Proceedings of the 17th Annual British Columbia Mine Reclamation Symposium in Port Hardy, BC, 1993.
The Technical and Research Committee on Reclamation

THE DEVELOPMENT OF A CLOSURE PLAN FOR ISLAND COPPER MINE

Ian A. Horne

Chief of Environmental Control, BHP Minerals Canada Ltd., Island Copper Mine, P.O. Box 370, Port Hardy, B.C. VON 2PO.

ABSTRACT

Island Copper began it's formal closure plan in 1988. It was a commitment made when seeking approval of the South Wall Pushback proposal, that extended the mine's life to 1996. A Closure Plan was submitted to the Vancouver Island Mine Development Review Committee in 1990. Following the committees review it was agreed to further develop the plan for submission in December 1994.

The format of the updated closure plan divides the mineral claim into eight zones of influence; the plant site, the open pit, the pit walls, the beach dump, the land dumps, water management, marine monitoring, and the Marble River pump house. This paper briefly outlines the research and monitoring being done in these areas for the closure plan. Emphasis was given to three options for reclaiming the open pit. They are; to allow the pit to fill with precipitation, runoff and acid rock drainage (ARD) ; or to create a meromictic lake with a passive ARD treatment system in the anoxic lake bottom; or to convert the pit into a municipal solid waste landfill.

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INTRODUCTION

When Island Copper first began production in 1971 the focus of environmental concern was directed almost entirely to the marine environment. As a result of this a comprehensive oceanographic monitoring program was developed and instituted in Quatsino Sound. This program has been ongoing for twenty-three years.

As late as 1985, Island Copper did not appear to have a long term environmental impact. The continuing comprehensive marine monitoring program showed that even the physical disturbance of marine benthos by tailings would recover fully when discharge ceased. In 1986, attention turned to the emerging ARD from some of the land dumps. The focus and strategy for mine closure had changed.

Island Copper committed to developing a Closure Plan in 1988, as part of the South Wall Pushback proposal. This project, currently underway added about four years of ore reserves, extending the mines life to 1996.

The Island Copper Closure Plan was submitted to the Vancouver Island Mine Development Review Committee (VIMDRC) in October 1990. The report discussed final closure strategies for the property with particular emphasis on the waste rock dumps, the open pit and ARD water management.

A meeting was held with the VIMDRC in Port Hardy on July 3, 1991, to review the report and to receive comments and suggestions from the committee members. It was decided that Island Copper would continue to develop the plan and submit a final closure plan in December 1994.

The format developed for the final closure plan divided the mine's zone of influence into eight distinct areas; the plant site, the open pit, the pit walls, the beach dump, the land dumps, the water management system, the marine system and the Marble River. This paper will touch briefly on each area, though the emphasis will be on the open pit.

CLOSURE PLAN COMPONENTS

Plant Site

Island Copper's reclamation permit requires the dismantling of buildings, burial of concrete foundations and revegetation of the site. An exemption to this may be granted by the Chief Inspector of Mines. The District of Port Hardy would prefer that the infrastructure be maintained for future development. However, the questions of personal, corporate and tax liability remain.

Beach Dump

The beach dump occupies 245 hectares of area created by placing waste rock, trucked out of the pit, into Rupert Inlet. The reclamation plan for this area includes recontouring, placing of till and revegetation on the foreshore and upland area. About 16 hectares of foreshore and upland were reclamied in 1992.

The intertidal zone will be recontoured to a 10% slope down to the low tide mark. About 600 lineal meters of beachfront were reclaimed in 1992. This work was completed in May and June, during the lowest tides of the year. Natural recolonization was monitored and a photographic record was made of the growth. Large boulders will be placed in the low littoral or into the sub-tidal zone to encourage the settling of macrophytes (otherwise known as kelp) . Within one year of the recontouring there will be a resonable growth and diverse population of intertidal organisms. After three to five years the only differentiation from a natural beach will be sharp edged blasted rock and not rounded beach cobbles.

Land Dumps

The land dumps, located to the north of the open pit, occupy 180 hectares. To date 86 hectares have been reclaimed using a grass/legume seed mix and planting red alder and pine seedlings. The ultimate land use objectives are wildlife habitat and eventually forestry. In consultation with local foresters the plan is to establish a stand of red alder which through natural succession will give way to the surrounding cedar/hemlock forest.

Water Management

Since the first evidence of acid rock drainage was detected in 1985, considerable effort has gone into monitoring and evaluating this issue. In the fall of 1991, Island Copper embarked on a high intensity, long duration monitoring program to determine the mass loading of metal contaminants in land dump drainage. From the twenty plus monitoring stations sampled in previous years, eight were selected for this program. At six stations electronic flow measuring devices with data loggers were set up. At three of these stations automatic water samplers were set up to collect up to six samples per day. At the other five points, samples were collected daily, Monday to Friday. From October 1991 to date a large body of data has been collected. A report written by Rescan Consultants Inc. (1992), covering the period October 1991 through March 1992 concluded that 50% of the cumulative water volume and subsequently metal loading, passed the gauging stations by late December.

Water Management (cont'd)

Except during one flood event, instantaneous flows measured once per day were within plus or minus 17% of the daily average (based on 24, hourly flows) 68% of the time (Rescan 1992). Evaluations were made of each stream, how it reacts to rainfall and the rate and nature of the loading. Needless to say the scope of this report goes beyond this paper. Kevin Morin will present a paper during this symposium which uses the data from this study.

The strategy for dealing with the ARD water during continued operation of Island Copper is to direct all land drainage into the Water Management Pond and use the water in the mill as process water. After closure the options relate closely to the final state of the open pit. I will discuss these as part of the open pit plan.

Marine Monitoring

Island Copper has been monitoring the marine environment of the Quatsino Sound system since 1970. The program encompasses physical, chemical and biological oceanography with annual reports submitted to the regulatory agencies. In addition to the monitoring program Island Copper has supported many graduate students whose thesies have researched topics such as tailings movement and distribution, as well as benthic (bottom dwelling organisms) recolonization of tailings.

As we head toward closure the marine monitoring program is being reviewed. A four year pre and post closure program has been outlined; two years of operational evaluation followed by two years of post-discharge monitoring. The pre-closure monitoring program will be similar to that presently carried out. The planned post-closure program would measure the rate of recovery of Benthic organisms disrupted by the physical process of tailings discharge. As well, the chemical composition and suspended sediment load of the marine waters will be monitored. It is expected that two years after the cessation of tailings discharge the benthic organisms will have colonized the tailings beds in numbers and diversity approching pre-operational levels.

Marble River

Since 1982, Island Copper and Western Forest Products along with the Department of Fisheries and Oceans have sponsored a salmon enhancement facility at our pump house. Water and power have been provided by Island Copper free of charge. On closure, the pumping facilities and the electrical service which originates at the mine site, would be removed. Some discussion has been held toward finding a solution to this problem. Island Copper is committed to the continued success of the Mable River salmon hatchery and remains confident that a suitable solution may be found.

OPEN PIT CLOSURE OPTIONS

The Original Proposal

The original proposal for reclaiming the open pit was to open a channel to Rupert Inlet and flood the pit with seawater. The desired result would be *a* viable marine aquatic environment forming an integral part of Rupert Inlet. Once flooded, fish and other marine organisims would enter the new habitat, mitigating habitat losses caused by the beach dump. The proposal showed that seawater filling could be completed in 40 days.

A contract was let to a physical oceanography firm to model the conditions in the pit after flooding. The model was based on typical, natural inlet systems common to British Columbia. Seventeen simulations were carried out using various combinations of channel depth, oxygen demand rates and time of year to begin filling. Then another 10 simulations were run to refine the model. The duration of the last 10 simulations was 200 years. The model forecast the eventual development of a deep-water anoxic zone, an oxygenated near-surface zone and a potential sporadic overturn of anoxic water being carried toward the surface (BHP-Utah Mines Ltd.,1990).

The Department of Fisheries and Oceans reviewed this plan and concluded that the pit should be flooded with seawater but that free access to fish be prevented after filling is complete. This position was taken upon the belief that the fish habitat would be marginal at best and that the long term risks to fish and fish health were not acceptable.

This response from Fisheries broadened the scope of other end uses for the open pit. Three options have been entertained in recent months. They include the slow filling with precipitation, runoff and ARD; the meromictic lake with natural bio-sulfide treatment of ARD injected at depth; and the municipal solid waste landfill.

Slow Fill Option

The base case for closure is to direct all mine site runoff into the open pit. Under this scenario it would take in excess of 50 years to fill the pit (the 1990 Closure Plan said nearly 30 years but that included water pumped from Marble River). This option gives the advantage of time, first, to develop new technology to control or treat acid rock drainage and second, to allow investment of a relatively small capital fund to build into a fund required to build and operate a treatment facility.

This method is currently being used at other closed mine sites in B.C.

Meromictic Lake Option

The Meromictic Lake option was considered as an alternate to creating and maintaining an open channel connection into Rupert Inlet. Meromictic means quite simply that the lake does not circulate within itself. The water column is stratifed and stable.

The plan in brief, would, be to cut a channel to Rupert Inlet and flood the pit with seawater to about 30m below the discharge elevation. Then a freshwater layer would be placed on top of the seawater.

The model developed to investigate this proposal (Fig.l) was a three layer box model. The upper layer or surface layer is mixed by wind and penetrative convection during the fall and winter. The middle layer lies below the thermocline and is mixed from the surface during cooling periods. The lower layer lies below the chemocline and without an introduced energy source would not mix (Allen, 1992).

The thermocline is a sharp change in water density caused by temperature. Above the thermocline the temperature rises or falls (depending on the season), with increasing depth. Below the thermocline the temperature remains nearly constant with depth. The chemocline is a sharp change in water density caused by, in this case, the salinity difference between freshwater and saltwater.

The seawater below *the* chemocline would, following the original model of pit flooding, become anoxic. In an anoxic environment, given a suitable source of carbon, sulfur reducing bacteria should flourish and produce hydrogen sulfide gas. Conceptually if acid drainage was injected via a pipeline, at the bottom of the flooded pit, the free metal ions in solution would react with the sulfide to form a stable metal-sulfide precipitate. The precipitate would then settle to the pit bottom. Hence Island Copper could create a passive in-situ treatment system.

The injection of esentially fresh water into the bottom of the pit does however, provide the energy source that would cause the lower layer to mix. The meromictic lake model was used to predict how long water could be injected before the meromictic lake would completely mix.

Simplisticly speaking, the model showed that by raising the salinity of the acid drainage to 1 (seawater is about 33) the meromixis could be maintained for over one thousand years (Allen, 1992) . The predicted longevity of acid generation at Island Copper is less than one thousand years (Li, 1991).

The meromictic lake proposal is in a conceptual stage. There is much research and engineering to be done to prove its viability.

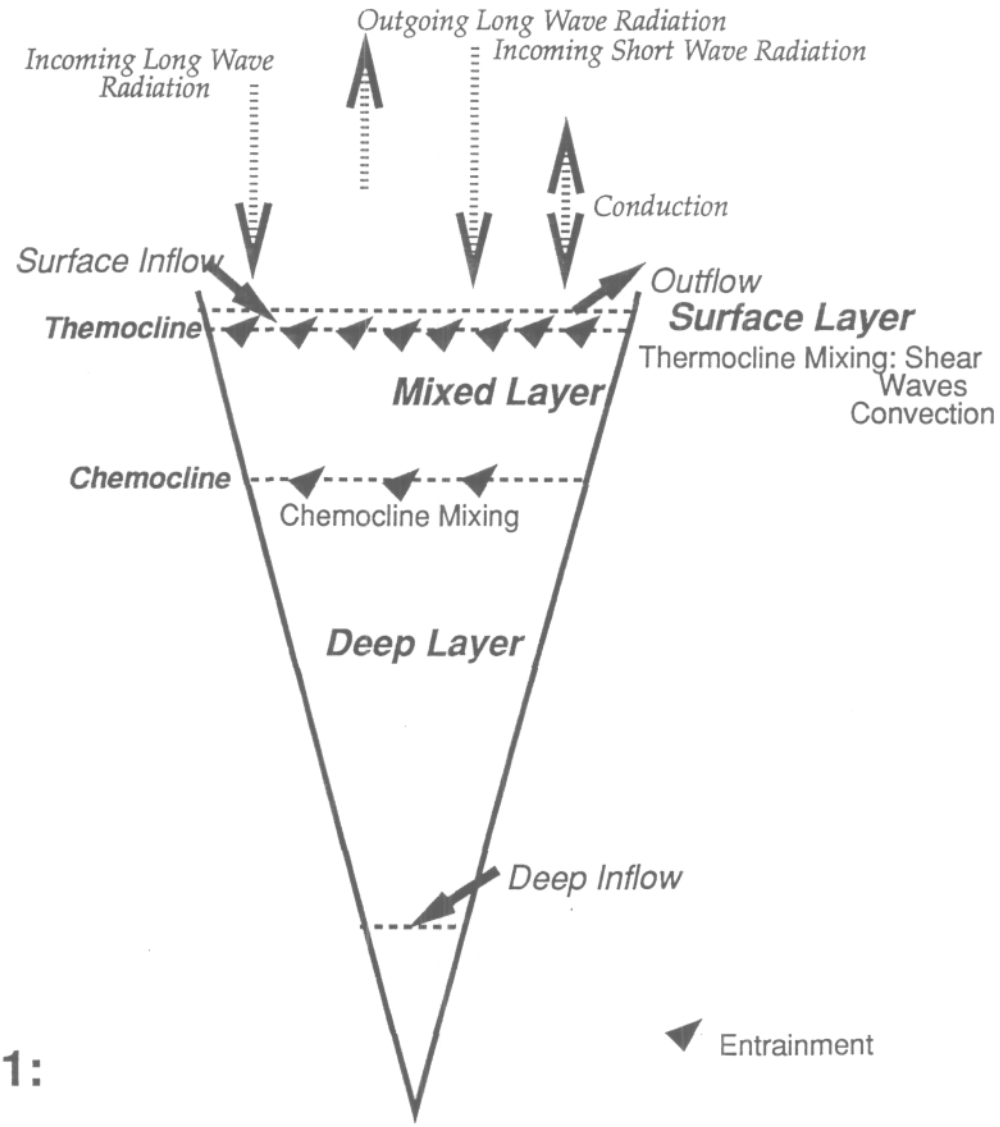

Figure 1:

Schematic of the Mine Lake

Waste Management Option

Island Copper is considering to undertake a feasibility study on utilizing the open pit as a municipal solid waste landfill site. Local community support is required for the study to proceed.

A conceptual study was completed and since mid-February 1993, has been presented to various elected, regulatory and public interest groups. In mid-March 1993, open public meetings were held in every local community. At the time this paper was written the meetings were still ongoing and no formal position had been taken.

The conceptual study identified the Greater Vancouver Regional District as the largest source of municipal solid waste (MSW) in B.C. The proposal was to take clean residual MSW ie. after it has been sorted with all recylables, reusables and hazardous waste removed. The MSW would then be compacted and loaded into containers; trucked to a marine terminal on the South Fraser River and loaded onto roll-on roll-off ocean going vessels. The ships would travel up the West Coast of Vancouver Island, enter Quatsino Sound and proceed to a marine terminal at the mine site in Rupert Inlet. At the mine site the vessels would be off loaded and the MSW, still in the shipping containers transported to the bottom of the pit. The waste would be placed in lifts across the width of the pit and covered daily with rock hauled from the mine's waste rock dumps.

Since the open pit is below sealevel, rain, surface runoff, groundwater and leachate from the waste would be captured within the pit. Rain and runoff water would be directed away from the waste. It would then be collected and pumped from the pit, separate from the leachate and treated as required. Leachate would be pumped directly from the waste and treated as required.

Natural gas generated by the decomposition of waste would be collected using extraction fans. The gas could be utilized as fuel for trucks and to gererate steam and/or electric power for pumps, fans and lights. Excess gas would be flared off. The leachate, gas extraction and treatment systems are existing technologies used in operating landfills.

Other areas to be considered include the stability of the pit walls and potential impacts on wildlife and fish habitat.

The lifespan of the facility would depend on the final design of the landfill. However, at an annual rate of 625,000 tonnes the facility would last 500 years. Increasing the rate to 1.25 million tonnes would give 250 years and at 2.5 million tonnes 125 years. The Greater Vancouver Regional District produces 1.46 million tons of non construction waste annually. They currently recycle 385,000 tons or 23% of this waste.

The benefits of this proposal to the North Island communities include potential employment opportunities for Island Copper employees. Preliminary estimates indicate the project would require about 50 people at the Island Copper site, plus additional personnel for the Vancouver terminal and ship crews. Potential support for local retail, commercial and service establishments as well as revenues to all levels of government would stabilize the local economy.

Finally, the landfill project would not conflict with other industrial operations wishing to take advantage of the available assets of flat land, energy generated from the landfill gas, a regular ocean shipping system between the North Island and Lower Mainland and the physical infrastructure on site. Nor would it preclude custom milling of ore from potential mining operations nearby.

I like to think of this landfill option *as a* long term mine reclamation project.

CONCLUSION

Island Copper is actively persuing research and monitoring toward the development of our updated closure plan. The plan will be submitted to the VIMDRC in December 1994. Mine closure is currently scheduled to occur in 1996.

REFERENCES

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