DECOMMISSIONING AND RECLAMATION OF THE JASPER GOLD MINE IN NORTHERN SASKATCHEWAN

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Abstract

The Jasper gold mine operated from February 1990 to June 1991, producing approximately 135,000 tonnes of ore. The ore was hauled off-site for milling and tailings disposal at the nearby Star Lake mill site. In April 1991, a decommissioning and reclamation plan was submitted to the regulatory agencies. The plan was accepted and decommissioning commenced in June and was completed by September 1991. A minimum three year transition phase monitoring programme was then undertaken to monitor the effectiveness of decommissioning work performed and the progress of revegetation.

Decommissioning work performed included sealing access to the underground workings, removing all surface structures and associated facilities, and preparing disturbed areas for revegetation. The mine portal was sealed by backfilling with waste rock. Raise break-throughs to surface were sealed by installing reinforced concrete caps over the openings. The strategy applied for revegetation was the encouragement of natural revegetation while avoiding the permanent introduction of non-native plant species.

The invasion of native plant species on disturbed areas was encouraged by various means. The seeding of short-lived agronomic grasses was successful in stabilizing soil conditions and providing a catchment mechanism for native airborne seeds. Scarification and recontouring of disturbed areas has also proven effective. Slash and deadfall from surrounding areas was also pulled out onto disturbed areas that had not revegetated four years after decommissioning. All of these methods have been effective in encouraging natural revegetation. However, earlier application of the slash and deadfall may have allowed for the abandonment of the property in the third year of the transition phase. The concrete caps used to seal the raise break-throughs to surface have performed as designed. Approval to abandon the site is anticipated in 1996, five years after decommissioning and the start of revegetation.

Introduction

The Jasper mine was a small (300 tonnes per day) underground gold mine located approximately 135 km north of La Ronge, Saskatchewan. The operation produced approximately 135,000 tonnes of ore and 42,500 tonnes of waste while operating from February 1990 to June 1991. Ore was hauled off-site for milling and tailings disposal at the nearby Star Lake mill site.

Decommissioning and reclamation commenced almost immediately upon completion of mining and involved work on minewater settling ponds, mine portal, mine break-throughs to surface, roads, buildings and associated facilities. The decommissioning work done in 1991 was accepted by the agencies and a minimum three-year transition phase monitoring program began. This paper will describe the methods used to decommission the site and the progress of revegetation on disturbed areas.

Decommissioning Plan Development

In order to receive approval for the project an environmental impact statement (EIS) had been submitted in April 1989, as required by the Saskatchewan Environmental Assessment Act. In this EIS, the potential environmental impacts due to mining were assessed and mitigative actions proposed. Areas investigated included acid generation prediction, surface hydrology, hydrogeology, surface water quality, wildlife, fisheries, and heritage resources (*Cameco, 1989*). A conceptual decommissioning and reclamation plan was also included in the EIS.

In April 1991, prior to the end of operating life of the mine, a decommissioning plan was submitted to the agencies. The plan was accepted and decommissioning commenced in June and was completed in September 1991. The transition phase monitoring program was then undertaken to monitor the effectiveness of decommissioning work performed and the progress of revegetation. If the monitoring results of this phase are acceptable to the agencies, an application to be released from the property can be made.

Description of Operations

The Jasper mine was a small underground gold mine accessed by a decline ramp. Mining was completed to a depth of 140 m using a short-hole shrinkage stoping technique. Mine openings to surface consisted of a main access portal, a vent raise, and seven stope raises. Minewater was pumped to surface and into settling ponds before being released to the environment. There were two sets of minewater settling ponds in use at different times to settle out and contain solids. There was no chemical treatment used in these settling ponds. The original set of two ponds were used during the underground exploration phase and were decommissioned soon after full-scale mining started in February 1990. Another set of three settling ponds were commissioned and used throughout the operational life of the mine. The water quality for the effluent discharged to the environment from these settling ponds during operations is shown in Table 1.

Table 1

Minewater Discharge after Settling
Typical Water Quality during Operations

	Feb. - Dec. 1990	Jan. - May 1991
pH	7.13	7.21
Conductivity	414	437
Total Suspended Solids	42	14
Ammonia (un-ionized)	0.09	0.05
Sulphate	43	50
As (total)	0.0012	0.0010
Cu (total)	0.012	0.010
Pb (total)	0.038	0.028
Ni (total)	0.006	0.008
Zn (total)	0.033	0.020

- All units are mg/L except pH (pH units) and conductivity (μS/cm).

No special disposal methods were required for waste rock based on an assessment of their acid-generating potential. Waste rock samples collected during both the exploration and production phases underwent standard acid-base accounting (*Sobek et al., 1978*). The results (Table 2) indicated a very low potential for acid generation given the low sulphur content and high ratio of neutralizing potential to acid production potential. The production waste rock samples also underwent major and trace element whole rock analysis, and a 24-hour agitated leach test (*EPA, 1985*). There were no significant metal levels of concern identified in the waste rock or test leachate. Waste rock was used as construction material for the settling ponds, laydown area, roads, and miscellaneous other uses. Waste rock not used as construction material was stored in a waste rock pile next to the portal.

Table 2

Jasper Waste Rock
Acid-Base Accounting Results

	% Total Sulphur	Acid Potential (AP) (g/kg)	Neutral Potential (NP) (g/kg)	Net Neutral Potential (NNP) (g/kg)	NP/AP
Jasper Waste Rock	0.06 (0.01 - 0.17)	1.9 (0.3 - 5.2)	14.6 (8.4 - 21.3)	12.8 (8.1 - 16.4)	15.9 (4.1 - 27.1)

- Average results are reported with the range shown in brackets.

Decommissioning and Reclamation Methods

Decommissioning and reclamation at Jasper was simplified by the absence of a tailings facility or problems with acid generating waste rock. Decommissioning was limited to the tasks of sealing access to the underground, removing all surface structures and associated facilities, and preparing disturbed areas for revegetation. The primary focus of reclamation at the site was the establishment of self-sustaining vegetation along with the monitoring of decommissioned areas. The strategy applied for revegetation of this site was the encouragement of natural revegetation while avoiding the permanent introduction of non-native plant species.

Natural revegetation was encouraged by various means. In some areas short-lived agronomic species were seeded to stabilize soil conditions and provide a catching mechanism for native airborne seeds. Slash and deadfall from surrounding areas was also pulled out onto disturbed areas. This helped catch seeds and provide shelter for emerging plants. Some areas were recontoured to blend in with the natural topography. The ground was left rough and uneven providing sheltered areas to trap seed and promote germination. Some areas of heavy compaction were scarified to break up the surface and promote revegetation.

Decommissioning of surface facilities and the underground began almost immediately upon completion of mining in May 1991. All surface buildings and associated structures were removed for salvage or disposed of. Some of the unsalvageable material was placed in the underground for disposal and some was placed in a refuse pit at the site. Selected material in

the refuse pit was burned as completely as possible. The remaining ash and nonburnable material was then hauled off-site to the Star Lake refuse dump and buried.

All salvageable equipment was removed from the underground workings and the mine allowed to flood naturally. Material left in the underground workings for disposal included wood, steel, plastic, and rubber. The portal entrance was sealed by backfilling with waste rock. Waste rock was backfilled a minimum of 5 metres into the portal entrance. At the portal entrance the waste rock was piled up against the entrance to a minimum depth of 2 metres above the portal's brow. A drainage ditch was established from the portal area to a nearby muskeg. Only minor settling of the backfilled waste rock, at the portal's brow, has been noted during yearly inspections. This area of settling was easily hand-filled with waste rock.

The portal is the only main access to the mine and is located in the side of a steep rock outcrop. All the mine workings are at an elevation below the portal entrance. Therefore, as groundwater flooded the mine, drain-off would be through the portal. Dewatering pumps were shut off in May 1991 and a natural outflow from the portal was observed in November 1991. Water quality monitoring of the seepage from the portal since 1991 is summarized in Table 3.

Table 3

Water Quality of Seepage from Backfilled Jasper Portal

	1991	1992	1993	1994	1995
pH	7.53	7.42	7.42	7.30	7.28
Conductivity	256	325	288	272	269
Total Suspended Solids	9	17	3	24	< 1
Ammonia (un-ionized)	0.011	0.020	0.004	0.002	0.001
Sulphate	35	28	20	20	16
As (total)	0.0012	0.0006	0.0008	0.0015	0.0008
Cu (total)	0.021	0.027	0.027	0.030	0.037
Pb (total)	0.135	0.030	0.011	0.018	0.015
Ni (total)	0.009	0.012	0.020	0.006	0.007
Zn (total)	0.097	0.203	0.240	0.143	0.098

- All units are mg/L except pH (pH units) and conductivity (μS/cm)

There were a total of seven stope raises that opened to surface and required sealing. These raise break-throughs (B.T.) to surface were approximately 1.8 m $\times$ 1.8 m in size and in most cases,

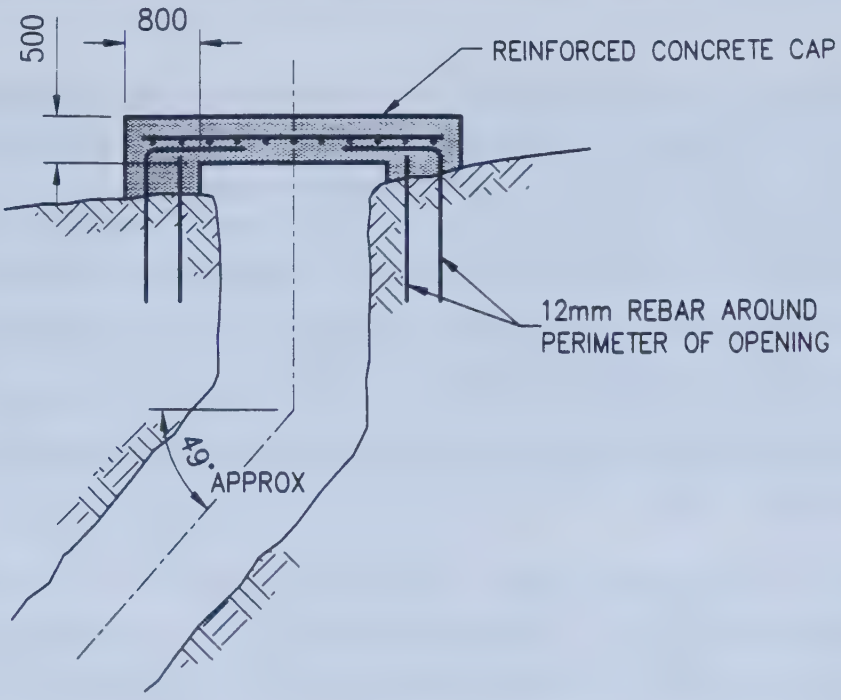
the first 2 to 4 m below surface were vertical. Below this the raises sloped at 49° from horizontal (Figure 1). These raises were sealed by installing reinforced concrete caps over the openings. The design of these caps were based on those used to decommission the Beaverlodge site in northern Saskatchewan (*Beaverlodge, 1982*). The caps were constructed by first removing all overburden down to bedrock for a distance of at least 1 metre around the raise B.T. A reinforced concrete cap, a minimum of 0.5 m thick, and extending at least 0.8 m outside the edge of the raise opening was poured over the raise (Figure 1). This cap was anchored to bedrock with a 1/2 inch rebar grouted 1.2 m into solid rock. The spacing between these anchor rebars was no more than 0.6 m and they were installed around the entire perimeter of the opening.

Where the raise openings were on relatively level ground, short footings were used to make a level base for the cap. In cases where the B.T. was on steeply sloping ground, a notch was blasted out around the raise opening to make a level base large enough to accommodate the cap (Figure 2). In all cases the size of the concrete cap was adjusted to ensure they extended at least 0.8 m beyond any fractured ground caused by the raise B.T.

The single vent raise had a 2.5 m × 2.3 m opening which was vertical for the first 4 m below surface, then sloped at 49° from horizontal for the rest of its length. The raise break-through was surrounded by a concrete collar 0.4 m thick, varying in height from 0.2 m to 0.8 m to provide a level base for the mine ventilation fan. The vent raise was sealed in the same manner as the stope raises with a 0.5 m thick reinforced concrete cap anchored to bedrock. This cap enclosed the entire original collar and was anchored to bedrock with rebar all around the outside of this collar.

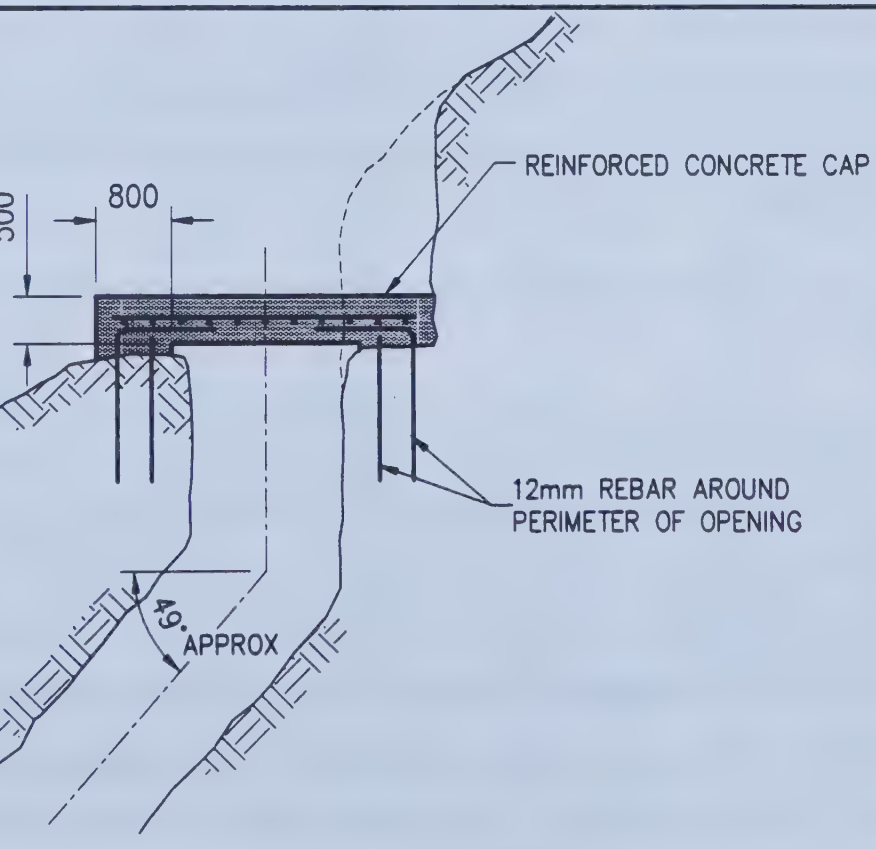
All raise caps have performed as designed based on yearly inspections since their installation in 1991.

The minewater setting ponds were constructed from waste rock and were decommissioned by shutting off the inflow of minewater and allowing the water to drain out. Material from the waste rock pile was used to partially fill in the settling ponds. A bulldozer was then used to push the sides of the waste rock berms into the centre and level out the ponds. In June 1992, the recontoured settling ponds were seeded with a mixture of fall-rye (Secale cereale) and barley (Hordeum vulgare) at a rate of 50 kilograms/hectare (kg/ha). A 16-20-0 (N-P-K) fertilizer was also applied after seeding at a rate of 50 kg/ha. The seed and fertilizer was broadcast using a hand-held seeder. The waste rock pile and portal areas were also seeded at this time. Germination was most successful where the ground was broken and uneven, providing lots of sheltered areas for the seeds. These annual grasses grew well but failed to reach maturity and produce seed due to cold weather in 1992.



TYPICAL RAISE CAP CONSTRUCTION
WITH BREAK-THROUGH ON LEVEL GROUND

FIGURE 1



TYPICAL RAISE CAP CONSTRUCTION
WITH BREAK-THROUGH ON SLOPE

FIGURE 2

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The recontoured settling ponds and other areas seeded in 1992 were re-seeded with the fall-rye and barley mix in May 1993. No fertilizing of these areas was done in 1993. Native plant species had began to invade the disturbed areas by the summer of 1993 and the fall-rye and barley was well established. In 1994 there was no additional effort made to revegetate the minewater settling ponds. Native plant encroachment was progressing and the fall-rye and barley was dying back. By the summer of 1995, native vegetation was well established on the top surface of the recontoured settling ponds. The predominant pioneering species were alder (Alnus sp.), fireweed (Epilobium angustifolium), and a variety of grasses. However, there was still only limited revegetation of the side slopes at the margins of the settling ponds. These side slopes are generally short (1-4 m) and composed of coarse-sized waste rock. The regulatory agencies required that additional work be done to accelerate the revegetation of these side slopes. Therefore in September 1995, brush and deadfall was pulled from the surrounding area and placed on the side slopes. This method has been successful in enhancing natural revegetation at other Cameco operations. The regulatory agencies have indicated that this additional work will fulfil their revegetation requirements.

A portion of the waste rock pile was removed for use in sealing the portal and decommissioning the settling ponds. The remaining pile was contoured to match the local topography and had a slope of approximately 26°. The recontoured pile was seeded with the fall-rye and barley mix in 1992 and 1993. Three years after the initial seeding, the fall-rye and barley has died back and there is patchy coverage by native species.

Some sections of the main access road were scarified in 1991. After three years native grasses have invaded most of these areas and are concentrated in the furrows left by scarification. Sections that were not scarified showed varying degrees of revegetation. In the fall of 1995, slash and deadfall was placed on the sections that remained bare. This debris would serve as a seed trap and also discourage people from driving on these decommissioned roads. The continued presence of vehicular traffic on the main mine access road had a noted effect on revegetation. This was the case even with the very light traffic experienced. Distinctive bare areas were noted in the tire tracks along the main access road with vegetation growing on the untravelled centreline. This effect was further demonstrated by the progress of natural revegetation observed on some of the secondary mine roads that had not been travelled on since decommissioned in 1991. By 1995, some of these roads were completely overgrown by alder, some reaching 1 m in height. Another likely factor is the limited size of these disturbances and subsequently their close proximity to undisturbed areas which act as a seed source. This is supported by observations at this site of better revegetation on the smaller isolated areas.

Saskatchewan Government/Cameco Interaction

When Cameco decided decommissioning of the site was to proceed, Saskatchewan Environment and Resource Management, Industrial Branch (SERM-IB) was contacted. A decommissioning

plan was developed using the conceptual plan in the EIS as a guide and submitted to SERM-IB for approval. The proposed plan was circulated to other provincial departments for comment. Approval to decommission was received after accommodating concerns raised by the agencies.

During the decommissioning of the site, SERM-IB made monthly inspections and at times more frequent depending on the decommissioning in progress. From these inspections recommendations and direction were given so that compliance with the plan and regulations could be maintained as decommissioning progressed.

During the transition phase, the period following decommissioning, annual inspections by SERM and the branches who had a stake in the approvals, were conducted. From these inspections, additional direction was supplied which would allow, by the end of the transition phase, the site to be returned to the province. The minimum transition phase period, as established in the approvals, was three years. We are now entering the fifth year. It is anticipated approval to abandon will be given in 1996.

The reason approval was not given after three years was that sufficient natural self-sustaining vegetation had not developed.

The other department that issued approvals to decommission the surface openings was the Occupational Health and Safety Division, Mines Branch. They were also part of the initial annual inspections during the decommissioning and transition phases.

Annual fees paid to the province during the decommissioning and transition phases were the surface lease and local tax payments. To minimize surface lease payments, the undeveloped/developed portions of land were reassessed during the decommissioning phase and an application made to reduce the undeveloped and developed portion of the lease. During the transition phase it was negotiated to eliminate the entire developed portion, therefore, paying undeveloped rates.

Local taxes were reduced by requesting annual reassessment as buildings were removed.

Conclusions

Decommissioning of the Jasper mine was accomplished in four months. The removal of all surface buildings and associated structures left the site ready for revegetating. Backfilling the portal with waste rock has proven to be an effective method of sealing the underground, when a watertight seal is not required. The design and installation of the concrete caps has also proven to be effective in sealing raise break-throughs to surface.

Natural revegetation of disturbed areas at this site has occurred to varying degrees in the four years since decommissioning. Various methods have proven effective in enhancing the progress of natural revegetation. The planting of short-lived agronomic grasses (fall-rye and barley) was successful in catching airborne seeds thereby establishing native vegetation. These short-lived grasses had died back after three to four years, avoiding the permanent introduction of non-native species.

Scarification of disturbed areas was found to be effective in promoting revegetation, especially on areas that experienced heavy soil compaction, such as mine roads. Slash and deadfall from undisturbed areas was useful for trapping native airborne seeds and discouraging traffic on disturbed areas. After four years, the progress of natural revegetation was as expected. Earlier application of the slash and deadfall may have allowed for the abandonment of the property in the third year of the transition phase. The various methods used to encourage natural revegetation were successful. Approval to abandon the site is anticipated in 1996. A final inspection will be done in late summer to determine if there are any outstanding issues.

References

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