Due to the availability of in-house resources, the geological characteristics report and kinetic cell sampling was designed to be undertaken by in-house geologists. Upon compilation of this data an experienced ARD consultant would be retained to interpret and present the data.

The tailings had been characterized during milling activities and the data available was deemed satisfactory to commence with tailings storage facility closure planning.

This component of the environmental plan was initiated immediately and completed.

3.0 Tailings Storage Facility

The tailings storage facility required an engineered closure design. Due to the characteristics of the tailings, it was decided to request proposals and retain a consultant with substantial experienced in sub-aqueous closure design.

This component was initiated immediately and has been completed.

4.0 Reclamation Plans

Reclamation plans had to be reviewed and updated to reflect the current property status. Planning involved re-evaluation of the existing reclamation plan and updating it to concentrate reclamation activities and projects during the initial stages of long-term care and maintenance so to maximize the resources available. Some of the projects include:

- revegetation project
- cover of acid rock drainage area
- resloping of portal to divert water to the treatment plan.

The plan has been updated and implemented.

5.0 Chemical. Reagent and Hazardous Waste Inventories

Long-term care and maintenance planning for the materials required an inventory of all chemicals, reagents, hazardous wastes and radioisotopes. Upon completion of the inventory, storage plans were to be developed including identification of items to be grouped and relocated to possible lower risk storage areas such as:

- the reagent bay in the mill complex, complete with spill containment.
- acid storage lockers.
- chemical storage cabinets.

This component is being undertaken by location. Inventory and re-location has been undertaken in the mill building. Inventory is presently underway in the assay lab. Further plans for neutralization, degradation, removal or disposal are being developed.
A balance of mixed chemicals and reagents used in the milling process require to be disposed of and treated in a sound environmental manner to render them non-toxic to the receiving environment.

Plans were developed to neutralize and dispose of the remaining mixed chemicals and clean up the mill building in preparation for decommissioning.

The primary chemicals that required neutralization are those that have been mixed and were stored in tanks within the mill building. Some dry chemicals also remaining on site were utilized in the neutralization process.

The chemicals planned for neutralization and discharge to the tailings storage facility (TSF) are detailed in Table 1. Final neutralized chemical concentrations are given in Table 2.
The neutralization process followed the same process that was used during milling operations; however, there was no ore mass and for some chemicals, a final polishing step was added for security.

Aspects considered for this program included the following:

- Discharge and monitoring program:
  - pH level monitoring as process is pH based
  - Each neutralized batch was sampled and analyzed by an independent lab
  - Discharge to the TSF was monitored in terms of effluent quality.
  - Discharge from the TSF was monitored on a weekly basis to ensure discharged water remained in compliance with permit limits.
- Safety Program:
  - Safety training was undertaken
  - WHMIS training
  - Emergency response plan was developed
  - Personal protective equipment (self-contained breathing apparatus and chemical antidotes) was made available to employees
  - First aid kit was checked and restocked
  - Gas-monitoring program was developed.

6.0 Compliance Assurance and Review of Monitoring Programs and Permit Requirements

Part of the planning process for environmental monitoring and permit requirements required a review of the existing programs and the relevance to long-term care and maintenance. As the physical structures and surface disturbances had not changed since operations, and two effluent treatment facilities remain in operation during long term care and maintenance, the review indicated that no changes to the monitoring programs are required at this time.

A plan to continue to fulfill all permit requirements was developed based on the resources available, and found to be satisfactory.

TABLE 1
CHEMICAL AND NETURALIZATION PROGRAM

Chemical	Quantity	Form	Concentration	Treatment/Neutralization Process
Sodium Cyanide	11m^3	Liquid	25,000 ppm	♦ 5-step process of standard neutralization techniques – Use of SO2/air process to reduce the cyanide concentration to approximately 1000 ppm – Use of ferrous sulphate and copper sulphate to complex the remaining free cyanide and precipitate the ferrocyanate. This step reduces cyanide to approximately 10ppm – Addition of calcium hypochlorite to neutralize ♦ Residue free cyanide to below 1.0 ppm – Use of polishing process to ensure complete reduction of copper solubility. A minor quantity of sodium sulphide was added to ensure copper solubility reduced. Wash down of cyanide mix tank, storage tank, loop and containment area. Final batch of calcium hypochlorite was put through the entire system to pick up and destroy any residue cyanide in the system.
Sulphur Dioxide	~ 5.85 m^3	Liquid	99%	Used during the cyanide destruction process
Copper Sulphate	1000 kg.	Solid Crystals	100%	Used during the cyanide destruction process
Ferrous Sulphate	815 kg	Dry	100%	Used during the cyanide destruction process
Nitric Acid	3 m^3	Liquid	58%	Neutralized through the addition of caustic solution
Lead Nitrate	500 kg	Dry	100%	Addition of water directly into the lead nitrate tank and the neutralized using lime slurry
Sulphuric Acid	Minor	Tank Residue	~ 91%	Neutralized through the addition of caustic solution.
Flocculant	800 kg	Dry Powder	100%	Added to one of the cyanide neutralization batches.
Quick Lime	15 tonnes	Dry	~ 90%	Used in the neutralization process
Laboratory Chemicals	Minor	Dry & Liquid	-	Appropriate chemicals were neutralized in with major chemical neutralization process

TABLE 2

TARGET EFFLUENT QUALITY AFTER CHEMICAL TREATMENT

Neutralized Chemical Solution	Form	Discharge Concentration
Sodium Cyanide	Liquid	< 1.0 ppm total CN
Sulphur Dioxide	-	-
Copper Sulphate	Liquid	< 0.3 ppm dissolved Cu
Ferrous Sulphate	Liquid	< 1.0 ppm dissolved Fe
Nitric Acid	Liquid	pH >8.0<11.00
Lead Nitrate	Liquid	<0.2 ppm dissolved Pb
Sulphuric Acid	Liquid	pH >8.0<11.0
Flocculant	Liquid	-
Quick Lime	Liquid	pH < 11.0

7.0 Treatment System Operating Procedures. Emergency Preparedness Plans. Communication Protocols

A plan was developed to ensure the operating procedures, emergency plans and communication protocols were updated and information was transferred to the remaining maintenance workers. The plan was developed to reflect the available human resources.

GOVERNMENT CONSULTATION

Government consultation was scheduled into each component depending upon the level of involvement required. Generally, consultation was scheduled during the planning stage, or upon completion of planning and prior to implementation.

PLAN IMPLEMENTATION

The environmental plan was implemented immediately upon completion of any one component of the plan. As that component is completed planning continues depending upon the outcome of each component.

LESSONS LEARNED

Experience gained from environmental planning for long-term care and maintenance has indicated a number of suggestions for future plans:

- Involve someone who will be remaining on the site. It would be beneficial to have someone with long-term interests in the site on the planning committee. Such people are more likely to foresee potential problems or challenges with the plans.
- Define who has corporate responsibility for the property. A corporate person should have ultimate responsibility for the site to assure corporate policy, procedures and communications are maintained.
- Ensure the site manager understands roles and responsibilities. The head person on site may not have experience with site management, and therefore should be thoroughly trained on the responsibilities and liabilities accepted with the position.
- Locate required information prior to staff re-locations. Locate and file any data, information or procedures that will be required for operations or maintenance during long-term care and maintenance phase. It is easier to have current responsible staff assist in locating this information prior to their departure rather than searching through offices or trying to locate their whereabouts.
- Ensure persons doing inventories are properly trained. Persons doing inventories must have a thorough understanding of the characteristics of the materials they may encounter, avoid hazardous materials and notify the manager of any damaged or unsafe materials.
- Inventory completeness. Ensure persons undertaking inventories are very thorough and search all areas of property for hazardous materials.
- Ensure materials or equipment removed from the property are dispensable. Corporate office may permit other corporate operations to remove materials or equipment from the long-term care and maintenance site. Ensure that these materials or equipment will not be required by the site during long-term care and maintenance.
- 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 all relevant permits are in place.
- Review the environmental operating plan for the site on a timely basis.