Reducing Historical Pollution

The Savage River Rehabilitation Project (SRRP) has made steady progress since the last savage river revival newsletter (February 2001). We now have a better understanding of the acid rock drainage problems at the mine site. This has enabled us to improve its environmental performance, and the project is well placed to achieve its aims.

The Savage River mine is located in northwest Tasmania in steep, mountainous terrain surrounded by areas of high wilderness value, including the Savage River National Park. The Savage River flows through the mine site and eventually discharges into the Pieman River, a trophy trout fishery. The climate is cool and wet, with a high average annual rainfall of approximately 1900 mm.

Operations during the first 30 years of the original open cut iron ore mine, established in 1967, have caused environmental harm to the entire Savage River and its tributaries. The principal cause of degradation is acid rock drainage seeping out from 200 million tonnes of waste rock dumps around the site. Sediment from the old mine has also contributed to the water pollution and stream degradation.

The 30 km stretch of the Savage River below the mine is directly affected by historical water pollution. In 1995, this river stretch was found to have lost 90% of its invertebrate diversity and 99% of its invertebrate abundance. Fish life there is also greatly reduced.

The Savage River above the mine is also affected because the pollution prevents fish from migrating between the river and the sea, which is an essential part of the life cycle of most Tasmanian native fish. Surveys show that the native fish fauna is severely depleted in the Savage River National Park, which is situated above the mine.

Several remediation works by the new mining company have significantly reduced the water pollution. The alkali flow-through structure in Broderick Creek has increased alkalinity and calcium levels downstream of the mine, thus reducing metal toxicity. The use of previously unused pits for both stormwater and acid rock drainage treatment has lowered levels of metals in the Savage River.

We expect that further improvements over the next five years will lead to the Savage River supporting a modified healthy ecosystem downstream of the mine. This in turn will allow greater fish migration into the National Park above the mine.

Toxicity targets achieved

Toxicological studies have been conducted since 2000 to investigate the key parameters responsible for biological degradation downstream of the Savage River Mine (as reported in the previous newsletter). The studies found that copper concentrations in the Savage River were often at toxic levels and should be reduced, especially when calcium/alkalinity levels are low.

As a result, the SRRP set environmental target levels based on this research.

The threshold line in the graphs below represents the first stage targets, which are mainly based on the toxicity of copper to fish. Values above the line represent waters that are likely to be more toxic to fish.
Managing current waste dumping

ABM is striving to make its waste dumping cost-efficient. All wastes are classified into one of the following four waste categories:

A-type alkaline-rich rocks, such as magnesite and calcite chlorite schist
B-type neutral or rocks of low acid-producing potential
C-type extremely weathered rock, i.e. clay
D-type potentially acid-producing rock

The D-type waste materials must be placed within oxidation-inhibiting waste dumps. The A and C-type wastes are used as construction materials for these dumps, and for other environmental rehabilitation purposes. Both the A-type alkaline rocks and especially the C-type clays are limited in quantity and need to be used sparingly. The B-type wastes do not require any specific handling.

Designing oxidation-inhibiting dumps

The construction of oxidation-inhibiting dumps for D-type waste rock requires a significant amount of management, planning and mining resource allocations (including surveying, dozing and compaction), which all add up to higher mining costs. In the current South Deposit operations only 12% of all waste rock is D-type. It is therefore imperative that this waste type is properly identified and segregated to minimise waste dumping costs.

ABM’s initial oxidation-inhibiting dump designs were designed with a highly compacted cap of low-permeability clay. The dumps were designed with very low-angled side slopes for long-term stability. The South West Dump (see photo) was a trial, with the clay cap constructed around B-type material. A loose soil cover for vegetation was not applied over the clay cap. However, revegetation trials on compacted clay slopes are underway.

1998–2000 water quality data

The above graph shows the levels of total calcium versus dissolved copper for water samples collected from 1998–2000. The two sample sites are:

- the ‘Savage River below South West rock dump’ situated directly below the mine workings
- the ‘Savage River below lease site’, which receives all other pollution from the mine lease site.

The graph shows that 20% of water samples exceeded the toxicity threshold for fish.

2001–2002 water quality data

The above graph shows the levels of total calcium versus dissolved copper in water samples collected in 2001 and 2002. The graph shows a significant improvement in copper levels at both sites with no samples above the toxicity threshold.

Given that all other environmental targets, such as dissolved aluminium and sulphate, are within the limits set by the toxicological studies, the data represents a significant improvement in the management of pollution sources from the mine lease. The SRRP aims for further improvements because the current threshold has a low safety factor. The more sensitive macro-invertebrate species, such as Ceriodaphnia, still show a toxic response within the first stage targets.

Techniques for reducing ARD from waste dumps

By Bruce Hutchison, Senior Geotechnical Engineer, ABM

ABM’s waste management strategies are focused on protecting the environment from existing and potential acid rock drainage (ARD) from both current and historical waste dumps.
Due to the steep topography and high rainfall at the mine site there are several drawbacks to this design, the three most important being:

- the high cost
- the limited quantity of material that can be placed on the steep hillsides
- and that rainforest tree roots will eventually break through the clay liner.

During a site workshop with ABM supervisory staff, one of Environmental Geochemistry International Pty Ltd’s consultants pointed out that less permeable clays can provide an adequate oxygen barrier if the clay remains saturated. A more cost-efficient method of clay capping was devised that takes advantage of the high rainfall of the West Coast. In this design (see diagram below), saturated clays are simply end dumped off the D-type waste tip head to form a layer that is 5–10 metres thick. Coarse A-type armouring is then end dumped over the clay to provide stability and also a thermal blanket. This rock armour inhibits drying of the clays due to its thickness of 10–30 metres (depending on the height of the dump). Any drying that may occur in the summer months will be quickly replenished during the other three ‘wet’ seasons.

Cleaning up historical dump

ABM is also committed to the rehabilitation of the historical dumps that are emitting substantial quantities of ARD.

B Dump is a good example of a large historical dump that is being rehabilitated by ABM in conjunction with the SRRP. Studies conducted by the SRRP indicate that approximately 40% of the ARD from the mine site (based on copper load) flows down Main Creek, which receives most of the drainage from B Dump and the tailings dams. SRRP rehabilitation proposals call for collecting the ARD in Main Creek and transferring it to a treatment plant, before it is discharged into the South Lens Pit.

To reduce the amount of water requiring treatment, ABM will:

- permanently divert tailings dam runoff into Townsend Creek, away from the upper portion of Main Creek
- construct a water-shedding cover over the top of the original dump surface
- construct alkaline wrap-around dumps on the eastern and northern side slopes.

Studies have indicated that these combined measures could reduce the amount of ARD being collected to around 10–20% of the previous flows in Main Creek.

Water-shedding covers

ABM has had to adapt its water-shedding cover design to suit the available materials and construction techniques. The company’s initial design had a low-permeability clay layer sitting at a 2% gradient. However, trials indicated that much of the ‘clays’ were in fact ‘silts’ and that the required low level of permeability (10^-8 to 10^-9 m/sec) could not be achieved, no matter what devices were used to compact the clays. To compensate for the higher permeability of the clay, the gradient of the water-shedding cover has been increased to 3%–5%, so that the water runs off quickly before it can penetrate the cover.

ABM also found that where waste rock (A and B types) were placed over the clay for haul truck roadways, the 150 tonne payload trucks had broken down the rock and compacted it to the required 10^-8 m/sec permeability level. Loaded haul trucks are now directed around the dump so that they break down and compact the A and B-type rock waste in the roads.

Alkaline covers

Waste dump management techniques have recently begun focusing on the use of ‘alkaline’ covers to increase the alkalinity of rainwater as it seeps into and off dumps. When alkaline waters reach the pyrite-bearing rocks, micro-encapsulation is thought to occur as a result of acid-base reactions. This retards the leaching of polluting minerals.

In some cases the use of certain alkaline materials, such as limestone, has caused the formation of mineral coatings that ‘clogged’ up the pathways for water transport within the waste dumps, thereby creating a ‘seal’ to the dump.

The eastern side of B Dump was too steep and high to form an effective oxygen-inhibiting cover, so ABM has expanded the upper B Dump surface by creating wrap-around levels of calcite chlorite schist (A-type material) on the eastern Main Creek side of the dump (see the photo below). The company hopes that this will eventually form an ‘alkaline’ water-shedding cover, although rainwater will still seep directly into the side batters and eventually down to the base of the dump. Monitoring over the past few years has shown that Broderick Creek becomes substantially more alkaline as its waters pass through the calcite chlorite schist of the coarse rock flow-through structure. This is a good indication that the wrap-around A-type material may be an effective alkaline water-shedding cover.
A 1 m wide, concrete-lined trench was built along the left bank of the river to collect the acid drainage. The 150 m long trench delivers the ARD into the pump works – a buried plastic tank into which a stainless steel pump can be lowered or raised. The pump delivers the ARD into South Lens Pit, via a 100 mm diameter poly-pipe, at a rate of up to 15 l/s. A bridge constructed from an old PMI drill mast provides access to the pump station and support for the poly-pipe.

A large rock bund protects the trench from river erosion. To prevent rocks and sediment from filling the tank and fouling the pump intake, ABM installed grates and a flap lid that automatically closes during flood conditions.

**Savage River Rehabilitation Projects**

**Whole of site feasibility study**

By David Brett, Thompson & Brett, Consulting Engineers

Over the past few years DPIWE has carried out a number of studies into the sources of pollution from the historical mine works at Savage River and reviewed options for remediation in various areas. All of this background work has now been applied to a feasibility study for the whole site. The feasibility study recognises the synergies between strategies to reduce contamination and appropriate treatment systems for different areas.

The SRRP Strategic Plan of December 2001 estimated that to achieve initial toxicity targets, 65% of total copper emissions from the site must be removed. Monitoring studies have shown that this level can be achieved by treatment of the:

- Main Creek below B Dump
- North Dump Drain
- Crusher Gully
- Old Tailings Dam.
The feasibility study focused on passive systems where possible but inevitably a treatment system will be required.

The feasibility of the rehabilitation project is affected by the rugged topography at Savage River and the high annual rainfall, ranging from 1500 mm per annum to over 2800 mm per annum. The high stormwater runoff, which is between 75% and over 90% of rainfall, results in high flows to be handled by drainage collection systems. Consequently, a major factor in developing an economic strategy for rehabilitation is to maximise the diversion of clean water from sources of contamination.

Monitoring of Main Creek above Townsend Creek during the period when the tailings dam outflow was diverted into Townsend Creek clearly showed the significant impact of B Dump on stream flow rates in the local catchment. This diversion effectively removed the tailings dam outflow from the section of Main Creek downstream from the tailings dam and upstream of Townsend Creek. This left only the local catchment flow in Main Creek, with B Dump occupying a major proportion of the catchment. The residual flow in the creek was surprisingly constant and represented approximately 70% of incident rainfall. The flow pattern mirrored the 60-day moving average of rainfall, indicating that most of the rainwater was percolating through the dumps and disturbed ground and emerging as contaminated seepage over a period of months. This phenomenon correlated well with the results of SoilCover modelling of the waste dumps. It demonstrates that flows in Main Creek could be significantly reduced by capping and diversion of runoff from disturbed areas, which is being done by ABM as part of their current mining operation.

Reduction in flows, however, does not necessarily reduce the levels of contamination and so treatment systems were reviewed. These included the options shown in the table below:

Preliminary designs were produced for a variety of options to develop cost estimates to ± 30%. These estimates considered the operating and maintenance costs over a 60-year period and Net Present Value (NPV) estimates were assessed for each option. This allowed a direct comparison so options could be ranked by their long-term economic viability.

The study concluded that, in general, passive systems were un-economic. However, trials of an alkaline system developed by Earth Systems were recommended, together with an ongoing review of high infiltration systems.

Active treatment in conjunction with clean flow diversion was identified as the priority, because it is the most cost-effective method. A key factor to the feasibility of active treatment was ABM’s central pit management which will make at least one of the open cut pits available for sludge disposal. This is particularly significant due to the very large volumes of treated ARD sludges from simple treatment processes. The Earth Systems’ autogenous mill process using magnesite proved to be the most economical option if the treatment efficiency could be maintained at around 60% by cleaning the sludge particles after treatment by contact with the turbulent discharge water in site drains and, ultimately, in the pit. Field trials are proposed to confirm this. If the autogenous mill process proves to be not sufficiently efficient, then more conventional lime treatment will be required.

### Passive Treatment Systems

- **Water covers**: Some scope to at least partly flood tailings at Old Tailings Dam.
- **High infiltration alkali covers**: An emerging technology to introduce alkalinity to the top of dumps that avoids the problem of passivation by coating alkali sources with precipitate. Potentially very expensive if not implemented as part of the mining operation.
- **Oxygen barriers**: The site climate helps to keep soil covers saturated but oxidation of site dumps is already advanced and dumps are likely to discharge contaminated seepage for decades even if further oxidation is stopped.
- **Water-shedding covers**: In Savage River, climate covers can not eliminate seepage but can reduce flows and thus lower treatment costs.
- **Alkali flow-through drain**: The existing flow-through spillway in Broderick Creek has proved to be a significant source of alkalinity.

### Active Treatment Systems

- **Magnesite**: Available on site and possibly suitable as a reagent using an autogenous mill system or purpose-designed PULSE reactor.
- **Lime**: Expensive and produces low-density sludge but is a proven technology.
- **Tailings**: Potential use while ABM is actively mining.
- **Bauxol**: Expensive and unproven but potential for final polishing of effluent.
- **Calcium carbonate schists**: On-site material but limited scope for increasing pH.
The overall site concept proposes:

- A centralised autogenous mill treatment plant (subject to efficiency testing) located near the ABM security gate entry area, discharging treated water to Centre Pit via a series of turbulent channels and settlement ponds.

- Collection of ‘concentrated’ ARD from Main Creek and Old Tailings Dam sites and pumping to the autogenous mill plant. (Note that ARD will be ‘concentrated’ by diverting as much clean water as possible from the sources of contamination.)

- Diversion of North Dump drainage via a pipeline to a mixing pond above Centre Pit where it will be mixed with alkaline water from the autogenous mill plant before entering Centre Pit.

- Diversion of the eastern catchment of North Dump Drain to the Old Tailings Dam.

The total NPV of the works items noted is estimated at in the order of $13 M.

Of particular interest, in conjunction with the rehabilitation project, was the feasibility of providing a mini-hydro scheme. This would involve excavating channels so water from both the Old Tailings Dam and Main Creek Dam is diverted via a penstock and power station on the Savage River below the South West Dump.
Positive peer review of project

The Strategic Plan of the SRRP calls for an independent review of the project every three years. The first review was commissioned in early 2002 after an extensive search for internationally recognised experts. The SRRP Management Committee was delighted to employ the highly respected panel led by Dr David Williams (University of Queensland), Dr Stuart Miller (Environmental Geochemistry International Pty Ltd), Dr Ward Wilson (Unsaturated Soils Engineering Ltd), John Miedecke (John Miedecke and Partners Pty Ltd) and Dr Chris Humphrey (Environmental Research Institute of the Supervising Scientist).

The purpose of the review is to ensure that the project is on track both strategically and scientifically and maintains a focus on Best Practice Environmental Management as it develops.

In March 2002, the review panel toured the mine site and Port Latta and was given access to all reports commissioned by the SRRP. The findings of the review were comprehensive and very informative. We now have a better understanding of the ARD processes occurring within the old waste rock dumps. The panel developed a risk assessment method for determining priorities now and into the future and some recommendations were implemented almost immediately.

In general the review panel found that the project was progressing well. The panel agreed with the SRRP team that solutions were possible and suggested additional avenues to explore to achieve the project’s goals. These included:

- greater emphasis on mitigation
- investigating the use of alkali covers.

The review panel also agreed that the compacted clay covers currently used for oxygen barriers were not practical for the waste rock dumps on the site, given the topographical constraints and the materials available. Subsequently, Environmental Geochemistry International and ABM worked together to develop a more cost-efficient design suited to the steep topography of the West Coast rainforest (described in the previous article).

The peer review process was invaluable and the SRRP Management Committee is looking forward to having its work reviewed again in 2005. By this time, progress towards a significant reduction in pollutant loads in the Savage River should be well underway.

Environmental Rehabilitation around Port Latta

By Greg Taylor, North West Land Managers

In addition to environmental rehabilitation at Savage River, the SRRP has also been significantly involved in two rehabilitation projects in the area around Port Latta, the site of the iron ore pelletising plant currently operated by Australian Bulk Minerals (ABM).

The first project was participation in Tasmania’s largest Coastcare project, which involved sponsorship from industry (ABM), state agencies (DPIWE/SRRP), local government (Circular Head Council) and the local community. The project transformed a 5 km coastal strip around Port Latta by cleaning up industrial refuse, controlling weeds, and revegetating degraded areas with local provenance plants.

The second project, funded exclusively through the SRRP, involved best practice environmental rehabilitation of two abandoned quarries near Port Latta. North West Land Managers, who successfully tendered to conduct this project, designed and managed a program involving earth works, erosion control systems, botanical surveys, native seed collection, plant propagation, weed control and a comprehensive monitoring and evaluation program.
The SRRP also aims to provide employment and training opportunities in northwest Tasmania. This goal has been achieved, drawing together and growing a significant skills base for environmental works in the region. The on-ground managers of the Coastcare project, Jeanette Morse and Greg Taylor, formed North West Land Managers, a business now providing rehabilitation skills and local employment opportunities. North West Land Managers has gone on to many projects including erosion control and revegetation of South West Dump at Savage River, and weed mapping, program design and implementation of weed control works for Pasminco on their Rosebery Mine lease.

The achievement of the SRRP objectives for the Port Latta region is there for all to see.

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