SEDIMENT MANAGEMENT PRACTICES
AT THE KEMESS SOUTH MINE

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ABSTRACT

The Kemess Mine is located in north-central BC and has a disturbance area of greater than 1,000 ha. Federal Metal Mining Effluent Regulations (MMER) require that total suspended solid concentrations be below 15.00 mg/L as a monthly average and 30.00 mg/L as a grab sample maximum in the regulated surface waters leaving the mine site. Surficial materials at the mine have a relatively high fines content, which make the removal of suspended solids from impacted water difficult. Therefore, sediment management is an integral component of the operations at the site in order to achieve the MMER targets. This paper describes the sediment management practices including recovery of sediment or tailings accumulations in stream beds at the Kemess Mine.

Kemess Mines targets permit compliance through the application of applied sediment management techniques discussed in this paper. These techniques are utilized as part of a toolbox approach to resolving sediment issues. A combination of techniques is applied dependent on site specific conditions to provide the most cost effective method for the maintenance of water quality and minimization of impact.

INTRODUCTION

The Kemess South Mine is an open-pit gold-copper mine located approximately 15 km east of Thutade Lake, in the northern Omineca Mountains of north central British Columbia (Figure 1). The mine is approximately 300 km northwest of Mackenzie at latitude 57 00" N, and longitude 126 45' W. The mine is contained within a claims area of approximately 15,057 ha (150 square km) and a disturbed area of over 1,000 ha. The project site is accessible via the Omineca Resource Access Road (ORAR), an all weather main line industrial road from Mackenzie, British Columbia. This road provides for transportation of mine supplies and concentrate. A 5,200 foot airstrip allows for air

Fig 1 Site Location Map
access, with the majority of personnel being flown from Prince George and Smithers.

**MMER REGULATORY FRAMEWORK**

The federal Metal Mining Effluent Regulation (MMER) was enacted in June 2002. The MMER requires that the Total Suspended Solids [TSS] concentrations for a grab sample collected from the surface water be below a concentration of 30.00 mg/L while the maximum monthly mean must be below 15.00 mg/L. When TSS concentrations in a stream leaving the mine site exceed the MMER levels, it is required that the company notifies Environment Canada (EC) of the exceedance and submits a follow-up report within 30 days of the end of the exceedance.

Kemess Mine has two MMER regulated discharge points, one at WQ-BXL and the other at WQ-14F. The WQ-BXL site monitors the quality of water draining the access road to the Tailings Storage Facility (TSF) and the WQ-14F site is used to monitor the quality of water leaving the pit and Waste Rock Dump area.

**SURFICIAL MATERIALS AT THE KEMESS MINE**

Surficial materials in the area of the Kemess Mine site vary greatly as would be expected in glacially modified mountainous terrain. Kame terraces near to the TSF area contain outwash material with material ranging from silt to large boulders reflecting the water energy during deposition. Much of the middle section of the site is a morainal blanket with ablation till overlying basal till. Around Kemess Lake are thick glaciofluvial deposits. Areas with swampy ground have been found to contain lacustrine and peat deposits although these tend to be localized.

Fines content in the soils at the Kemess Mine vary with the mode of deposition. Till material has been found to commonly have over 30% of materials passing the #200 sieve (75μm) with some basal till samples having more than 60% passing the #200 mesh. Glaciofluvial material tends to be less than 10% passing the #200 sieve but higher fines contents were encountered in areas where silt layers were present.

**MINE RELATED SEDIMENT**

Mine related sediment from the TSF area is generally the result of haul road construction and borrow development. Much of the water from areas with exposed soils is directed into the TSF or through ditching to the Seepage Recycle Pond (SRP). In addition to these sources the cyclone sands that are used to construct the downstream buttress of the TSF typically has fines contents in the order of 8%. This material deposits rapidly in the sediment pond located upstream of the SRP.

Runoff water from the TSF access road may contain fine TSS, especially during the spring runoff period. The water from the access road is diverted through a series of ditches to a number of settling ponds in the BXL area prior to discharge to the environment through the MMER regulated site, WQ-BXL. The BXL Ponds have been engineered and modified to be very successful in the removal of the fine sediments. There is also the ability to treat with flocculant addition, if necessary.
The pit and Waste Rock Dump areas yield sediment from haul roads and ditching that diverts water around the open pit. Blasted rock is used to sand the pit roads during the winter months and this material yields very fine-grained run-off. Run-off from the haul roads is directed to sumps within the pit and waste dump areas. The water in these sumps is either used for process water or for watering the pit roads during dry periods. Some of the water may report to ground, which may report to the waste Rock Collection Ditching that flows along the southern portion of the dump into a sediment pond before discharging into Waste Rock Creek. Flocculant addition has also been used to treat for TSS. The water from the pit and the Waste Rock Dump area report to the environment through MMER regulated site WQ-14F.

Kemess has developed a method to remove sediments from stream beds in the event of a tailings spill to the environment. The method utilizes a suction system with a screened intake. The method has been tested in winter and open flow conditions and found to be applicable for the removal of fine-grained sediments from shallow water bodies.

SEDIMENT MANAGEMENT AT THE KEMESS MINE

Sediment management practices at the Kemess South Mine involve the use of a variety of techniques to reduce erosion and promote sedimentation where erosion has occurred. In cases where assistance is required or when large areas as seeded or planted, local First Nations reclamation labourers are contracted.

Armouring of ditch lines using suitable riprap is not often possible due to access constraints or a lack of suitable rock. The application of rock check dams to control water velocity and provide base level control is used at sites where riprap is not readily available. When ditches are excavated through fine-grained soils the use of enviro-matting in the ditch line offers additional protection for the soils from erosion. Kemess Mines also installs silt fencing in areas where there is a risk of run-off from disturbed areas transporting sediment to the receiving environment. The planting of willow cuttings in the ditch lines helps promote stabilization through revegetation and this is conducted when the ditch is part of a permanent control structure (e.g. Waste Rock Collection Ditching). Exposed soils are seeded as soon as possible after disturbance to stabilize soils. In addition to hand seeding and planting, Kemess uses a Plotmaster 400 and a Finn T-75 hydroteeder to allow for the timely revegetation of large disturbed areas.
A buttress is currently being constructed on the downstream face of the TSF using cycloned tailings sands. Runoff from the buttress and area downstream of the TSF is collected in a sediment pond and, subsequently, in the SRP. During construction of the TSF buttress large amounts of sediment have washed into the sediment pond and SRP, which has resulted in siltation of the sediment pond and, to a lesser extent, the SRP. Water reclaimed from the SRP is used as process water, therefore, this increase in sediment has affected pumps and other equipment resulting in increased maintenance costs. To address this sediment issue, Kemess utilizes a 10” dredge to re-mobilize fines, which are pumped into the tailings circuit where they eventually reach the TSF. The dredge unit is operated almost continuously and is moved between the SRP and the upstream sediment pond as required.

Runoff water from the TSF access road is diverted through a series of ditches to a number of settling ponds in the BXL area prior to discharge to the environment. In addition to the settling ponds there is the ability to add flocculants to the discharge water if required. The BXL discharge is considered intermittent, as it generally discharges during the spring freshet, and the water quality noted at WQ-BXL is usually within compliance.

Run-off from the pit area and Waste Rock Dump is directed into collection ditching and a sediment pond prior to discharging from the site. Kemess Mine has exceeded the MMER monthly mean TSS concentration of 15.00 mg/L during spring run-off as a result of the high fines content of the run-off from these areas. During 2005 Kemess Mine began to utilize flocculants to reduce TSS concentrations in flows discharging from the site. The most effective flocculants for treating sediment are cationic which have been found to have toxic effects on fish if not properly dosed. The cationic flocculant (Magnafloc 368) is therefore mixed with an anionic flocculant (Magnafloc 156) to neutralize any residual toxic effect of the cationic flocculant prior to discharge from the site. This mixing of cationic and anionic flocculants also improves the flocculation and settling of the sediments. Ciba Specialty Chemicals (Ciba) conducted jar tests to prove the effectiveness of the flocculant mix and has conducted toxicity testing on blends of Magnafloc 156: Magnafloc 368. It was found that a 2:1 blend has a negligible toxic effect such that toxicity can easily be avoided.
Jar tests were conducted in conjunction with Ciba Specialty Chemicals on samples of the run-off from the Waste Rock Dump area to determine the effective flocculant dosage required for optimum settlement. These tests showed that flocculant concentrations of from 1.5 ppm to 2 ppm were effective in promoting sedimentation. A flocculant hut was established over the main discharge point prior to the spring 2005 and a 4:1 blend of M156:M368 was utilized with a target dosage of 1.5 ppm to treat the water during spring runoff. The 4:1 blend was chosen for the initial testing of the flocculant system as it was less likely to cause a toxic effect in fish than the 2:1 blend. The use of flocculant was found to be effective at reducing the TSS concentrations at the receiving environment site downstream from the sediment pond discharge.

**REMOVAL OF UNWANTED SEDIMENT DEPOSITS FROM STREAM BEDS**

Kemess has had tailings slurry enter the receiving environment on two separate occasions. In both of these events the slurry entered a stream and tailings solids were observed to rapidly settle to the substrate within a short distance from the point of entry. To remove the deposited material from the streambed Kemess utilized a suction system consisting primarily of a 3” trash pump with a screened intake. The method has been tested in winter and during open flow conditions and found to be suitable for the removal of fine-grained sediments from shallow water bodies.

The screen on the intake hose can be fashioned from small mesh screen (~1/4”) and hose clamped to the end of the intake. The screen is used to prevent the suctioning of larger clastic material from the stream substrate that may damage the pump. The optimum height of the intake hose above the stream substrate varies depending on a number of factors including size of pump, depth of water, and the amount of head that is required for the pump to discharge.
The screened intake is placed above the deposit while the deposit is agitated to re-suspend material. The hose is moved from side to side in areas where solids are noted, removing any solid material from the floor of the stream. Care must be taken by the operator to ensure that stable footing is maintained to reduce the risk of accidents.

![Removal of Tailings from Stream and Geotextile Discharge Area](image)

The discharge from the pump may be directed into a natural swale if the material is not being recovered or, as in the case with tailings, be directed onto a length of non-woven geotextile to allow for material recovery. There should be sufficient distance from the stream and vegetative cover for natural settlement of fine-grained sediments where a natural swale or depression is used as a settling area. The use of a non-woven geotextile allows for water to drain through the fabric while all sediment greater than the pore size is retained. The typical pore sizes for non-woven geotextile are on the order of 0.150 mm to 0.200 mm with exact specifications being available from the manufacturers. The use of this type of material allows for the recovery of materials up to the fine sand range.

**CONCLUSION**

The Kemess Mine is located in mountainous terrain in north-central British Columbia where surficial materials vary greatly over the site. Fine-grained sediment (<75μm) is found over much of the site, with greater than 30% content of fines possible depending on the nature of the materials. The highly variable fines content of the surficial materials makes sediment management a key component of operations at the mine. TSS is regulated at two sites on the Kemess property by the MMER, WQ-BXL and WQ-14F, which drain the TSF access road and the pit and waste rock area. Kemess Mine addresses sediment management issues through the application of a variety of methods that are dependent on the type of issues to be treated.

Sediment discharge from the Kemess mine is generally controlled through the use of sediment ponds, which include the infrastructure to treat the flows as required. Kemess has used flocculants to promote settling of sediments in areas where there is inadequate room to construct proper sized sediment ponds. The use of flocculants has been found to decrease the sediment load being discharged from the site during
the spring run-off. Sediment ponds are also kept effective by routinely dredging out any accumulated solids. Revegetation and stream stabilization measures are also used to reduce sediments in streams.

If excessive sediments, such as tailings, are released and accumulate in shallow streams, Kemess utilizes a simple suction system to remove these sediments and return the streams to natural conditions. This system is effective in both winter and summer use.

By using a variety of techniques to manage sediment loading in the environment, Kemess Mines has been quite successful in maintaining compliance. The techniques are employed on a case-by-case basis, either individually or in combination.