Savage River Rehabilitation Project Strategic Plan 2015

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Introduction

This document outlines the Strategic Plan for the Savage River Rehabilitation Project (SRRP) with a focus on objectives, priorities and tasks, to support the project vision of:

> *Long-term remediation of environmental harm resulting from pre-1997 operations at the Savage River mine to the greatest extent possible, through effective and efficient deployment of the available funds, with a major focus on restoration of the aquatic environment downstream of the mine site.*

The SRRP Management Committee, associated staff and consultants have contributed to the development of this strategic plan, which has been informed by:

- The 2001, 2004, 2009, 2012 Strategic Plans and the annual reviews of progress and updates of expenditures and timelines,
- The feasibility study of whole-of-site treatment options carried out in 2003,
- A full expert review of the SRRP in 2002, 2005, 2009 and 2013, plus a one-day expert review workshop in 2008,
- Individual projects that have been undertaken as part of the overall SRRP in order to develop options for the remediation of various acid rock drainage (ARD) sources,
- The Grange Resources *Life of Mine Plan* (2011), which extended the expected mine life to 2034.

This Strategic Plan focuses on maintaining water quality improvements made by the project to date, and developing long term solutions to mitigate the biggest risks to long term water quality goals downstream of the Savage River mine site. The project has not recently been involved in remediation activities at the Port Latta Pelletising Plant site and has no current intention of doing so. The main contribution from historical operations to the current environmental issues at Port Latta is fugitive iron dust emissions, which are controlled by current site operations.

Project Background

The mine site

Historically, gold and osmiridium were mined in the areas surrounding the Savage River mine site in north-west Tasmania. Between 1870 and 1920, Main Creek and its tributaries produced 570-850 kilograms of gold. In 1912, approximately 150 diggers were working the Savage River and Nineteen Mile Creek areas for osmiridium, which at that time was more valuable than gold. The early prospectors were aware of the large magnetite ore body, but its low grade and difficulty of access and transporting the ore discouraged serious exploration until the 1950s.

The Savage River Mine has produced magnetite concentrate since 1967. The concentrate is pumped 83km via a pipeline to the Port Latta Pelletising Plant on the Bass Strait coast for export. The mine is located in steep terrain surrounded by native rainforest. The climate is cool-temperate with an average annual rainfall of approximately 1900mm.

Operations over the first 30 years of mine life caused significant environmental harm to the Savage River catchment. The principal cause of degradation is acid rock drainage (ARD) leaching from 200 million tonnes of waste rock deposited in dumps around the site.

The Savage River below the mine is impacted by ARD to the extent that in 1995 a 30km stretch of river downstream of the mine site was found to have lost 90% of its invertebrate diversity and 99% of its invertebrate abundance. Fish abundance was also greatly reduced. Surveys in the Savage River National Park, which is situated upstream of the mine, have shown that populations of native fish fauna are depleted, as pollution emanating from the mine site acts as a barrier to fish migration.

In 1996 the (then) owners of the mine, Pickands Mather and Co. International (PMI), ceased operations. On 26 March 1997 the Tasmanian Government, PMI and an incoming operator, Goldamere Pty Ltd, trading as Australian Bulk Minerals (ABM), reached a settlement that assigned $24 million for the remediation of historical pollution arising from the first 30 years of operations. In January 2009, Grange Resources Ltd merged with Goldamere Pty Ltd and Goldamere changed its name to Grange Resources (Tasmania) Pty Ltd.

The Savage River magnetite mine is now Australia's largest integrated iron ore mining and pellet production facility, and has an expected life of mine to 2034. In the 2014 financial year, the mine produced 2.6M tonnes of concentrate, which was an all-time record.

In 2014 Grange also commenced construction of the South Deposit Tailings Storage Facility (SDTSF). The SDTSF has been designed with the ability to mix and co-treat legacy ARD from the Old Tailings Dam and B-Dump using the excess alkalinity in fresh tailings. The potential transfer of the ARD seeps from the Old Tailings Dam will also improve the long term integrity of the Main Creek Tailings Dam. The co-treatment of the ARD seeps within the SDTSF should result in an improvement in water quality in Main Creek and Savage River.

Project funding

The remediation funds are split between two sources, as shown below.

Fund Description	Value at 1 July 2015
Environment Protection Fund An interest bearing statutory fund dedicated to Savage River Mine remediation controlled by the EPA Board	$13.5M
Purchase Price Fund To be paid to the Crown by Goldamere Pty Ltd in accordance with the Revised Goldamere Pty Ltd Agreement dated 18 December 2014*. The Purchase Price Fund is the amount owed to the Government by Grange Resources in accordance with the Goldamere Agreement.	$8.8M

**NB the revised agreement replaces the original Goldamere Agreement, dated 10 December 1996.*

Expenditure of the Environment Protection Fund is guided by Clause 4.8 of Schedule 1 to the *Goldamere Pty Ltd (Agreement) Act 1996*, which states 'The Crown agrees to expend any moneys received from PMI in connection with its environmental obligations on environmental improvements or rehabilitation at the Savage River Mine and Port Latta'.

Similarly, the Purchase Price Fund is specifically allocated by the Goldamere Agreement to 'works undertaken by or on behalf of the Crown within or adjacent to the Leased Land for the purpose of:

- *(i) rehabilitating areas disturbed by Past Operations; or*
- *(ii) mitigating pollution arising as a direct result of Past Operations; or*
- *(iii) co-treating pollution pursuant to clause 7.2(c) of the Goldamere Pty Ltd (Agreement) Act 1996; and*
- *(iv) environmental monitoring associated with such works.'*

This fund is effectively a debt to be worked off by Grange Resources at the request of Crown in such instalments as are necessary for the Crown to fund agreed remediation works.

Project Management Committee

The Savage River Rehabilitation Project (SRRP) Management Committee was established under the Goldamere Agreement. It comprises representation from the EPA Division in DPIPWE, Mineral Resources Tasmania (MRT) in the Department of State Growth and Grange Resources and is tasked with determining appropriate directions for the project and then making recommendations regarding remediation works and expenditure of the funds to the EPA Board.

Expert Reviews of the project in 2002, 2005, 2009 and 2013 have consistently found that the governance mechanism of the SRRP Management Committee is best placed to establish a best practice model for ARD management on the site. Further, the reviews emphasise the importance of collaboration between the parties in achieving agreed goals and outcomes. Significantly, the continued operation of the mine is regarded as a critical determinant of success of the project, as this ensures that expertise and resources are available on site to provide cost-effective, best practice remediation and rehabilitation options.

Objective and principles

The objective for the SRRP is:

- To promote recovery of a modified but healthy ecosystem in the Savage River downstream of the mine, and permit fish migration into the upper Savage River.

The committee aims to achieve the objective through the following overarching principles:

- To work in a collaborative way with all stakeholders in the project,
- To approach the rehabilitation and remediation of historical disturbances at the Savage River Mine in a strategic manner,
- To integrate remediation works with ongoing mining operations wherever practical and to co-operate with Grange Resources during the planning and implementation of projects,
- To demonstrate best practice in all aspects of the project and to communicate progress and findings to the community.

Activities

The SRRP will undertake the following activities to achieve the project objective:

- Investigate and evaluate legacy site pollution and risks to water quality goals and targets,
- Develop cost effective long term solutions to mitigate risks to long term water quality goals and targets,
- Minimise flows of acid drainage using methods such as capping / covers and diversion drains,
- Investigate and utilise passive treatment systems where possible, cost effective and practicable,
- Develop a cost effective neutralisation treatment system for the site, and
- Provide for the collection and delivery of residual acid drainage to eventual neutralisation treatment at one or more treatment plants that are expected to be necessary following cessation of the current mining activity.

Risk Management

The key risks to the project successfully achieving its objective are as follows.

1. Insufficient funding to achieve specific solutions
2. Closure of mining operations prior to currently planned life of mine to 2034,
3. Loss of key personnel and knowledge,
4. Failure of key ARD containment structures / systems / processes (e.g. tailings dams, capped rock dumps, pipelines).

The consequences and strategies of these risks are summarised in Table 1.

Table 1: SRRP Risk Management

Risk	Consequences	Management strategies
Insufficient funding	• Options for remediation are constrained. • Certain long-term neutralisation systems / processes are not affordable.	1. Prioritise key sources of ARD and conduct benefit cost analysis to determine best-fit remediation options. 2. Investigate options for raising revenue. 3. Investigate emerging technology / methodologies that may be more cost effective.
Closure of mining operations	• Loss of most cost effective approach to neutralisation, remediation and maintenance of existing systems. • Acceleration of the need for on-site neutralisation options. • Loss of expertise. • Increase in difficulty associated with monitoring and maintenance of monitoring systems. • Huge increase in costs associated with all project activities	4. Maintain effective communication with project partners to ensure that the likelihood of closure is understood and can be planned for. 5. Ensure that solutions implemented by the project recognise this risk and are suitable. 6. Model closure scenarios with project team so that generic courses of action (possibilities) are understood and can be implemented in a timely way. 7. Communicate risks to key stakeholders.
Loss of key project personnel	• Loss of expertise and knowledge.	8. Ensure adequate handover where staff movement can be anticipated. 9. Maintain effective knowledge management systems and strategies.
Failure of key ARD containment structures / systems / processes.	• Increase in ARD / contaminated flow, with negative consequences for downstream water quality. • Increased cost associated with remediating / rectifying failed structures or systems.	10. Identify structures, systems and processes that are vulnerable to failure. 11. Model failure scenarios for key vulnerabilities and ensure that findings are incorporated into benefit cost analysis of remediation options. 12. Ensure that risk and consequences are clearly understood and communicated to key stakeholders.

Actions

Actions which comprise the major focus of agreed works for the period of the Strategic Plan are detailed below.

Waste Rock Dumps

The legacy waste rock dumps are the main sources of metal-rich acid rock drainage (ARD). The 2009 Expert Review noted that ARD generation from historical waste rock dumps has ‘peaked', and loads to the receiving environment are being reduced by ARD capture in North Dump Drain and by the remediation of the B Dump Complex, and other dumps.

The 2013 Expert Review confirmed this view, noting a greater reduction in metal loads and acidity than expected. However, this is tempered by the 2014 Water Quality Review (Koehnken) that concluded the decrease in copper fluxes observed at the sampling sites at the Old Tailings Dam North, North Dump Drain, Savage River and in Main Creek is likely to be attributable to the on-site remediation works and a resultant stable hydrology, rather than a ‘burn out’ of metals in the deposits. Assuming this is correct, if site conditions change and hydrology is altered, there may be an increase in copper fluxes.

B Dump

Direct monitoring of the B Dump seeps cannot be achieved, but the seeps are currently captured in water monitoring at Main Creek below South Deposit. Once the South Deposit Tailings Storage Facility (SDTSF) is built, it will capture and co-treat the B Dump seeps and monitoring of the SDTSF outflows should be undertaken to determine the reduction of copper loads to the Main Creek as a result of B Dump seep treatment (Koehnken, 2014). The SDTSF is currently under construction with an expected completion date in the third quarter of 2016.

The need for treatment over the longer term (and/or on mine closure) should be assessed after a period of monitoring of the B Dump seeps.

ACTION 1:

a) Construct bunds to capture B Dump seeps so that they can be monitored, once the SDTSF is operational.
b) Continue to monitor the B Dump seeps to determine the extent of any required ongoing treatment by the SRRP upon mine closure.
c) Undertake a full water quality review at the end of 2016.

North Dump

Seeps from North Dump are diverted to South Lens via the North Dump Drain and are currently passively treated in South Lens utilising alkalinity from the active North Pit. On mine closure, when no further alkalinity is provided by North Pit, it is anticipated that the North Dump seeps will require a neutralisation system in order to continue treatment of the seeps.

The recent water quality review (Koehnken, 2014) states:

> *...dissolved copper concentrations have been highest in August during recent years, which corresponds to the lowest sulphate concentrations. This suggests that copper is present as a secondary mineral and is being flushed out of the dump when water levels within it increase, rather than being generated in proportion to sulphate.*
>
> *It is likely that this trend reflects the present hydrology of the dump, and water quality and trends could change if the water levels in the dump increased, leading to flushing of ‘new’ material. It is also noted, however, that the position of the dump, being adjacent to the hillside, reduces the risk of major changes to the hydrology of the dump.*

Discussions between Dr Koehnken and the SRRP Committee have reinforced the view that the metals in the seeps from North Dump are unlikely to decline at a fast enough rate to avoid active treatment upon mine closure when alkalinity in South Lens is exhausted.

ACTION 2:
Continue to monitor the water quality of the North Dump seeps, as part of the monthly sampling program, to assess the extent of any long-term treatment required by the SRRP following mine closure.

Crusher Gully

Recent water quality reviews have noted that there is an unaccounted for input of copper, upstream of the monitoring point at 'Savage River below Southwest Rock Dump' and that this is now the largest contributor of copper on the Savage River side of the lease site. Potential sources may be Crusher Gully or Southwest Waste Rock Dump (Koehnken, 2014). Additionally, the 2013 Expert Review recommended an extended water quality and flow monitoring for the site.

ACTION 3:
Investigate and quantify the Crusher Gully seepage and/or inputs from Southwest Waste Rock Dump by installing a monitoring station at Western Crossing, prior to making a cost-benefit analysis of any future works at this location.

ACTION 4:
Install an additional long term monitoring site at Western Crossing, to improve coverage and precision of data.

Old Tailings Dam

The Old Tailings Dam (OTD) contributes approximately 50% of the whole-of-site acid load. Acidity generated from the OTD seeps is passively neutralised in Grange's Main Creek Tailings Dam (MCTD). The OTD represents the greatest long term risk together with the potential for the MCTD tailings to acidify post-closure if the OTD seeps are not adequately addressed. The 2013 Expert Review recommended that further studies be undertaken to better understand the OTD / MCTD interface and to assess secondary mineralisation of oxidised waste rock and OTD tailings to better predict acid loads.

ACTION 5:
Analyse long term data from monthly water quality monitoring program to improve understanding of long-term chemistry changes at the OTD site.

ACTION 6:
Conduct assessment of secondary mineralisation in the OTD, particularly for the oxidised waste rock, and also for the OTD tailings.

ACTION 7:
Implement and install OTD seeps capture and transfer system, including bunding on MCTD to facilitate successful closure of the MCTD in the third quarter of 2016.

When Grange Resources ceases to actively use the Main Creek Tailings Dam, the OTD seeps will no longer be passively treated by the alkalinity contained within Grange's tailings. At this time, the seeps will be captured and diverted to the South Deposit Tailings Storage Facility (see figure 1). The SDTSF will be modified to accommodate the OTD seepages and ensure the seepages are neutralised by mixing them directly with fresh tailings as they are deposited.

If required, temporary bunding can be used to prevent the seepages short-circuiting the dam and being discharged untreated. The SDTSF will co-treat the OTD seeps and B Dump seeps with Grange's tailings until closure in 2034, after which an alternative method of treatment of the seeps is likely to be required.

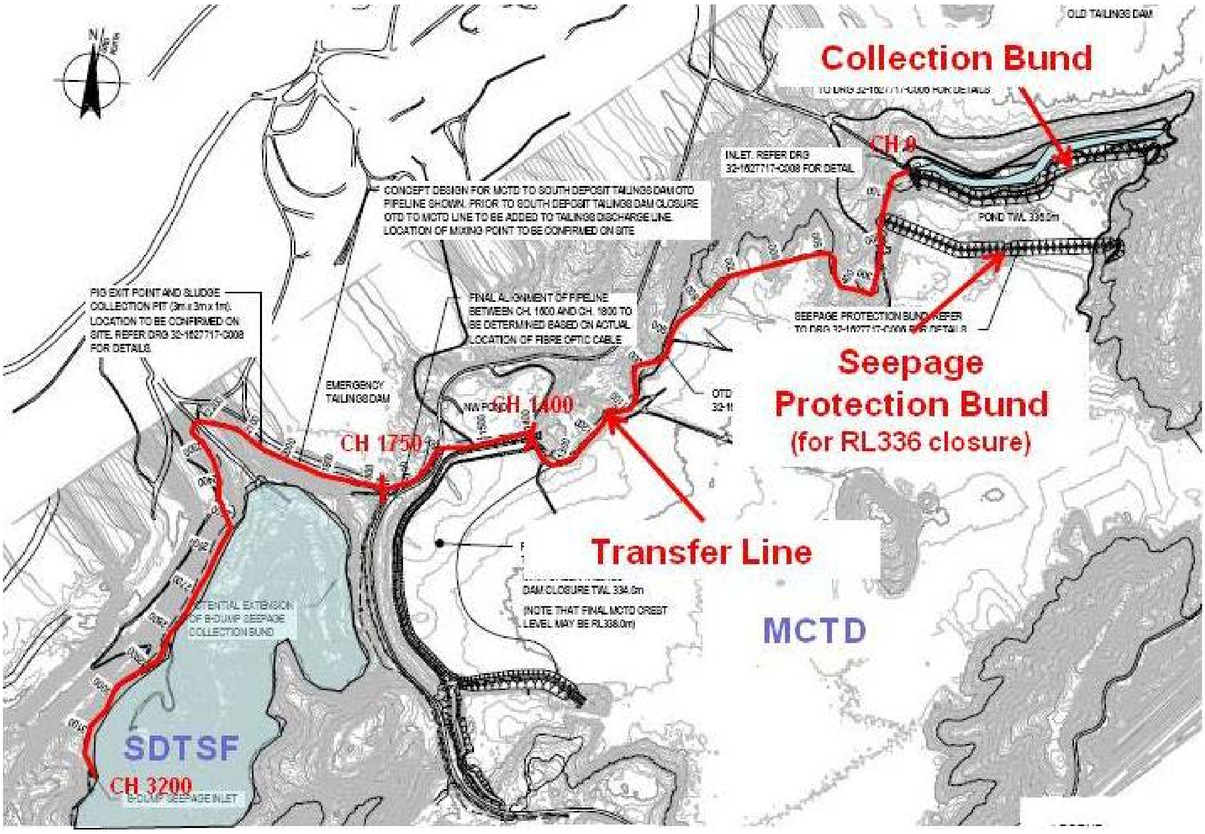

Figure 1: OTD – SDTSF transfer pipeline.

With respect to long-term OTD remediation, the SRRP has identified some possible options:

ACTION 8:
Investigate the use of gravels and organic covers to reduce infiltration of oxygen and water into the tailings, plus

- o capture and treatment of ARD seeps in a neutralisation plant with associated sludge storage, or
- o capture and co-treatment with Grange tailings, followed by treatment in a neutralisation plant at mine closure in around 2034.

The 2013 Expert Review reported that the OTD wall and upper beach are much more vegetated than previously observed, having shown progressively thicker and taller vegetation over time. That review concludes this indicates that the surficial tailings have oxidised and that the oxidation products have been leached by rainfall, providing a source of water within the upper OTD tailings to support vegetation. The review also notes that successful vegetation of the OTD wall and upper beach suggests vegetation as a suitable cover strategy, potentially providing the SRRP with a very cost-effective rehabilitation option.

The SRRP considers that the best opportunity for the management of the OTD seeps is through co-treatment in the new South Deposit Tailings Storage Facility (SDTSF) until mine closure, followed by active treatment after that time.

The 2013 Expert Review also recommended that further studies be undertaken to better understand the geophysics of the OTD/MCTD interface. However rather than undertake this as a priority project, and given the challenges and likely ongoing costs involved in the management of the OTD, the SRRP Management Committee proposes to seek and take advantage of research opportunities through university or industry projects. The Committee will look for opportunities of supporting research that is directly applicable to the mitigation of ARD production from the OTD.

ACTION 9:
Ongoing study of the water balance of the OTD tailings. Include rainfall runoff monitoring, and the effect of hardpan formation and vegetation, which may facilitate cost-effective closure of the OTD.

South Lens

South Lens is a treatment pit receiving acid drainage diverted from North Dump Drain, seepage from Bretts Drain, alkaline inputs from North Pit, Centre Pit North, Broderick Creek and stormwater from the catchment. An overall alkaline outflow from South Lens reports to the Savage River with an estimated 4 to 5 kg/day of copper being captured in South Lens (Koehnken, 2014).

Given the importance of South Lens in the treatment of acid drainage and metals from the site, the SRRP considers that it is worth reviewing the data specifically for inputs and outflows from South Lens to determine its finite neutralisation capacity.

ACTION 10:
Conduct investigation into South Lens Pit to determine the extent that the current neutralising function of South Lens is provided by the combination of direct/indirect sources of water inflows. The following questions are of particular interest:

- What neutralising capacity comes from North Pit water (i.e. volume and chemistry)?
- Returned flow from water pumped to the workshops is assumed to have little effect on the water balance. Is this true?
- Is there spare alkalinity for future needs (i.e. could South Lens Pit neutralise greater volumes of acidic water)?

Whole of Site Copper Trends

Copper levels for a range of calcium values in samples analysed between 2012 and 2014 at Savage River monitoring sites indicate that they are below fish targets and, apart from one value, below *Ceriodaphnia* targets (Koehnken, 2014).

This result raises the possibility that copper is no longer the most significant toxicant of concern, assuming copper continues to be captured and passively treated for the Savage River and Main Creek. The SRRP has received a recommendation to undertake a full review of previous toxicological test work (completed in 2001/2002) and perform further toxicological tests to confirm the key toxicants that pose the greatest ecological risk.

ACTION 11:
Undertake a full review of previous toxicological test work (completed in 2001/2002) and perform further toxicological test work to confirm the key toxicants, aside from copper, that pose the greatest ecological risk.

Neutralisation Plant

Conventional off-the-shelf lime neutralisation plants, such as high density sludge plants, are considered the most effective way to actively treat ongoing ARD. As this option is unaffordable in this context, the SRRP has sought to develop a limestone neutralisation system which would be affordable.

Recently completed work has shown that likely cost of this option is significantly higher than initially estimated and as the technology is unproven at a commercial scale, the SRRP has chosen to not pursue the development of this technology any further.

The SRRP will continue to seek affordable options for the active treatment of ARD sources where required, such as the ARD from the OTD, and potentially from the waste rock dumps.

> **ACTION 12:**
> Examine requirements to utilise the existing lime silo and lime slurry dosing system as an alkalinity source for ARD neutralisation for treating the B Dump and OTD seeps in the SDTSF when co-treatment is not possible, such as during extended shuts.

> **ACTION 13:**
> Conduct feasibility study to examine reconfiguring the existing lime silo and lime slurry dosing system for use as an alkalinity source for ARD neutralisation after mine closure.

> **ACTION 14:**
> Continue to monitor advances in treatment technology and seek suitable solutions for active treatment on the site.

Integration with Grange Resources' Life of Mine Plan

Given the high costs of all options identified to date, the best opportunity to maintain and improve water quality over the short to medium term is to integrate the treatment of the OTD and B Dump seeps with Grange's new South Deposit Tailings Storage Facility, to provide capture and neutralisation of the seeps in a cost-effective manner for the life of the mine. This will improve water quality in Main Creek for the life of the mine, and provide the infrastructure required for water treatment after mine closure, when treatment is likely to be required. This option also provides the SRRP with additional time during which to seek affordable options for the further mitigation and treatment of those sources.

> **ACTION 15:**
> Divert OTD seeps into SDTSF when completed and co-treat the OTD seeps and B Dump seeps in the SDTSF for the Life of Mine.

> **ACTION 16:**
> Investigate possible mitigation strategies for the OTD southern seeps and evaluate costs and benefits of alternative approaches.

> **ACTION 17:**
> Capture B Dump seeps on closure of the SDTSF, should the seeps pose a risk to the SDTSF at that time.

> **ACTION 18:**
> Consider other potential locations for collection and treatment of acid drainage, based on results of monitoring.

Project funds management

The SRRP Environment Protection Fund (EPF) is cash held in an interest bearing trust account. The balance of this fund, at 1 July 2015, was approximately $13.5M. The Treasurer's approved rate is applied to all interest bearing accounts, which is equivalent to the 180 day bank accepted bill rate less 50 basis points (i.e. 2.1 - 2.3% throughout 2014). This is currently the sole source of income for the project.

The SRRP has previously recognised that the low rate of return on the funds poses a risk to the success of the project and has sought a better return on the invested funds on several occasions without success.

The project funds, including income from interest, are not expected to outlast the production of acidity from the OTD. Although the monitored reduction in waste rock dump acid production may mean that these sources are more manageable and perhaps less costly than previously thought, additional sources of funding are required to continue the control measures that have successfully reduced ARD at the mine site.

Alternative sources of revenue such as through the operation of a mini hydro-electricity scheme on site, as identified in the previous Strategic Plan, have only been developed to scoping level. Reprocessing of tailings may also be a revenue source, if economically viable quantities of marketable residues can be retrieved.

These possibilities require more detailed analysis and planning before any commitment is made.

> **ACTION 19:**
> Continue to investigate potential sources of revenue that are compatible with the long term objectives of the SRRP, including tailings reprocessing and the mini hydro-electric plant.

Longer term planning

As noted in *Table 1 – Risk Management*, a key risk to the success of the project is early closure of the mine, or cessation of mining activity, which would dramatically increase the cost of any intervention and complicate arrangements for maintenance of existing solutions. There is a clear need for the management committee to gain a better understanding of priority actions that would need to be undertaken in the event of early closure, to ensure that gains made by the project to date are secured.

> **ACTION 20:**
> Develop mine closure scenarios with project team so that generic courses of action are understood and priority actions can be implemented in a timely way, should circumstances require it.

Summary of Actions

ACTION 1:

a) Construct bunds to capture B Dump seeps so that they can be monitored, once the SDTSF is operational.

b) Continue to monitor the B Dump seeps to determine the extent of any required ongoing treatment by the SRRP upon mine closure.

c) Undertake a full water quality review at the end of 2016.

ACTION 2:

Continue to monitor the water quality of the North Dump seeps, as part of the monthly sampling program, to assess the extent of any long-term treatment required by the SRRP following mine closure.

ACTION 3:

Investigate and quantify the Crusher Gully seepage and/or inputs from Southwest Waste Rock Dump by installing a monitoring station at Western Crossing, prior to making a cost-benefit analysis of any future works at this location.

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Investigate the use of gravels and organic covers to reduce infiltration of oxygen and water into the OTD tailings, plus

- capture and treatment of ARD seeps in a neutralisation plant with associated sludge storage, or
- capture and co-treatment with Grange tailings, followed by treatment in a neutralisation plant at mine closure in around 2034.

ACTION 9:

Ongoing study of the water balance of the OTD tailings. Include rainfall runoff monitoring, and the effect of hardpan formation and vegetation, which may facilitate cost-effective closure of the OTD.

ACTION 10:
Conduct investigation into South Lens Pit to determine the extent that the current neutralising function of South Lens is provided by the combination of direct/indirect sources of water inflows. The following questions are of particular interest:

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ACTION 11:
Undertake a full review of previous toxicological test work (completed in 2001/2002) and perform further toxicological test work to confirm the key toxicants, aside from copper, that pose the greatest ecological risk.

ACTION 12:
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ACTION 18:
Consider other potential locations for collection and treatment of acid drainage, based on results of monitoring.

ACTION 19:
Continue to investigate potential sources of revenue that are compatible with the long term objectives of the SRRP, including tailings reprocessing and the mini hydro-electric plant.

ACTION 20:
Develop mine closure scenarios with project team so that generic courses of action are understood and priority actions can be implemented in a timely way, should circumstances require it.

Conclusion

The SRRP Management Committee intends to continue with agreed activities and actions detailed in this plan to effectively and efficiently undertake remediation of legacy ARD at the Savage River mine site. Risks to the project will continue to be identified, managed and communicated in an ongoing way.

The SRRP Management Committee concludes that given the current level of funding and the understanding of the likely longevity of the ARD at Savage River, particularly from the Old Tailings Dam, the best opportunity for the treatment of the ARD in the short to medium term may be through the co-treatment of ARD with tailings from current operations.

While Grange Resources continues to operate, water quality targets are expected to be met in the Savage River, through the co-treatment of OTD and B Dump seeps in the new South Deposit Tailings Storage Facility until 2034, and the neutralisation of the North Dump Drain seep within South Lens.

After cessation of mining, the acid and metal load from legacy ARD sources will require long-term neutralisation, which is currently unaffordable with SRRP funds. In the short term, the SRRP will examine the costs and benefits of a mini-hydro scheme on site, which may prove to be a workable solution.

Advances in scientific research and the application of emerging technologies at Savage River may provide cost effective solutions in the future. The SRRP Management Committee will continue to seek and monitor cost-effective treatment options that may be implemented at Savage River upon mine closure, and will take advantage of opportunities to be involved in research projects, where directly applicable to SRRP issues.

List of Appendices

Appendix A shows an aerial photo of the Savage River Mine and current water monitoring localities.

Appendix B provides a summary of performance between 1997 and 2014 and against the SRRP's key objectives.

Appendix C summarises the major works undertaken on the site over the last 10 years.

APPENDIX A: Savage River Mine

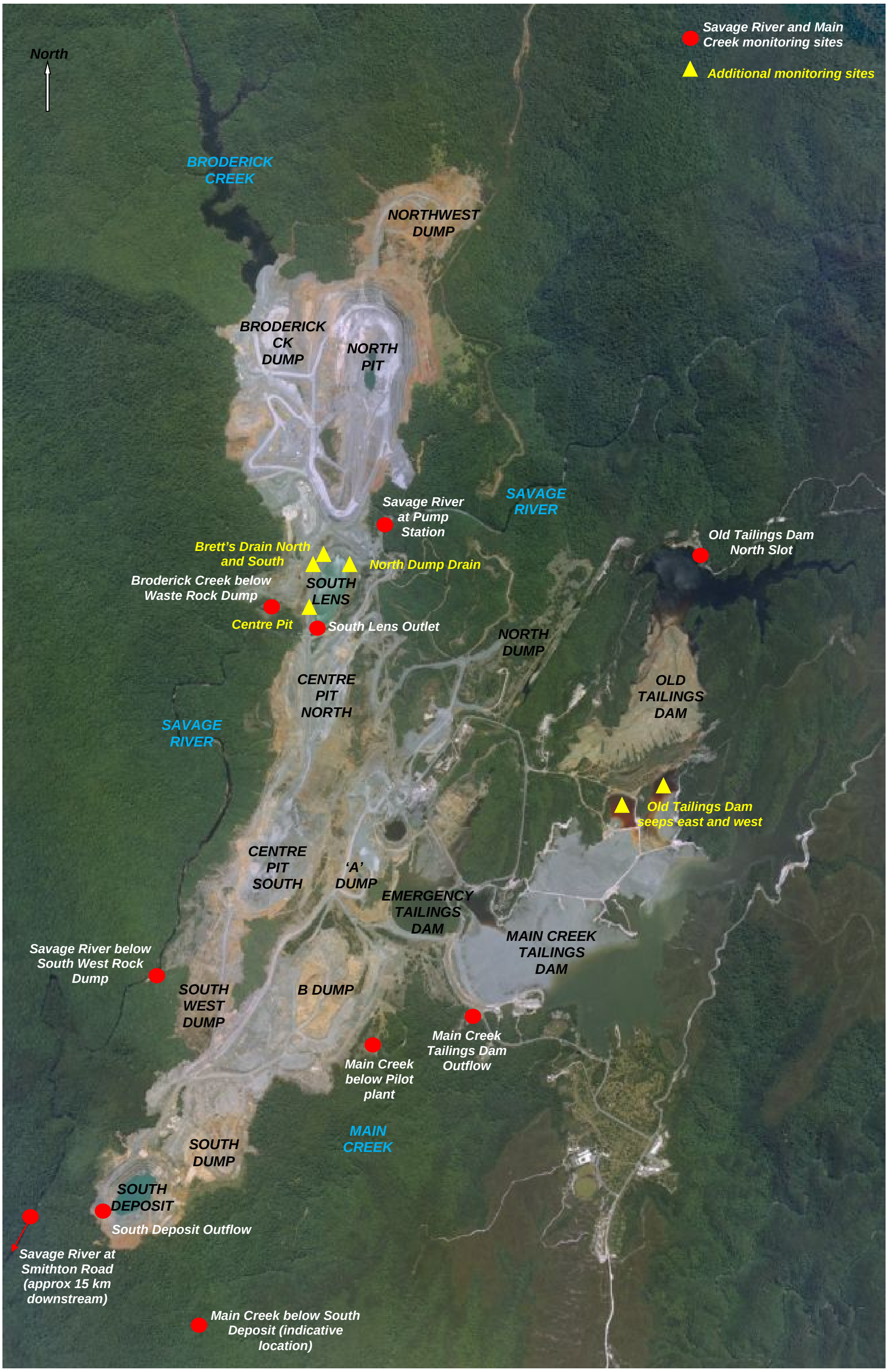

Figure 1 Savage River mine and water quality monitoring locations (photo c. 2012)

APPENDIX B: Performance Assessment 1997 - 2014

The performance of the SRRP to date is described below.

Objective 1: To promote recovery of a modified but healthy ecosystem in the Savage River downstream of the mine, and permit fish migration into the upper Savage River.

Water quality

Site-specific toxicological test work completed in 2001 and 2002 found that copper toxicity is affected by calcium and alkalinity in the Savage River. The work established target copper levels over a range of calcium values, and identified two toxicity targets, one to protect fish and other hardy aquatic fauna, and another to protect more sensitive aquatic invertebrates.

The aim of the SRRP in 2004 was to reduce the total copper load into the Savage River by 65%, to provide a three-fold safety factor to the toxicity targets for fish, and to also reduce the concentration to levels which allow more sensitive species to exist in the river.

Early project water quality data show that the copper levels in the Savage River in the vicinity of the mine were consistently above these toxicity targets.

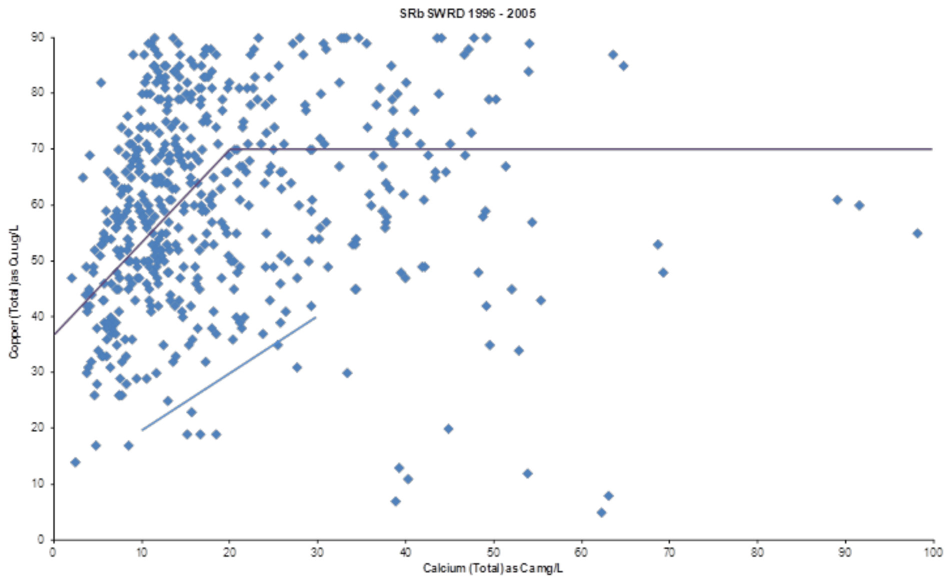

Figure 2. Total copper at Savage River at South West Rock Dump compared to toxicity targets (1996 – 2005)

A recent water quality review for the SRRP (Koehnken, 2014), showed that all measured copper concentrations are now below the target for fish, and are generally below the macroinvertebrate target, as shown in Figure 3 below.

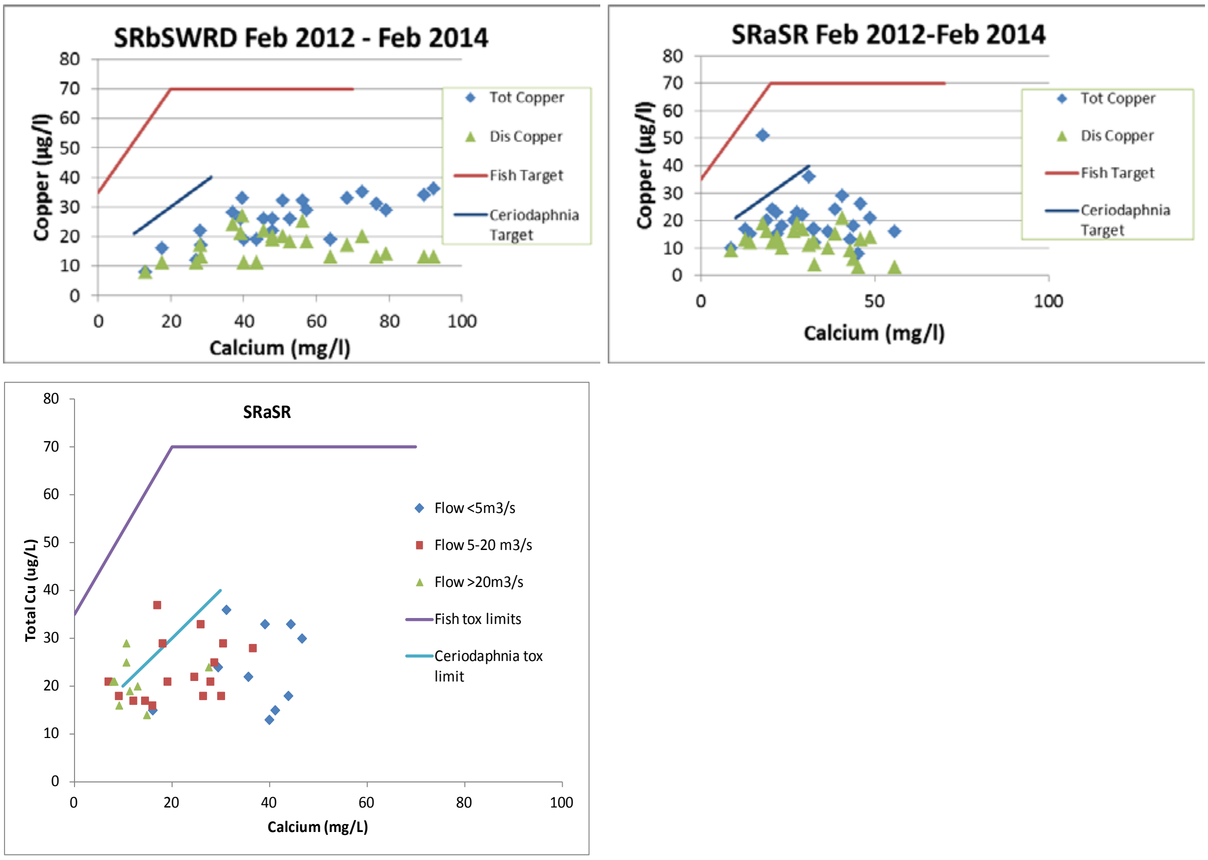

Figure 3. Copper concentrations against toxicity targets at Savage River below South West Rock Dump (SRbSWRD) and at Savage River at Smithton Rd (SRaSR), and for different flows at Savage River at Smithton Road (Feb 2012 to Feb 2014).

The decline in copper flux over time at locations on the Savage River is shown in Figure 4.

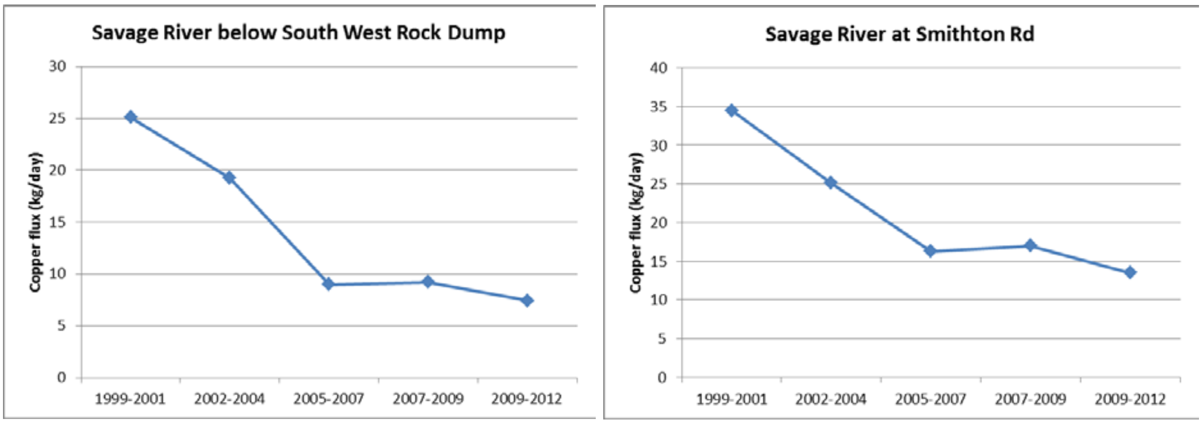

Figure 4. Reduction in copper fluxes at Savage River below Southwest Rock Dump and at Smithton Rd Bridge

Koehnken (2014) also notes that although there has been a decrease in copper generally across the site, there has been an increase in other metals and parameters associated with alkaline flows. The report recommends that the site specific toxicological targets be reviewed and if required, additional toxicological test work be completed.

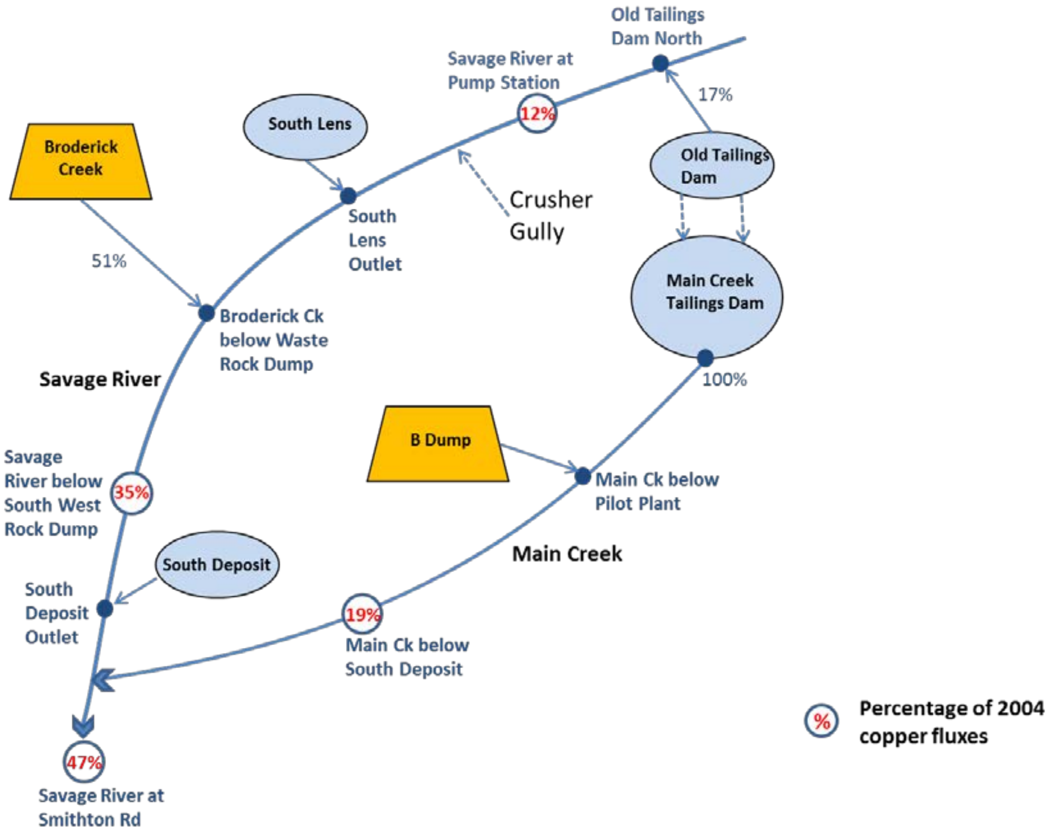

Figure 5. Copper fluxes in 2014 as a percentage of 2004 copper fluxes

Location	***2004 Cu loads (kg/day)***	***Target (65% reduction)***	***2014 Cu loads (kg/day)***
SRbSWRD	19	6.6	6.1
SRaSR	25	8.7	12.4

Table 2. Comparison of current copper loads against targets

Aquatic Bioassessment

Overall, the findings of the 2011/12 bioassessment were generally consistent with previous monitoring events, in terms of macroinvertebrate and fish community measures and river health ratings. In comparison to the 2007/2008 study, however, that there has been some recovery in the condition of the invertebrate fauna in the lower reaches of the Savage River. The lower reaches of the Savage River system appears to contain reasonably intact fish communities, with recruitment occurring within the river and from the Pieman River system. However, impacts from the mine may be preventing recruitment of native fish into the upper reaches of the Savage River, especially above the mine site.

Further aquatic bioassessments have been recommended periodically over the next 5 to 10 years to assess changes in the conditions downstream of the mine.

Objective 2: To develop and implement an agreed long-term strategic plan for the rehabilitation and remediation of historical disturbances at the Savage River Mine and Port Latta plant

The SRRP has progressed according to the 2001 and 2004 strategic plans, and the annual reviews of progress and updates of expenditures and timelines, including reports to the EPA Board. Given extensions in the mine life to 2029, the various projects undertaken to date, and the regular review of progress in terms of water quality, and the additional information gathered since 2004, a revised Strategic Plan is required at this time.

This plan focuses on remediation of historical disturbance at the Savage River site, as the committee does not propose to allocate further funds to the Port Latta site.

The contribution from historical operations to environmental issues at the Port Latta Pelletising Plant has been fugitive atmospheric dust emissions. Baseline ground contamination surveys conducted at the plant in early 1998 established that the ground around the plant buildings and the roads and tracks adjacent to the pelletising plant were covered with iron dust that had built up during 34 years of operations. This dust was considered to be pre-existing contamination and pollution as described in the Goldamere Act and therefore covered under the objectives of the Savage River Rehabilitation Project. The management of fugitive dust emissions is a joint responsibility as additional iron dust has no doubt built up since 1998 and, as such, is the responsibility of Grange Resources.

The SRRP committee investigated the cost effectiveness of sealing roads and tracks around the plant in the late 1990s. At the time, this proved to have a high capital cost and was considered likely to fail due to engineering issues and the high potential for re-deposition of dust.

The annual average PM_{10} levels at Cowrie Point almost halved between 2001 and 2010. In addition, decreasing annual averages since 2009 reflect additional measures taken by Grange to reduce the impact of their operations in the surrounding communities.

Based on the information above, the SRRP does not consider the Port Latta site to be a priority for the allocation of funds.

Objective 3: To integrate remediation works with ongoing mining operations wherever practical and to co-operate with Grange Resources during the planning and implementation of projects.

Key projects completed over recent years include:

- The B Dump cover system, constructed by (then) ABM as part of their waste deposition while mining the South Deposit. This included the construction of a water-shedding and alkaline side hill cover system over the dump, using eight million bulk cubic metres of alkaline rock and clay. Construction works were completed in late 2006. Remediation of the B Dump complex was a high priority for the SRRP as it contributes around 40% of the whole of site copper load. The water shedding cover system has reduced the overall rainfall infiltration into the dump from 90% to 23%. This will reduce the volume of water requiring treatment at a later date.
- Practical completion of the North Dump Drain contract to capture and divert seepage from the historic North Dump to the disused South Lens alkaline pit for treatment. The completion of North Dump Drain diversion to South Lens included a retention pond and pipeline construction. The completion of this diversion system means that 17% of the total copper and aluminium emissions from the mine site no longer enter the Savage River.

Objective 4: To overtly demonstrate best practice in all aspects of the project and to communicate progress and findings to the community.

Recent SRRP activities completed to meet this objective include;

- The 6th Australian Workshop on Acid and Metalliferous Drainage was held at Burnie in 2008 which included a site tour of the Savage River mine and SRRP works.
- Attendance and presentation at the Joint Conference of the 6th International Acid Sulfate Soil Conference and the Acid Rock Drainage Symposium (6ASSARD) in Guangzhou, China, by three SRRP Management Committee members.
- During 2009, three SRRP Management Committee members attended the 8th International Conference on Acid Rock Drainage (8th ICARD) held in Skellefteå, Sweden where they presented three papers on the SRRP.
- Invited expert speaker at Mine Rehabilitation & Closure Planning in Brisbane, 2010.
- SRRP staff, consultants and researchers co-authored papers presented at the 9th ICARD in Ottawa, Canada, in 2012.
- Publication of the *Savage River Revival* newsletter from time to time, which is available on the EPA website.

APPENDIX C: Major works and studies completed

SRRP Carbonate Neutralisation Plant

Conventional off-the-shelf lime neutralisation plants, such as high density sludge plants, are recognised as the most effective way to actively treat ongoing acid rock drainage. The SRRP has long recognised that there are insufficient funds available to implement this option on the site.

An alternative system using limestone has been investigated in-house on a small scale, and further technical advice was recently received from consultants CH2M Hill regarding scale-up to a full-scale pilot module. The SRRP had hoped that the use of limestone as a reagent would lead to a less expensive active treatment option for the Old Tailings Dam and B Dump seeps.

The work completed by CH2M Hill has shown that the installation of a pilot trial module to treat 10 L/s of the ARD flow from B Dump (approximately one third of the B Dump flow) was estimated to cost approximately $1.1 million. Ongoing operational costs were not included in this estimate.

To treat all the ARD flows identified, the site would require:

- An additional two modules to treat the balance of the B Dump flows (assume an additional $2M).
- An additional module to treat seeps from the OTD (assume $1M).
- The majority of sludge treatment and storage costs had not yet been incorporated in the cost estimate.
- No allowance for the pre-oxidation step required for the OTD seeps was included.
- Ongoing operational costs were not included/
- The module would be a prototype and would most likely require refinements.

Given the costs involved are significantly higher than had been estimated as part of the previous Strategic Plan and technology is unproven at a commercial scale, the SRRP has chosen to not pursue the development of this technology any further.

CH2M Hill also noted that the available budget for the SRRP appears to be insufficient for effective treatment of ARD from the mine site. As an example, the Britannia Mine Water Treatment Plant (high density sludge plant) to treat 16 L/s had a capital cost of CA$15.5M (2007 Canadian dollars) and a total cost over 20 years, including operational costs of CA$27.2M.

Old Tailings Dam

SRK Consulting conducted a significant study into the OTD in 2009 and estimated that it would take approximately 122 years to oxidise all sulphides in a 3m layer of tailings. The OTD is approximately 60 metres deep near the dam wall so the capacity of the OTD to create water quality problems, possibly for centuries, is clear.

The 2009 Expert Review noted that a possible option to mitigate the long term risk posed by the OTD may be to produce a depyritised tailings material using Grange’s tailings to cover the OTD to shut down the oxidation of sulphides. While this may reduce or prevent future acid production, ARD would still be expected to seep from the OTD and require treatment for some time. A study undertaken to investigate this has shown that the capital cost for this option is between $16 to 20 million. .

B Dump

Research conducted on the B Dump cover system by the University of South Australia, between 2010 and 2012, has shown that about 41% and 72% of the sulphides in the Potentially Acid Forming (PAF) material under the alkaline eastern side hill cover and without the cover respectively were leached out in the past 5 years, confirming that the calcite-chlorite schist alkaline cover has effectively reduced the Acid Generation Rate. Pyrite particles within the cover layer were shown to have thick iron oxyhydroxide coatings. In some cases the coating was over 1 µm thick, and was also armoured with silicate particles. Pyrite particles in B-dump without the alkaline side hill cover contain very low oxygen and pitting indicates dissolution/oxidation in progress. The cover has reduced the sulphide oxidation rate by about 43% over the past 5 years. The remaining copper load in the B Dump seeps is due to the dissolution of a secondary copper containing phase that coats pyrite grains within the dump. The copper load is expected to decline in the next few years as no other copper phases were found in the drill cores investigated as part of the research project.

Lois Koehnken assessed water quality in Main Creek in 2012 for Grange Resources and noted that recent results from the Main Ck below South Deposit monitoring site can be compared with historic results from the Main Ck at Savage River site to show changes in the Main Creek catchment over time. The comparison showed a decrease in acidity of ~0.5 tonnes/day similar to an increase in alkalinity in the MCTD outflow. In addition to the decrease in acidity, there has been a sizeable decrease in the flux of total metals in lower Main Creek. This cannot be solely attributable to an increase in alkalinity from MCTD, as metals do not disappear when neutralised. The very large decrease in manganese (which is not neutralised at the pH of the river), and decrease in sulphate from 16 to 9 tonnes/day are consistent with a reduction in acid drainage entering the system. A possible reason for this decrease is the capping of B Dump which occurred between the two monitoring periods. If related to the capping of the dump, ongoing monitoring will be required to determine if this reduction is a temporary change associated with hydrological changes within the dump, or an actual decrease in acid drainage generation due to a reduction in oxygen entering the dump.

North Dump

North Dumps seeps are currently transferred to South Lens pit for treatment. Overall, the diversion of NDD into South Lens has resulted in a significant decrease in metal concentrations and acidity in the Savage River. The North Dump Drain diversion did not have a big impact on pH or alkalinity within South Lens. In fact, alkalinity has increased from 93 to 110 mg/L since 2000 due to higher alkalinity from Centre Pit North and the changes in North Pit catchment.

Crusher Gully

The SRRP has previously attempted a collection and pumping transfer scheme to treat Crusher Gully seeps in South Lens. This proved unsuccessful, due to loss of infrastructure during flooding in the Savage River. An options study completed in 2009 identified three options for a more robust capture and diversion system, ranging in cost (± 50%) from $300 000 to $1.3 million.