GRANGE RESOURCES (TASMANIA) PTY LTD
SAVAGE RIVER MINE

DEVELOPMENT PROPOSAL AND ENVIRONMENTAL MANAGEMENT PLAN

SUPPLEMENTARY REPORT

South Deposit Tailings Storage Facility

November 2013
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<th>Abbreviation</th>
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<td>average annual daily traffic</td>
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<td>Australian Bulk Minerals</td>
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<tr>
<td>AEP</td>
<td>annual exceedance probability</td>
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<td>Australian National Committee on Large Dams</td>
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<td>Australian and New Zealand Environment Conservation Council</td>
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<td>ARD</td>
<td>acid rock drainage</td>
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<td>ASGR</td>
<td>acid sulphate generation rate</td>
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<td>bank cubic metres</td>
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<td>BPEM</td>
<td>Best Practice Environmental Management</td>
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<td>Council of Australian Governments</td>
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<tr>
<td>CPS</td>
<td>Centre Pit South</td>
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<tr>
<td>Cumecc</td>
<td>flow in cubic metres per second</td>
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<tr>
<td>DFTD</td>
<td>devil facial tumour disease</td>
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<td>Department of Infrastructure, Energy and Resources</td>
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<td>DOB</td>
<td><em>Eucalyptus obliqua</em> dry forest</td>
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<td>DoE</td>
<td>Department of Environment – formally SEWPAC</td>
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<td>DPEMP</td>
<td>Development Proposal and Environmental Management Plan</td>
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<td>DPIPWE</td>
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<td>dS/m</td>
<td>deciseimens per metre</td>
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<td>MCaSR</td>
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<td>MCbPP</td>
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<td>MCbSD</td>
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<td>South Deposit</td>
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<td>SDTSF</td>
<td>South Deposit Tailings Storage Facility</td>
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<tr>
<td>SEMS</td>
<td>Safety and Environmental Management System</td>
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<tr>
<td>SEWPaC</td>
<td>Department of Sustainability, Environment, Water, Population and Communities</td>
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<tr>
<td>SPRAT</td>
<td>Species Profile and Threats Database</td>
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<td>Savage River Rehabilitation Project</td>
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<tr>
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<td>top water level</td>
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<td>waste rock dump</td>
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GLOSSARY

**Acid–base accounting (ABA)** – The use of chemical reactions and indicators as a tool to identify in advance any mine materials that could potentially produce acid rock drainage (ARD). Static laboratory procedures that evaluate the balance between acid generation processes and acid neutralising processes.

**Acid forming (AF)** – A sample with a significant sulphur content and a low pH indicating that oxidation has commenced.

**Acid neutralising capacity (ANC)** – The inherent acid buffering which occurs when acid formed from pyrite oxidation reacts with acid neutralising minerals contained within the sample.

**Acid rock drainage (ARD)** – Drainage or seepage produced by the exposure of sulphide minerals such as pyrite to atmospheric oxygen and water.

**Electrical Conductivity 1:5 (EC1:5)** – EC1:5 results are a measure of electrical conductivity on a 1:5 soil water extract (w/w) determined by equilibrating the waste samples in deionised water overnight, at a solid to water ratio of 1:5 (w/w). This gives an indication of the inherent salinity of the waste material when initially exposed.

**Non–acid forming (NAF)** – A sample classified as NAF may, or may not, have a significant sulphur content but the availability of ANC within the sample is more than adequate to neutralise all the acid that theoretically could be produced by any contained sulphide minerals.

**Potentially acid forming (PAF)** – A sample classified as PAF always has a significant sulphur content, the acid generating potential of which exceeds the inherent acid neutralising capacity of the material.

**Waste rock A-type** – Grange waste rock classification for waste rocks which are hard, durable, non–acid forming and typically contain a high ANC.

**Waste rock B-type** – Grange waste rock classification for waste rocks which are soft and have a moderate ANC and a negative NAPP.

**Waste rock C-type** – Grange waste rock classification for waste rocks which are clays and silty clays.

**Waste rock D-type** – Grange waste rock classification for waste rocks which have a positive NAPP due to the presence of sulphides in excess of available ANC. This classification also includes rocks which have not been geochemically classified or which have an uncertain classification.
1 Introduction

Grange Resources (Tasmania) Pty Ltd (‘Grange’) is proposing to develop a new tailings storage facility (TSF) to be called South Deposit Tailings Storage Facility (SDTSF) at its Savage River mining operation. A Development Proposal and Environmental Management Plan (DPEMP) which describes the development, construction, management and operational closure of SDTSF, and also describes tailings management and remediation of legacy pollution at the site, was submitted to the Waratah–Wynyard Council on 3 May 2013.

The Waratah–Wynyard Council referred the DPEMP to the Tasmanian Environmental Protection Authority (EPA) which has requested the proponent to provide a supplementary report.

The EPA also forwarded a summary of issues raised by a single public representation, forwarded to the Waratah–Wynyard Council by the EPA Division.
2 The Land

Figure 1 The Land

The Land to which this activity pertains is defined in Figure 1, the red outline defining an area around the dam and the inundation zone. The zone extends from the ETD and MCTD walls in the north, down to the Main Creek below South Deposit monitoring site in the south, running parallel to the South Deposit pits and B-Dump.
Removal of vegetation will occur in the area marked “Dam Stripping Area” in Figure 2. Clearance of vegetation will be done progressively as the dam develops. The ramp will be constructed from South Deposit down to Main Creek, with some initial clearance at the bottom of Main Creek to allow the first placement of waste rock in the creek bed. As the dam rises in 10m lifts, each new lift will provide a stable structure for vegetation to be
progressively removed up the Main Creek embankments. By removing the vegetation in stages as the dam wall rises, the potential for sediment loss downstream will be decreased. The dam wall will also act as a settling pond/filter for upstream sediment. Runoff, where possible, will be directed into the upstream pond. Should timing allow, initial clearing works for the ramp will be completed in the drier Summer/Autumn months to further minimise sediment loss.

Furthermore there are three types of habitat disturbance associated with the proposed action:

- Vegetation clearance back to bedrock - called "Dam stripping area" in Figure 2.
- Dumping rock over existing vegetation, effectively preventing its use as habitat - called "Dump disturbance area" in Figure 2.
- Inundation zone - Upstream of the dam will which will become inundated by water and then tailings as described in Section 8.4.2. of the DPEMP.

The spillway will also be cleared to bedrock.
3 Policy and Conservation Assessment Branch Requirements

3.1 Geoconservation Sites

Provide a Statement on the potential impacts of the proposal on the magnesite karst feature.

When geoconservation sites (as shown on <http://www.thelist.tas.gov.au>) are plotted for the area around Savage River (Figure 3), some sites show up south and west of the old Savage River township and again near Long Plains, some 10 km south of the proposed SDTSF.

Figure 3 Regional Scale Geoconservation Sites

When Figure 4 is examined it shows the listed geoconservation site south of the old Savage River township and overlapping the eastern edge of ML11M/2008 but not overlapping the footprint of the proposed SDTSF, and the Main Rivulet Bowry Creek Magnesite Karst Area southwest of the mining lease and the SDTSF footprint.
Figure 4 Geoconservation Sites and Grange Mining Leases

The regional geology of the SDTSF area is shown in Figure 5, which is a marked up excerpt from N. Turner’s (2008) regional mapping. This mapping shows that the storage facility is founded on Oonah formation and a small section of mafic schists. These rocks are not part of the Main Rivulet Bowry Creek Magnesite Karst.
Figure 5 SDTSF Dam Geology

Excerpt from Regional Geology
(N. Turner 2008)
3.1.1 *Main Rivulet Bowry Creek Magnesite Karst*

The Main Rivulet Bowry Creek Magnesite Karst Area, together with related karsts at Lyons River and Keith/Arthur River, is the best developed magnesite karst known in Australia, and one of only a few substantial examples globally. This area is located to the south and west of the SDTSF (see Figure 4). The management goals for the area note that surface landforms are of limited extent but are sensitive to direct damage by souveniring and excavation or quarrying. Karst groundwaters including springs are sensitive to remote catchment effects, including potential water quality degradation due to forestry or quarrying. The surface landforms are mostly in good condition although minor damage has occurred due to outcrop sampling. One mineral exploration drillhole intersected deep hydrothermal groundwater flows, creating an artificial surface spring which proved impossible to plug due to the complex karstic nature of the subsurface conduits.

Being essentially karst landforms and springs developed in magnesite carbonate rock, the geosite is very sensitive to the pH of the water in Main Creek.

The construction of the SDTSF should improve the downstream environment and reduce any impacts on Karst formations as;

1. Water quality in Main Creek is poor with high acidity and low pH. This is due to existing ARD pollution. The median pH at Main Creek below South Deposit between March 2009 and March 2013 was 6.24 with a range from 4.8 to 7.95 and a median acidity of 7 mg/L.
2. The proposed SDTSF will provide an opportunity to neutralise the existing acidic seeps emanating from the B Dump complex and provide a flow-through waste rock dump comprised of alkaline rock downstream of the SDTSF which will add further alkalinity to the water in Main Creek. Main Creek water quality is discussed further in Sections 5.2 Chemistry of Main Creek Catchment Seeps, 5.3 Impact of Proposal on Closure and 5.13 SDTSF Water Quality Emission Levels of this report.
3. The SDTSF will reduce the risk of tails spills and decrease sediment flows, as the SDTSF will be constructed to full height before tailings are placed in it.
4. The flow regime in Main Creek will not change significantly from the present. Approximately 50% of the creek flow is already moderated by the two dams in the catchment (upstream of the proposed SDTSF). The STDSF is not expected to change the existing flow regime by more than 10%.
3.2 Cumulative Impacts on Tasmanian Threatened Species

Provide a discussion on the cumulative impacts on Tasmanian threatened flora and fauna, taking into account the potential cumulative effects of the proposal, based on existing and other approved developments in the region, including Grange’s current mining operations across the whole mine site.

3.2.1 Mine History

Magnetite mineralisation was discovered at Savage River in 1887. For many years, interest in the deposit centred on the copper and gold potential of the area. Adits were developed in the hillsides but no significant base or precious metal mineralisation was identified.

Exploration of the prospect was carried out by the Australian Bureau of Mineral Resources in 1956, including ground and air magnetometer surveys. Diamond drilling was undertaken in 1957 and 1959.

In 1965 Savage River Mines Limited, a joint venture of Australian, Japanese and American interests, was formed to develop the project.

The Savage River Project was operated for the full term of a 30-year lease by Pickands Mather & Co. International (PMI), an affiliate of Cleveland-Cliffs Inc., on behalf of the joint venture. To access the magnetite reserves, PMI developed an open-cut mine, concentrator plant and township at Savage River. A pipeline was constructed from the concentrator plant to a pelletising plant and dedicated port facilities at Port Latta. Production commenced in 1966 and ranged as high as 2.4 million tonnes per annum (tpa) of iron ore pellets.

During the late 1980s, PMI approached its joint venture partners and proposed that it acquire their interests in the Savage River Project. This proposal was accepted and, shortly thereafter, PMI reduced pellet production to approximately 1.5 million tpa. PMI ceased activities at Savage River in early 1997 and ownership of the Savage River Project was transferred to the Tasmanian Government on 26 March 1997.

The mine was operated as a conventional open cut initially working the Centre Pit located south of the Savage River. Leases north of the river were granted in 1984 and the small South Lens Pit and the much larger North Pit were then developed. The centre of operations moved towards the new pits due to greater ease of mining and improved ore blending.

In March 1997, ABM purchased the assets of the Savage River Project from the Tasmanian Government. ABM and Grange merged in 2009 with the operation continuing.

The mine continues to be a conventional open cut. ABM’s operations deepened and re-configured the existing open cuts and mined several smaller satellite ore bodies that were not mined by PMI.

The Savage River mine along with the associated infrastructure, notably the township of Savage River, has placed a significant footprint in the landscape. The mine has been in operation since 1967; currently the Savage River mine covers approximately 1700 ha which
is a mix of cleared, or partially modified or revegetating land. Figure 6 shows this footprint and also identifies areas that are in the process of rehabilitation (estimated to occupy over 100 ha).

3.2.2 Cumulative Impact

The mining leases operated by Grange Resources at Savage River being 11M/2008, 14M/2007, and 2m/2001 covers approximately 3,200ha, of this area approximately 1500ha is impacted by mining operations (to the commencement of the pipeline track). The pipeline corridor travels north on 11M/2008 to Port Latta on the northwest coast. It is approximately 83 kilometres long an less than 65 m wise other than a section at the northern end which is 7.5 kilometres long and 350 m wide and a section at the southern end which is 13.3 kilometres long and 350 m wide.

Much of the mining lease will never be mined. These areas that avoid clearance are protected from other land uses such as forestry and public access. They inadvertently provide secure habitat for the Tasmanian devil.

After mining has ceased and the infrastructure closes down, there will be some areas permanently altered. Tailings dams and pits will never return to a vegetated state. However there are many parts of the footprint that have and can be rehabilitated. The rehabilitated areas in Figure 6 clockwise from top left are:

- Pipeline Corridor – natural revegetation of disturbed land alongside the pipeline corridor. This demonstrates the rapidity of natural regrowth in this soil and climate and suggests that providing conditions for this to occur may be more successful than forced rehabilitation.
- Old Tailings Dam (OTD) – this dam wall was sprayed with seed before 1996 by the previous mine operators.
- The former Savage River Township – the township area was cleared and rehabilitated by Grange in 1997 in conjunction with the SRRP. This involved removing buildings and infrastructure, providing a clay / soil base and planting suitable (local) seedlings complemented with seeding and an ongoing weed management program.
- South West Rock Dump – the top levels of the legacy SW Rock Dump were capped with compacted clays by Grange in 2001 and 2002 and were then planted with seedlings and a short-term organic substrate.
Experience at the Savage River mine (particularly on SW Rock Dump) indicates the most important factors for successful vegetation growth or regrowth at Savage River seem to be providing suitable growing media, ideally enhanced by protection such as the provision of slash and an ongoing weed and predator management program.
For this proposal Grange intends to clear up to a total of 148 ha (depending on the final size of the buttressing waste rock dump downstream of the dam) which is an additional 4% of the Savage River section of the ML. Grange is unaware of any other existing or approved developments in the region which will add to the cumulative impact of Grange’s proposed SDTSF.

### 3.2.3 Tasmanian devil

Based on the estimated loss of 1500 ha (1700ha, less partially modified and rehabilitated land) of vegetation since 1966, assuming densities of 0.3 to 0.7 devils per square kilometre, the carrying capacity may have declined by 4.5 to 10.5 devils. The low density of the population known to occur within the form of vegetation in the region would suggest that this impact is at the lower end of this estimate.

However the mine site is not vacated by Tasmanian devils. They are regularly observed on site and have been recorded denning under buildings in the past. Devils become acclimatised to human activity and it is well recognised how they can inhabit in association with anthropogenic disturbances. Devils present in the Savage River area have been raised in an environment characterised by noise and visual disturbances. The individuals are not likely to be adversely affected by further operations. Modified environments and revegetated habitats are likely to support elevated numbers of prey.

### 3.2.4 Spotted-tailed quoll

A reduction in carrying capacity for the spotted-tailed quoll is also likely to have occurred. However, taking into account its larger range, the impact will have been much less.

### 3.2.5 Wedge-tailed Eagles

Wedge-tailed Eagles are still present within the wider landscape; however, there is no historical data to show they have been breeding within the Savage River mine. Past impacts are more likely to have been from wildfires that impacted on tree suitability for nesting and would have occurred prior to 1999 (Pre EPBC Act).

### 3.2.6 Water Quality

The water quality emanating from the site has had the capacity to impact on threatened species particularly *Galaxias* spp., frogs and the Australian Grayling. By the end of 1996, the two streams which traverse the mining lease, the Savage River and Main Creek, were adversely impacted by mining. Acid rock drainage (ARD) was considered to be one of the main water quality issues at Savage River. Waste rock dumps containing material from the southern pits, particularly Centre Pit South, were considered most prone to acid leaching. Cu and Ni both exceeded the ANZECC (1992) guideline value for soft waters below the mine site.

The Pieman River Monitoring Program data showed high metal concentrations in the Savage River (Koehnken, 1992) with all metal concentrations (with the exception of Fe) increasing as the Savage River flows through the mine site and then decreasing before the Savage
River/Pieman River confluence. The median Cu concentration was over 25 times the ANZECC (1992) recommended value for soft waters just below the mine site with maximum Cu concentrations 3–5 times higher than the median concentrations. Davies (1995) suggests that high Cu concentrations were a major reason for the degraded aquatic ecosystem below the mine. Main Creek flows south from the Main Creek Tailings Dam to eventually join Savage River approximately 12 km downstream from the mine site. The water quality determined about 5 km downstream from the tailings dam in Main Creek, was poor with a median pH of 4.5 and concentrations of Cu, Mn and Ni all well above the ANZECC(1992)/USEPA(1988) guideline values.

A study of the downstream effects of the mine was commissioned by PMI in 1995 and reported in Davies (1995). The following conclusions were made:

- The faunal diversity and abundance at riffle and edge habitats in the upper Savage River is similar to other unimpacted streams of the region.
- The faunal communities of the Savage River have suffered severe impacts consistent with major changes in water quality and sediment characteristics.
- The major impacts are associated with the river reach between Broderick Creek and some 30 km downstream of the mine road bridge.
- Little recovery is occurring downstream from the ameliorative action of inflowing tributaries.
- The degree of impact is sufficiently severe to eliminate up to 90% of the major taxa (families) of aquatic macroinvertebrates and to decrease overall abundance by up to 99% in the reach downstream of the confluence with Main Creek.

Water quality has been improved by current mining operations with water quality criteria set by the SRRP now being achieved in the Savage River (see Section 5.3 Impact of Proposal on Closure). Water quality will be further improved by the SDTSF, especially in Main Creek where water quality continues to be below the standard set by the SRRP, thus the cumulative impact of the SDTSF will be positive.
4  Mineral Resources Tasmania Requirements

4.1  Post-closure Maintenance

Describe what ongoing maintenance will be required post closure with respect to the dam wall and waste rock dump.

To determine the post closure maintenance requirements for the dam and waste rock dump the issue of stability is important. It should be noted that the Factor of Safety for the SDTSF will be significantly higher than prescribed for this category of dam due to the presence of the waste rock dump buttressing the SDTSF immediately downstream of the "dam embankment". The SDTSF dam will be a stable, non-eroding, durable structure. The dam will be a well-drained, stable structure. Grange will construct the waste rock dump to the standards applied on site since 1998 which utilise angles of repose (< 37°), slope of batters plus berm, which means that overall the dump angles are much lower.

The footprint of the SDTSF dam and buttressing waste rock dump can be seen in Figure 53. The dam will be subject to the ANCOLD (2012) inspection and maintenance protocols for a ‘high’ hazard category dam. These include the provision of an Operation and Maintenance Manual and a Dam Safety Emergency Plan. Regular audits and dam safety inspections will be carried out as per the ANCOLD requirements at the time of operational closure.

The waste rock dump will be constructed with rocks at angle of repose. Given that other waste rock dumps constructed to this specification have been on site and stable since the 1970s, little ongoing maintenance on this structure is expected. The waste rock dump will be a stable, non-eroding, durable structure.

4.2  SDTSF Footprint

Provide a map or figure of the SDTSF footprint and southern mine workings in relation to the mining lease boundaries.

Figure 60 in the DPEMP provided an aerial photo of the southern end of the mining leases with the inundation area, spillway and SDTSF Dam wall shown. This is also shown and further clarified in Figure 7 where the inundation area, the dam wall, the spillway and the South Deposit pit are shown in light green. As can be seen the SDTSF is located completely within existing mining leases.
4.3 Historic Heritage Sites

Clearly identify the location of the mining heritage sites with respect to the SDTSF footprint, identifying which sites will be flooded or otherwise disturbed by the proposal.

The EPA on behalf of Mineral Resources Tasmania has requested a map of historic heritage sites showing the inundation area for the SDTSF. Table 1 lists the historic heritage sites described in Appendix O of the DPEMP. Figure 8 then locates these sites in the Main Creek valley and shows the location of inundation zones, the SDTSF embankment and the South Deposit pit.

Sites 1, 2, 5, 6, 7, and 8 are inundated as per Figure 8, of these sites, site 2 (Smiths Mine) holds some historical significance at the regional level (Appendix O, DPEMP, pg13). Further information on the historical significance of these sites can be found in Appendix O, Figure 8 of the DPEMP.
### Table 1  Historic Heritage Sites

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Figure 8 Historic Heritage Site Locations
5 EPA Division Requirements

5.1 Definition of Seeps

The Main Creek catchment seeps are variously referred to in the DPEMP document and associated appendices as B Dump, B dump complex, ETD, MCTD etc.

Clearly identify the location of seeps, potential origin and current discharge point into the Main Creek catchment, and expected discharge point on final closure.

Clarify the nomenclature used in the DPEMP and associated appendices to describe the seeps with reference to the above.

5.1.1 Nomenclature and Location of Seeps

As noted by the EPA, the DPEMP refers to B Dump seeps while it’s Appendix H refers to historic acid drainage sources emanating from the Old Tailings Dam (OTD), Emergency Tailings Dam (ETD), Main Creek Tailings Dam (MCTD) wall, and B Dump, a large mainly historic waste rock dump.

Main Creek catchment seeps are shown in a flow diagram in Figure 9.

Figure 9 Flow Diagram Main Creek Catchment Seeps
The B Dump seeps are shown in Figure 9 inside the blue box. All of these sources of ARD are together called ‘B Dump seeps’ or occasionally ‘seeps from the B Dump MCTD Complex’. In the DPEMP and in this Supplementary Report the term ‘B Dump seeps’ has been used for all of these seeps combined, this term used by the Savage River Rehabilitation Project (SRRP) to describe these seeps.

In summary, the individual sources that contribute to the B Dump seeps are:

- **B-Dump** – The waste rock dump that is thought to be the major source of ARD pollution in the area
- **ETD** – From the Emergency Tailings Dam wall
- **MCTD seep** – From Main Creek Tailing Dam Wall

### 5.1.2 Potential Origin of Seeps

![Figure 10 Natural Topography](image)

Figure 11 above shows the original creek beds entering Main Creek (in blue) the creeks provide natural flow paths through what is now the MCTD wall, the ETD wall, A Dump and B Dump.

As ARD forms within the waste rock of a dump/dam wall due to sulphide oxidation, it flows downwards under the influence of gravity until it meets a low-permeable surface at which time it follows the line of least resistance. In all dumps and in the Old Tailings Dam as studied at Savage River, the ARD ends up in original creek beds following topographic routes, this can be seen by the correlation between the seep collection/sampling points to the original creek beds.

In the case of B Dump, the original haul roads provide the first line of low permeability and some of the ARD (seeps) flows along the haul roads to the north (Figure 11 and Figure 12). The two eastern ramps are now buried below the eastern side hill cover which Grange
constructed under contract to the SRRP, but they still direct ARD flows to the north due to their low permeability compared to the loose waste rock tipped on top.

Figure 11  B Dump Ramps

Figure 11 is from a 2002 oblique aerial photo of Savage River and shows the haul roads used by Pickands Mather & Co. International (PMI) on the eastern side of B Dump. White arrows indicate the direction of the roads (north and down).

The seeps are ephemeral and can be seen on the access road to Main Creek in Figure 12. This flows down the road leading into the Main Creek valley, disappears into the original creek bed below B Dump waste rock and is first collected at the Main Creek below Pilot Plant site (MCbPP).

Figure 12  B Dump Ramp Seeps
The ramps are high up in the B Dump and as a consequence do not capture significant ARD flows.

The ARD which is not intersected by hard compacted haul roads percolates downwards into the original creek beds where it flows until it exits the dump as shown in Figure 12.

5.1.3 Current Seep Discharge into Main Creek

5.1.3.1 ETD and MCTD Seeps (collected at MCbPP)

Grange understands that both the ETD and the MCTD were originally constructed of unsegregated waste materials probably containing potentially acid forming pyrites which is likely to be the source of minor seeps on the dam walls (Figure 9). There are two ephemeral seeps which flow from the ETD wall into the Main Creek valley. These flow down the road leading into the Main Creek valley (road in Figure 12), disappear into the original creek bed below B Dump and are first collected at the Main Creek below Pilot Plant (MCbPP) pond which is a SRRP monitoring location.

Figure 13 shows the MCTD seep as it appears on the southern side of the MCTD wall after rain. Several seeps were measured on the MCTD wall by Thompson and Brett before 1997 and that study indicated that the seepage flow from most of these seeps correlated directly to rainfall on the dam wall. The seeps shown here usually, but not always, dry up in summer weather and appear to be coming from the rock abutment.

These seeps flow into the original creek bed; which is below B Dump waste rock and like the ETD seeps are captured and monitored at the MCbPP site. These MCTD seeps have very small rainfall catchments and as a consequence do not result in significant flows.

Figure 13 Ephemeral MCTD Wall Seep

5.1.3.2 North eastern B Dump seeps (Collected at MCbPP)

B dump was constructed over the tributaries of Main Creek and Main Creek itself. The northern most pond which collects ARD seeps from B Dump is called MCbPP (Figure 14 and Figure 15), this pond is within Main Creek.
At MCrPP, the seeps from the MCTD, ETD and A-Dump mix with B Dump seeps in a pond, from which clean stormwater run-off has been diverted to the greatest extent possible.

**Figure 14** Main Creek below Pilot Plant (MCbPP)

In Figure 14 the pond into which the seeps collect can be seen in the foreground and the pilot plant which was operating in 2007, is in the background. Figure 15 shows the pond, looking east from the flow through seen in Figure 16 (below).

In Figure 16 the discharged seeps from the ARD pond can be seen flowing through the rock fill. The capture pipe which was used to feed the ARD into the pilot plant can also be seen. The v-notch used to measure flows sits below this point, the v-notch does not collect all flows at this point, as it is not attached to bedrock and it’s likely some of the flow passes under the v-notch.
5.1.3.3 South eastern B Dump Seeps (Collected a MCbDD)

As you work down Main Creek from the Pilot Plant site, the B dump seeps next appear at Main Creek below Dolomite Dam (MCbDD) (Figure 17 and Figure 18). The seeps emanating from B Dump in this location are measured at a V-notch, however, like the MCbPP the v-notch weir below the dolomite dam does not capture all flows.

Furthermore the ARD from the MCbPP seeps flow down the creek and also enter the MCbDD pond along with stormwater. Thus this site captures the inputs from all seeps entering upper Main Creek, which includes seeps from the MCTD and ETD in addition to the B-Dump seeps (Koehnken, 2013).

All B Dump seeps then flow down Main Creek and are measured downstream at Main Creek below South Deposit (MCbSD). The MCbSD site also contains alkalinity from MCTD supernatant water and from the southern flow-through, as well as stormwater run-off.
5.1.3.4 B Dump – Southern Flow through Seep (Intermittent alkali seep)

The southern end of B dump also has an ephemeral seep which flows to the south. The original creek bed can be seen in Figure 10 as a dotted blue line. This seep flows through what is now the southern flow through and delivers alkalinity to Main Creek (Figure 9).

5.1.4 Expected Seep Discharge on Final SDTSF Closure

As the Main Creek valley fills with tailings and water, the lower levels of B Dump will be inundated with some, albeit limited, percolation of tailings into the waste rock. The inundation will cause the B Dump acidic seeps to rise as the tailings rise in the SDTSF. A similar effect can be seen with the rise of the OTD acidic seeps with the rise in the MCTD
tailings level since 1997 (Figure 43 to Figure 48). The rise in phreatic level will also reduce the head driving the B Dump seeps from about 110 to about 40 m, substantially reducing flows, as demonstrated by seepage analyses (and application of Darcy’s Law).

The seep discharge points from B Dump are expected to be the current discharge locales backing up into the original creek beds. There is expected to be some diffusion into the surrounding alkaline side hill cover.

Figure 19 showing the expected location of the seeps at final. The location of B Dump, its eastern alkaline side hill cover and intermittent alkali (Southern) flow through can also be seen. Original creek beds are marked as green dotted lines.

The ETD seeps and the MCTD seeps will report to the SDTSF surface along the current flow paths as they’ll be less influenced by the rising phreatic head.

**Figure 19  Final Supernatant Water Height**
5.2 Chemistry of Main Creek Catchment Seeps

Drawing on all information available characterise the chemistry, including acidity and metal concentrations and flow of the seeps identified in response to the question above.

As noted above, the B Dump seeps report at two distinct ponds in Main Creek - MCBPP and MCBDD. Due to the difficulty of collecting or segregating the seeps at source, it is not possible to discriminate between the individual inputs, so using the MCBDD water quality to describe the quality of the B Dump seeps is an over-estimate of the contribution from B Dump, but more accurately reflects the total inflow of diffuse emissions likely to enter the SDTSF during mine life (Koehnken, 2013).

5.2.1 Water Quality – Concentrations

The concentrations of water quality parameters between 2009 and 2011 at Old Tailings Dam Eastern Seep (OTDE), MCTD, MCBPP, MCBDD, and MCBSD are shown in Figure 20, Figure 21, Figure 22, Figure 23 and Figure 24 for select parameters. The MCTD overflow includes reaction by products from the neutralisation of the OTD seeps which occurs in the northern section of the MCTD. Figure 20 to Figure 24 show the various Main Creek inputs from North to South.

Figure 20 Water quality summary OTDE Seeps

Figure 21 Water quality summary MCTD Overflow
The water quality of the MCBPP is the chemistry of the northern and north-eastern B Dump seeps, the MCTD seeps, ETD seeps, A-Dump as well as alkalinity from the eastern side hill cover over B Dump and some stormwater flows in Main Creek.

The water quality of the MCBDD contains the above seeps as inflow plus additional alkalinity inflows and stormwater inflows.

The southern flow through seep was sampled by Grange for the SRRP in December 2009 and showed an acidity of 8 mg/L, Total Fe 2,940 µg/L and Total alkalinity 9 mg/L.
5.2.2 Seep Flows

As noted above, the individual seeps have not been measured directly either in terms of water quality or flow. The monitoring locations in Main Creek where the seeps are collected have been monitored by the SRRP at various times over the past fifteen years. These flows are shown in Table 2 below.

Table 2 Summary of Flow Statistics for Main Creek Catchment

<table>
<thead>
<tr>
<th>Site</th>
<th>Median L/s</th>
<th>Average L/s</th>
<th>Max. L/s</th>
<th>95th L/s</th>
<th>20th L/s</th>
<th>Min. L/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>OTD East 1/98–11/99 n=48</td>
<td>1.1</td>
<td>1.1</td>
<td>3.3</td>
<td>1.8</td>
<td>0.8</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>OTD West 1/98–11/99 n=50</td>
<td>1.8</td>
<td>1.9</td>
<td>8.8</td>
<td>3.9</td>
<td>1.1</td>
<td>0.4</td>
</tr>
<tr>
<td>MCTD 12/97–12/99 n=94</td>
<td>300</td>
<td>330</td>
<td>890</td>
<td>580</td>
<td>200</td>
<td>120</td>
</tr>
<tr>
<td>MCBDD 12/00–11/02 n=31</td>
<td>41</td>
<td>52</td>
<td>168</td>
<td>138</td>
<td>33</td>
<td>10</td>
</tr>
<tr>
<td>MCBSD 1/11–10/11 n=254</td>
<td>327</td>
<td>504</td>
<td>3373</td>
<td>1533</td>
<td>205</td>
<td>96</td>
</tr>
<tr>
<td>Main Creek u/s Savage River 8/94–9/00 n=480</td>
<td>690</td>
<td>940</td>
<td>6600</td>
<td>2600</td>
<td>440</td>
<td>350</td>
</tr>
</tbody>
</table>

Flow for all sites except the MCBSD is based on instantaneous flow at time of water quality monitoring. MCBSD flow is based on the average daily discharge for 2011.

The OTD seeps although part of the "Main Creek catchment seeps" are significantly different in that they are neutralised by Grange’s tailings in the MCTD and are formed from the oxidation of sulphides from tailings (gangue from ore processing) whereas the B Dump seeps are formed from the sulphide oxidation of waste rock. As a result the OTD seeps tend to be relatively high in acidity and iron whereas waste rock seeps tend to be lower in acidity and iron but higher in metals.
5.3 Impact of Proposal on Closure

Provide an assessment of the environmental impact of the SDTSF on the receiving environment assuming seeps within Main Creek catchment, identified and characterised above, will not be captured on closure.

The assessment should focus on the potential for acidification of the SDTSF water cover and potential for subsequent production of acid and dissolution of metals. It should take into account the chemical characteristics of the seeps and the potential reaction pathways, including the acceleration of sulphate and acid generation in the presence of ferric ions.

The assessment should also address the influence of the physical environment on the potential for acid generation and metal dissolution, for example the effect of wind and fetch on tailings disturbance, development of a tailings ‘crust’ etc.

The assessment should be placed within the context of current improvements observed in Main Creek and Savage River over the last decade.

5.3.1 Existing Environment

The current receiving environment for the proposal is Main Creek and 12kms downstream, the Savage River. The water quality in Main Creek is shown in Figure 24 above (MCbSD). It is also shown at SRRP monitoring locations at various times in Table 3 below.

Table 3 Summary of Water Quality in Main Creek Catchment

<table>
<thead>
<tr>
<th>Location</th>
<th>Acidity mg/L</th>
<th>Alkalinity mg/L</th>
<th>Cu_{tot} mg/L</th>
<th>Fe_{tot} mg/L</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median</td>
<td>90th</td>
<td>Median</td>
<td>90th</td>
<td>Median</td>
</tr>
<tr>
<td>OTD East Seep 8/94–9/03</td>
<td>2670</td>
<td>3456</td>
<td>&lt;2</td>
<td>&lt;2</td>
<td>2.16</td>
</tr>
<tr>
<td>n=120</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OTD West Seep 8/94–9/03</td>
<td>3260</td>
<td>4167</td>
<td>&lt;2</td>
<td>&lt;2</td>
<td>0.74</td>
</tr>
<tr>
<td>n=120</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Creek Tailings Dam (MCTD)</td>
<td>3</td>
<td>4</td>
<td>28</td>
<td>40</td>
<td>0.006</td>
</tr>
<tr>
<td>1/09–10/11 n=33</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Creek below Pilot Plant</td>
<td>217</td>
<td>240</td>
<td>&lt;2</td>
<td>&lt;2</td>
<td>1.83</td>
</tr>
<tr>
<td>(MCbPP) 12/9–9 /11 n=15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Creek below Dolomite Dam</td>
<td>245</td>
<td>322</td>
<td>&lt;2</td>
<td>&lt;2</td>
<td>2.54</td>
</tr>
<tr>
<td>(MCbDD) 8/99–11/03 n=60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Creek u/s Savage R 8/94–9/00</td>
<td>18</td>
<td>23</td>
<td>&lt;2</td>
<td>&lt;2</td>
<td>0.33</td>
</tr>
<tr>
<td>n=250–500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Creek below South Deposit</td>
<td>7</td>
<td>31</td>
<td>3.5</td>
<td>15.7</td>
<td>0.13</td>
</tr>
<tr>
<td>(MCbSD) 1/9–10/11 n=44</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Data from SRRP monitoring. NA=not available
The earliest records of water quality in Table 3 above are the Main Creek u/s Savage River and the OTD seeps from 1994. At this time a study of the downstream effects of the mine was commissioned by SRM in 1995 and reported in Davies (1995). Sampling was undertaken during the spawning period of the brown trout (Salmo trutta) (which is the dominant fish species in the Pieman River catchment).

Davies (1995) made the following conclusions:

- the faunal diversity and abundance at riffle and edge habitats in the upper Savage River is similar to other unimpacted streams of the region;
- the faunal communities of the Savage River have suffered severe impacts consistent with major changes in water quality and sediment characteristics;
- the major impacts are associated with the river reach between Broderick Creek and some 30 km downstream of the mine road bridge;
- that little recovery is occurring downstream from the ameliorative action of inflowing tributaries;
- the degree of impact is sufficiently severe to eliminate up to 90% of the major taxa (families) of aquatic macroinvertebrates and to decrease overall abundance by up to 99% in the reach downstream of the confluence with Main Creek.

The severely degraded aquatic ecosystem of Main Creek and the Savage River downstream of the mine is thought to reflect both mine-derived trace metals and sediment. Trace metals can have direct toxicological effects on aquatic biota, while sediment can fill the interstices in the bed sediments, thereby substantially altering the benthic habitats and associated fauna.

Biological monitoring in the Savage River and Main Creek between 1995 and 2008 has found an improvement in the ecology of the Savage River as remediation of acid drainage sources on the mine site have progressed; however, the ecology of Main Creek remains severely impacted with no fish and very poor macroinvertebrate communities in the waterway (Davies et al., 2008). The investigators documented a decline in macroinvertebrates in Main Creek between 2001 and 2008, although the cause of this was not identified.

The SRRP has derived site-specific toxicity targets for remediation of the Savage River and Main Creek (Davies et al., 2001; Eriksen, 2002), see Figure 25 and Figure 26. These targets, based on dissolved Cu and Ca concentrations in the water, are compared to recent water quality results at MCbSD in Figure 26. Overwhelmingly, it is low flow conditions which pose the greatest toxicological risk to Main Creek. Water quality results for flow rates in excess of 1 m$^3$/s frequently achieve toxicological targets.
The figures above compare water quality results from Main Creek above Savage River (MCaSR) and MCbSD against the site-specific water quality targets developed by the SRRP (Davies et al., 2001; Eriksen, 2002). The more recent data set from MCbSD has many more data points below the toxicity target for fish as compared to the historic MCaSR site, demonstrating some improvement in the Main Creek catchment, in part due to the water shedding cover and alkaline side cover on B Dump.

### 5.3.2 Potential for Acidification of SDTSF Water Cover

Grange has sought separate independent reviews on these issues from Technical Advice on Water, Aquatic Science and RGS Environmental. These reports are provided as Appendices B to D and are summarised below.
5.3.3 Environmental Impact on SDTSF of Not Capturing the B Dump Seeps

5.3.3.1 Iron in B Dump Seeps

Figure 27 shows that iron fluxes in the B Dump seeps are low compared to other metals, with manganese and aluminium contributing the majority of the metal acidity. Sampling results also show that substantial portions of the iron in the samples is present in the particulate form (ferric), resulting in dissolved iron values being lower than total iron values (Figure 28). These results are consistent with the pH values of the samples which are in the range of 3.0 to 3.5. At this pH ferric iron hydroxides precipitate leading to very low Fe$^{3+}$ concentrations (Figure 29).

**Figure 27** Median Total Metal Loads for Manganese, Aluminium, Copper and Iron

**Figure 28** Comparison of Total and Dissolved Iron in the Seeps

*The red line indicates the 1:1 ratio of total iron to dissolved iron*
Regular monitoring at MCbDD was completed in 2001–2003, and these results have been used to characterise iron in the B Dump Seeps. A comparison of water quality results from 1998–1999 at a Main Creek monitoring site near the Savage River and 2009–2010 at MCbSD suggested that metal and acidity fluxes in Main Creek may be decreasing (Koehnken, 2009). Therefore the 2001–2003 results are likely to provide a conservative estimate of the B Dump water quality.

5.3.3.2 Iron Mass Balance in SDTSF

During mining operations, iron in the SDTSF will be derived from tailings and process water, seeps, overflow from the MCTD, and natural runoff entering the impoundment. The flow, iron and pH information for inflows has been extracted from the SRRP database and is summarised in Table 4.

Assuming all of the iron entering the dam remains in the dam, approximately 6,000 tonnes of iron will be captured in the SDTSF over the 20-year mine life. This is an over-estimation as some of the iron in the process water is dissolved (based on monitoring results) and is likely to pass through the dam. Similarly, some iron associated with fine particulates or catchment inflows will be discharged from the dam. Recognising the uncertainties of the estimates, it is clear that upon mine closure, there will be a reservoir of iron contained within the SDTSF, and the annual input from the B Dump seeps will always be a small additional input by comparison.

The iron contained in the dam will likely be present as coatings on tailings particles, which will limit the direct contact between the pyritic tailings and the water in the dam. Post-mine closure, seeps entering the dam as surface inflows will have limited contact with pyritic tailings due to the formation of iron-crusts on the tailings, and the natural accumulation of sediment over time, and should the closure bunds be built any contact will be contained within the bund.
### Table 4  Estimates of Iron Sources Reporting to SDTSF

<table>
<thead>
<tr>
<th>Source</th>
<th>Median Flow L/s</th>
<th>Median Daily Total Fe Flux</th>
<th>Median pH</th>
<th>Basis for Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>OTD seeps</td>
<td>5.5</td>
<td>772 kg/day</td>
<td>3.2</td>
<td>Σ (Average OTD flows x Average OTD Fe concentration) from database</td>
</tr>
<tr>
<td>B Dump seeps entering SDTSF</td>
<td>40 (to be reduced to 11 post-mine closure)</td>
<td>10 kg/day</td>
<td>3.6</td>
<td>Monitoring results from MCBDD monitoring site in database</td>
</tr>
<tr>
<td>Process water</td>
<td>20</td>
<td>0.2 kg/day</td>
<td>7.0</td>
<td>Based on present MCTD discharge Average inflow of 401 L/s x 0.3 mg/L Fe based on typical Fe content of surface water on the West Coast. Flow from hydrologic modelling for SDTSF (GHD). The pH is from typical west coast waters</td>
</tr>
<tr>
<td>Surface inflows</td>
<td>401 (160 into SDTSF catchment, 240 from MCTD catchment on closure)</td>
<td>10.37 kg/day</td>
<td>5.5</td>
<td>(based on typical west coast water)</td>
</tr>
</tbody>
</table>

#### 5.3.3.3 Mixing of Tailings and Seeps

During operations, the OTD seeps will be actively mixed with tailings in a pipe reactor, whilst the remaining seeps will be passively mixed with tailings directly in the dam. Based on the neutralisation test work completed using the process tailings, there is sufficient neutralising capacity in the process tailings to neutralise the OTD and B Dump seeps. Test work included in the DPEMP (Section 8.2.7, 226 – Also see Appendix P of DPEMP) shows that the resultant pH of the water after mixing was 7.4. There was also a large residual alkalinity content (>80 mg/L) in the supernatant water, suggesting that the outflow from the dam will contribute considerable alkalinity to the downstream environment whilst the mine is operating.

These results are consistent with water quality mass-balance investigations completed in the Main Creek valley in 2009, which found that the overflow of alkaline water from the MCTD partially neutralised the B Dump seeps, resulting in a reduction in dissolved iron and aluminium concentrations and a reduction in acidity loads of ~100 kg/day between the MCBDD and Main Creek below South Deposit (MCBSD) sites. This improvement in water quality only reflects the alkalinity discharged from the dam, and does not include the available alkalinity within the tailings particulates which the mixing test work has found to be substantial and sufficient to neutralise the OTD seeps and the B Dump seeps.

Neutralising the seeps with the process water will increase the pH of the OTD and other seeps, resulting in the oxidation of any ferrous iron in the inflows, and precipitation of ferric hydroxides in the dam. The settling of the metal precipitates will be assisted by the presence of tailings in the impoundment, which provide a large surface area onto which the iron (and other metal) hydroxides/oxides can precipitate. Ferric iron precipitates are highly insoluble above pH 2.5 (Johnson & Hallberg, 2005).
Based on this scenario, the risk of ferric iron reduction occurring in the B Dump seeps and driving the formation of acid drainage during mining operations is low, due to:

- the neutralisation of the seeps through mixing with alkaline process water and tailings
- the presence of iron as insoluble ferric hydroxides at the pH in the dam
- the capture and burial of the ferric hydroxides with the settled tailings in the dam
- the lack of acid drainage formation from pyrite due to the saturated, low-oxygen condition of the tailings.

### 5.3.4 Potential for Ferric Iron in B Dump Seeps to Drive Sulphide Oxidation in SDTSF Following Mine Closure

Water quality monitoring investigations in 2009 suggested that the flux of copper and other contaminants from the Main Creek valley was decreasing, although there is insufficient information available to accurately determine whether some or all of the recorded decrease was attributable to a hydrologic ‘lag’ associated with the partial capping of the dump, or an actual reduction in the rate of acid drainage creation within the dump (Koehnken, 2010).

Koehnken (Appendix B, 2013) carried out geochemical modelling using PHREEQC to investigate the ‘what if’ scenario posed by the EPA, regarding the potential for ferric iron to drive sulphide oxidation in the dam should the B Dump seeps continue to be discharged into the SDTSF post mine closure. Model input was based on the pH and median metal loads in the seeps as presented in the previous sections. Using the water quality results as model input is considered a conservative approach as, over a 20-year period, B Dump is likely to reduce emissions, due to the extension of the water-shedding cover and the inundation of the lower layers of the dump (and possibly due to the dump ‘burning out’).

Initially, the model was used to predict the speciation of iron within the B Dump seeps based on present water quality characteristics. This run also identified solid phases (goethite, hematite) for which the solution was over-saturated, providing an indication of the compounds likely to precipitate from the solution. The predicted Fe$^{2+}$ and Fe$^{3+}$ concentrations from these runs provide the maximum concentrations of free iron that could be available in the B Dump seeps, assuming no precipitation of solids. This exercise was completed using the present water quality of the B Dump seeps, and varying the starting ratios of Fe$^{2+}$ and Fe$^{3+}$ concentrations. The runs were also completed using five-times the present metal and sulphate concentrations in the B Dump seeps to account for a worst case scenario in which the flow of the seeps is reduced, but the metal loadings remain the same.

The first set of model results show the following:

- Iron oxide/hydroxide compounds would be expected to precipitate from the seeps unless all iron was present as Fe$^{2+}$ (note: the results from this run do not take into account any loss of iron due to precipitation).
- The percentage of iron available as Fe$^{3+}$ is low in all of the runs (approximately 2% to 3% of the initial ferric iron content specified at the beginning of the run) showing that that most of the dissolved Fe$^{2+}$ in the seeps will be coordinated within dissolved compounds. The model predicts that FeSO$_4$$^+$ will be the predominant dissolved form of ferric iron in the seeps.
• Relatively higher percentages of the total ferrous in the water are present as the dissolved ion (Fe\(^{2+}\)) compared to ferric, with the model predicting Fe\(^{2+}\) as the predominant dissolved ferrous species.

• The model runs (6 to 8) using five-times the concentration of the present B Dump seeps showed similar results with respect to available Fe\(^{3+}\), with only a small percentage of the total ferric input available as the free ion.

• Gypsum (CaSO\(_4\)\(\cdot\)H\(_2\)O) is predicted to be precipitated from the B Dump seeps along with goethite and hematite at the higher concentrations.

In the second step of the modelling, the B Dump seeps were allowed to reach equilibrium with the solid phases identified in the initial model run (goethite, hematite). The predicted Fe\(^{2+}\) and Fe\(^{3+}\) concentrations from these runs is indicative of the water quality in the seeps and dam after being in contact with iron coatings and/or solids in B Dump or the SDTSF.

The results from the second set of modelling runs, in which the B Dump seeps were allowed to reach equilibrium with goethite and hematite, show the following:

• In all of the runs, almost all of the iron entering with the seeps is removed through the precipitation of hematite and goethite.

• In runs 9 to 11, Fe\(^{3+}\) is virtually absent, and Fe\(^{2+}\) is present at concentrations of 1–3 µg/L.

• In runs 12 to 14, the higher concentrations of iron in the B Dump seeps result in higher concentrations of available Fe\(^{2+}\), but the concentration of Fe\(^{3+}\) remains extremely low.

The results show that the availability of Fe\(^{3+}\) is extremely limited at the pH of the B Dump seeps. The available Fe\(^{2+}\) would need to be oxidised to Fe\(^{3+}\), and remain available, in order to react with pyrite. Ferrous oxidation would be limited in the low dissolved oxygen environment of the dam, and the ferric iron resulting from any oxidation would be rapidly lost from solution, again limiting the potential for sulphide oxidation.

Also relevant is the stability of iron hydroxides at pH greater than 2.5, which will limit the availability of iron to react with pyrite in the dam. In the case that pH values in the dam decrease below 2.5, and ferric ions become available and react with sulphides to create acid drainage and ferrous ions, the low oxygen content of the tailings (due to water saturation) would minimise the oxidation of the ferrous back to ferric, so there is a low risk of a perpetual reaction being initiated without an additional, continuous source of dissolved ferric to the dam.

5.3.5  **Metal Dissolution (Cu/Al) in B-Dump Seeps**

Best practice environmental management would have the seeps captured and treated on mine closure as there is a risk that some dissolution of metals would occur. It is important that this risk is put into perspective.

The B-Dump seeps are low in iron and high in aluminium and are also the dominant copper source on the Savage River lease. During the deposition of tailings within the SDTSF it is expected that nearly all the copper and aluminium will be precipitated as a result of co-
disposal with the tailings resulting in an environmental gain. Recent work on the B-Dump seepage by AMIRA (2011) noted that based on total S assays, it appears that ~64% of entire acidity from the Type D materials within the B-dump was released within the last 5 years weathering based on the ABA and NAG testing results for the B-dump type D materials collected in May 2005 and April 2010. At this rate, remaining pyrite in the dump will be exhausted within the next four years. This suggests that the acid load from this source is decreasing. Consequently the above dissolution of copper and aluminium from the precipitated metals after closure in the event of the B-Dump seeps not being captured may not be substantive.

When metals are precipitated as a hydroxide as shown for aluminium below, hydroxides will be removed from solution as shown in the reaction below.

$$\text{Al}_3^+ + 3\text{OH}^- \leftrightarrow \text{Al(OH)}_3(s)$$

This reaction then results in replacement of the hydroxides (OH\(^-\)) removed from solution with increased hydronium (the acid H\(_3\)O\(^+\)) concentration. This is because the hydroxide concentration multiplied by the hydronium concentration in water will remain constant.

$$2\text{H}_2\text{O} \leftrightarrow \text{H}_3\text{O}^+(aq) + \text{OH}^-(aq)$$

The solution then becomes more acidic as a result. This is why the acidity of an ARD solution can be estimated from the metal concentrations.

The dissolution of metals will occur when an acid dissolves the metal back into solution. From equation (1) the amount of aluminium in solution will be described by the solubility product (equation (3)). Therefore when more acid is added the hydroxide concentration goes down (see reaction (2)) and the aluminium concentration increases to compensate, given that K\(_{sp}\) is a constant.

$$K_{sp} = [\text{Al}_3^+][\text{OH}^-]^3$$

If the seeps were allowed to discharge into the SDTSF the concentration of aluminium would increase as a result and become the main source of acidity. Strong dissolution of aluminium hydroxide would not be expected however as the source of the acidity, aluminium ions, would in turn be increasing the propensity for the formation of hydroxide. The system would therefore be expected to be near equilibrium.

Al and Cu concentrations within the B-Dump seeps is near equilibrium (pH of these metals in solution is ~3.5), in order for greater dissolution of Al or Cu, the pH would have to be drop significantly, the primary way for this to occur would be if the iron concentrations in the B-Seeps were orders of magnitude greater than present. The OTD seeps that have significantly greater concentrations of Iron and have a lower pH (~2.5) than the B-Dump seeps, this would have the potential to drive greater dissolution of Al and Cu, if these seeps weren’t diverted away from the SDTSF on closure. The differences in seep chemistry are a result of the differences between waste rock and tailings.
The dissolution of copper ions is also expected to be relatively stable as they precipitate at a similar pH to aluminium. Ferric iron however has a much lower Ksp value and will have the potential to cause more substantive dissolution of Aluminium and copper hydroxides. It is therefore a higher priority that the seepage from iron rich sources of ARD such as the Old Tailings Dam seepage is kept separate.

5.3.6 Physical Environment

The circulation of water can result in the generation of acid when pH is low and ferric iron and to a lesser extent oxygen can be circulated and come into contact with sulphides within the tailings. After oxidation, the ferric iron is converted into ferrous iron which may again be re-oxidised and the process may then be repeated. This cycle can potentially generate acidity. It is best practice that water bodies are kept at a minimum depth of 1 m, to minimise this effect (Appendix C, Aquatic Science, August 2013, pg8).

The Gard Guide (MEND, 2001) notes that the diffusive transfer of oxygen in water is in the order of 10,000 times slower than diffusive transfer in air and that a water cover from 1 to 3 metres deep is needed if preventing re-suspension of fine tailings due to wave action is a consideration.

With regard to the impact of the physical environment, Figure 30 (Figure 162 in the DPEMP) shows the final height of the SDTSF with the emergency spillway in place. A supernatant water cover in excess of 2 metres is provided, with greater depth provided in the north-eastern corner where overflow from the MCTD will occur. This corner has the greatest potential for mixing of waters as a result of this inflow and the consequent mixing of oxygen from the surface to deeper within the water column. The additional depth of > 3 m in the north-eastern corner should guard against this.

The formation of a ferric hydroxide layer or ‘crust’ will also limit the potential for oxidation by ferric iron circulation (Appendix C, Aquatic Science, August 2013, pg8).

As noted in Section 10.2 of the DPEMP, Grange's experience with the MCTD closure will provide knowledge to ensure that the final closure of the SDTSF does not contribute to environmental harm. An important aspect which may impact on this is the development of wave action across the pit lake and the consequent need to construct fetch barriers across the top of the tailings. Grange has demonstrated the capacity to construct these barriers on the MCTD and will monitor the effectiveness of this work on the MCTD before confirming whether it is needed on the SDTSF on closure.
Figure 30 does not show the seep collection bunds. The final decision on these will be made by the EPA/SRRP.
5.3.7 Assessment of Impact on Closure

The water quality evidence suggests there is a low risk of the B-dump seeps promoting acid drainage generation in the SDTSF due to the presence of ferric iron. Notwithstanding this, removal of the seeps is still considered the best practice approach for seeps management, as it is always preferable to divert acidic streams away from tailings impoundments. Removing the seeps all but eliminates the risks associated with unanticipated events, and minimises the potential for metal hydroxides other than iron (e.g. aluminium or copper) to dissolve. Removal of the seeps will also preserve the residual alkalinity in the dam which will serve as a water quality buffer into the future.

The MCBSD monitoring site shows Total Cu concentrations vary between 87 and 500µg/L (Figure 24) and has a similar catchment to the SDTSF. If the neutralisation by tailings can reduce the SDTSF copper concentration to near the MCTD levels as anticipated the project will reduce the toxic metal load in the downstream environment substantially. Other metals and associated metals are also expected to be substantively reduced (Appendix C, Aquatic Science, August 2013, pg8).

Water quality improvements observed since the implementation of works in the last 10 years, mean that the above calculations and assessment provided above and in Appendices B and C are conservative and the mixing of tailings with ARD to mitigate pollution will be easier to achieve.

From a whole of site perspective the effective neutralisation of metals from the B-Dump complex will provide the biggest pollution reduction that has occurred on the lease since the SRRP began. From the SRRP water auditing undertaken between 1998 and 2002 the B-Dump complex was responsible for 40% of the whole of site copper load at that time. The removal of a large portion of this pollution source should occur as a result of the SDTSF construction and effective management.

The effectiveness of the impact will be evaluated by monitoring the downstream water quality at MCBSD.
5.4 Modelling Main Creek Seeps capture on closure

Model Description
Describe the software program and type of model used to assess the ability of the seepage collection ponds to capture Main Creek seeps on closure.

Describe the specific model configuration and boundary conditions. This must be in enough detail for a reviewer to duplicate the modelling if necessary. This may include, the hydraulic head boundary conditions, hydraulic properties (permeability) of the materials, infiltration conditions, weight and hydrostatic force of the ponded water etc.

The following models should be presented and described, along with all assumptions and model limitations:

- A baseline closure model (i.e. we would expect a baseline model to be established with the closure conditions in place, including ponded water level, but without a bund to capture the seeps), and
- A bund closure model (i.e. closure conditions but with a bund in place to capture the seeps).

Discuss the basis behind the parameters used in the models including hydraulic head and permeability of each strata, defining the information base used, e.g. empirical studies, theoretical principles, expert opinion etc.

Presentation of model output
Provide clear diagrams with an explanation and interpretation, showing pressure head contours, flux sections and flow vectors providing a clear indication of the magnitude and direction of flow for the baseline closure model and the bund closure model.

For each model (baseline closure and bund closure model), the diagrams must be of a scale(s) that focuses on the area(s) of relevance, so that the effect of the bund on groundwater flow can be clearly seen when compared with the baseline model. The diagrams from each model must be of the same scale(s) and cross section(s).

A map or cross sections must also be presented covering the entire modelling domain.

All configuration files, inputs files and output files should be provided as an appendix to the supplement.

Sensitivity analysis:
Undertake a sensitivity analysis to determine the effect of variation in head differential and permeability, providing an estimate of the potential seepage loss into tailings from the collection pond.
This section outlines the seepage modelling of the B-Dump seeps (seeps entering Main Creek catchment through B-Dump, which require capture on closure of the SDTSF) as carried out by GHD. GHD’s complete report on Supplemental information is included in Appendix A.

5.4.1 Model Description

Previous works done on B-dump and SDTSF have provided some inputs to this seepage analysis. The works include:
1. CPS WRD Concept Review – Hydrogeology Study (GHD, July, 2012)
2. Savage River – ARD Pipeline Design (GHD, February, 2013)

5.4.2 Method of Analysis – Software

The B-Dump seepage collection bund modelling has been undertaken using the groundwater/seepage analysis module within the software program Slide Version 6.0 by Rocscience. This software uses a finite element formulation for modelling 2D saturated and unsaturated steady state flow to predict the water table and quantify the seepage flows.

Note that as a policy, GHD do not provide electronic configuration files of their modelling data and codes. The required parameters and geometries are however provided in the tables and figures in the report. This should be sufficient for others to replicate the modelling.

5.4.3 Geometry

It is proposed to construct an 875m long seepage collection bund to capture the seepage from B-Dump post-closure of SDTSF. Head conditions on the SDTSF side of the collection pond of:
- Head of 1m (normal conditions) SDTSF head TWL296.5m; and
- Minimum head of 0.1m (extreme dry conditions) SDTSF head TWL295.6m. The extreme dry conditions to result in a 0.1m head differential have been produced from a water balance undertaken on SDTSF at closure where inflows to the pond were based on the conservative case of three consecutive months of the driest month on record, reduced by a further 5% to nominally account for the effects of climate change, combined with the highest average monthly evaporation, increased by 5%.

A steady-state seepage analysis has been completed to check the ability of the seepage collection pond to capture the B-Dump seepage. A stylised conceptual model of the B-Dump in its existing condition is presented in Figure 31.
A plan view of the seepage model locations is shown in Figure 32. Three post closure geometry sections for the B-Dump seepage collection bund were modelled as follows:

- **Model 1** (Figure 33): Cross-section of B-dump and Main Creek where the dump met the valley floor, this section represents approximately 700m length of the 875m long collection bund;
- **Model 2** (Figure 34): Cross-section cut across smallest section of B-dump, this section represents approximately 175m length of the 875m long collection bund; and
- **Model 3** (Figure 36) Long section along Main Creek.

In addition to the above seepage collection bund models, an additional case to represent the SDTSF closure without the seepage collection bund was considered, as per the EPA request for information. This is shown as Model 1a in Figure 35. This comparative case has only been completed for the geometry in Model 1 base case, which represents the majority of the flow (when comparing Model 1 and Model 2) based on flux and total representative length of this geometry section (775m of 875m bund length). GHD assume this has been requested to compare the performance of the proposed collection bund to a case without collection.
Figure 32  Seepage Location Cross Sections Plan View
Figure 33  Model 1: WRD in Valley Floor (approximately 700m long)

Figure 34  Model 2: WRD in Valley Floor (approximately 175m long)

Figure 35  Model 1a: Comparative case Model 1 without seepage collection bund
Figure 36  Model 3: Long Section

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Supplementary Report - South Deposit Tailings Storage Facility
5.4.4 Model Boundary Conditions

The following model boundary conditions have been set to simulate site conditions at B-Dump in the base case as listed below:

- Rainfall on the B-Dump water shedding cover, results in only 10% infiltration to the dump. The remainder of rainfall on the cap is assumed to runoff and is passed through the alkaline flow through;
- Rainfall on B-Dump outside the water shedding cover, results in 70% infiltration to the dump;
- Rainfall on vegetated areas where 10% infiltrates through the weathered zone and discharges ultimately to Main Creek via the fractured rock aquifer (natural surface runoff is excluded from the model).

Quantification of runoffs from the shedding covers (BD7 and BD8) have provided the basis for the estimating infiltration into B-Dump and these are documented in Thompson and Brett (2006). These runoff/infiltration estimates have since been broadly verified by additional studies (Bruce Hutchison pers. comm., 2012).

Assumptions used are:

- Discharges occur at the toe of waste dumps;
- Only minor flows occur in the bedrock fractured rock aquifer;
- Mean daily rainfall (normal) is 5.5mm (based on BOM data for Savage River since 1966).
- Normal TWL in SDTSF at closure is RL 296.5m (SDTSF 0.5m below spillway invert level);
- Normal TWL in the seepage collection bund RL 295.5m (based on the pipe inlet in the seepage collection pond);
- Additional boundary conditions used in sensitivity analysis discussed in Section 5.4.7 Sensitivity Analysis Case Scenarios as follows:
  - Mean daily rainfall is 0.2mm (representing average rainfall during the driest month on record from BOM used in comparison the likely seepage occurring during the head conditions during the extreme dry months case listed as boundary condition 11);
  - The conservative TWL in SDTSF at closure during the ‘extreme dry conditions’ is RL 296.0m using a water balance with base case parameters for the water balance;
  - The lowest TWL in SDTSF at closure during the ‘extreme dry conditions’ is RL 295.6m, using a water balance with worst case parameters for the water balance.

5.4.5 Hydraulics Parameters

The hydraulic conductivity (k) values assigned to the 2012 B-Dump hydrogeological models and 2013 SDTSF seepage models are presented in Table 5 below. There were some
inconsistencies in the selection of parameters presented within the DPEMP and previous documents, these inconsistencies are where parameters have been purposely varied to be conservative (worst case), rather than presenting the parameters which are considered as realistic (best estimate).

Table 5  Hydraulic Conductivities Used In Recent Reports

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>k (m/s)</td>
<td>kh/kv</td>
</tr>
<tr>
<td>Tailings</td>
<td>1 E^-06</td>
<td>10</td>
</tr>
<tr>
<td>Waste Rock</td>
<td>1 E^-04</td>
<td>1</td>
</tr>
<tr>
<td>Regolith (Weathered zone)</td>
<td>1 E^-07</td>
<td>1</td>
</tr>
<tr>
<td>Fractured Bedrock/ Upper Foundation</td>
<td>5 E^-07</td>
<td>1</td>
</tr>
<tr>
<td>Bedrock/ Lower Foundation</td>
<td>1 E^-08</td>
<td>1</td>
</tr>
<tr>
<td>1 m thick Shedding Cover</td>
<td>5 E^-07</td>
<td>10</td>
</tr>
<tr>
<td>Clay</td>
<td>5 E^-07</td>
<td>10</td>
</tr>
<tr>
<td>Filter Face</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Flow-through Drain</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 6  Base Case k Values (Realistic)

<table>
<thead>
<tr>
<th>Material</th>
<th>k (m/s)</th>
<th>kh/kv</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tailings</td>
<td>1 E^-07*</td>
<td>10</td>
</tr>
<tr>
<td>B Dump Waste Rock</td>
<td>1 E^-04*</td>
<td>1</td>
</tr>
<tr>
<td>Regolith (Weathered zone)</td>
<td>1 E^-07</td>
<td>1</td>
</tr>
<tr>
<td>Fractured Bedrock</td>
<td>5 E^-07*</td>
<td>1</td>
</tr>
<tr>
<td>Bedrock</td>
<td>1 E^-18</td>
<td>1</td>
</tr>
<tr>
<td>1 m thick Shedding Cover</td>
<td>5 E^-07</td>
<td>10</td>
</tr>
<tr>
<td>Clay (Face/ Bund)</td>
<td>1 E^-04</td>
<td>1</td>
</tr>
<tr>
<td>Filter Face</td>
<td>1 E^-04</td>
<td>1</td>
</tr>
<tr>
<td>Flow-through Drain</td>
<td>0.26</td>
<td>1</td>
</tr>
</tbody>
</table>

*Denotes materials which are considered for assessing impact on parameters in the sensitivity analysis discussed in Section 5.4.7 Sensitivity Analysis Case Scenarios.

The above parameters are considered appropriate for the modelling of the B-Dump seepage collection pond, based on GHD’s experience at Savage River Mine. In addition these parameters have been reviewed by Prof David J Williams. Additional comments on base case parameter selection as follows:

- Reflective of ‘all in’ tailings grading permeability. Coarse tailings near discharge point in MCTD are 1x10^-6 m/s based on measured values and slime tailings near the MCTD decant pond are 1x10^-8 m/s. The B-Dump bund is not directly adjacent the SDTSF discharge point, therefore tailings will be finer than those found at the MCTD crest and are expected to be more reflective of ‘all in’ tailings grading as they will be a layered mix of coarse and fines as the beaching profile changes over time. A higher horizontal to vertical permeability has therefore been used to account for this layering effect. Reference to this tailings permeability can be found in ‘MCTD Raise to RL333 Design Report’ GHD, February 2010.

- Based on analysis of measured runoff data, reference paper ‘Savage River Mine

- Based on measured permeability of compacted clays sourced from spillway cutting adjacent A-Dump (similar materials/location to those proposed for B Dump bund) as placed in MCTD, reference ‘Grange Resources MCTD Raise to RL333m Work as Executed Report’ Grange Resources, July 2013.


5.4.6 Base Case Seepage Analysis

In order to assess the base case scenario under the most realistic conditions of the post closure the following conditions have been considered, Table 7.

Table 7  Base Case Scenarios

<table>
<thead>
<tr>
<th>Case</th>
<th>Description</th>
<th>Climate Condition</th>
<th>SDTSF Pond Level</th>
<th>Mean Rainfall (mm/day)</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Base Case (Realistic)</td>
<td>Normal</td>
<td>296.5</td>
<td>5.5</td>
<td>1,2,3,1a</td>
</tr>
</tbody>
</table>

Table 8 presents a summary of the calculations for the base case and for Models 1, 2 and 1a. The seepage shown is reported from a flux section taken within the models which is then converted to total seepage by multiplying the flux by the length of the bund section. Model results can be seen in Figure 37, Figure 38 and Figure 39.

Table 8  Base Case Seepage Analysis Results

<table>
<thead>
<tr>
<th>Model</th>
<th>Case</th>
<th>Description</th>
<th>Seep Flux (m³/day/m)</th>
<th>Total Seep M³/day</th>
<th>% Seep Captured</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>Base Case (Realistic)</td>
<td>0.822</td>
<td>579</td>
<td>99.4</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Base Case (Realistic)</td>
<td>0.564</td>
<td>99</td>
<td>99.2</td>
</tr>
<tr>
<td></td>
<td>1a</td>
<td>Base Case (Realistic)</td>
<td>0.000</td>
<td>570</td>
<td></td>
</tr>
</tbody>
</table>

Figure 37  Model 1 Base Case Scenario
The models presented in Figure 37 and Figure 38 show flow lines from within B-Dump entering the seepage collection bund (Models 1 & 2).

In the GHD (2013) report (Appendix A), Figures 14 to 28 in Appendix A (pg. 27-32) show the flow vectors. The flow vectors are largest where the higher flows occur, which is from the eastern side of B-Dump (left of figure) into the seepage collection pond. Flow lines to the west (at right of figure) show flow within the tailings and waste rock upwelling into the collection bund. This upwelling action is caused by the hydraulic head driving seepage from the western ridge and from the SDTSF pond into the seepage collection bund, which in the base case is a 1m head differential in the pond and higher to the western ridge within B Dump.
Table 10 shows that the total seepage captured in models 1 and 2 are 99.4 and 99.2% respectively, showing losses are negligible. Importantly this shows all flow is into the collection bund; be it from the waste dump side or from the tailings pond side. After this there is no mechanism for contamination into the main SDTSF pond from B-Dump as flow continues into the collection bund. Any by-products from ARD moving through tails directly under the collection pond will report directly to that pond and be transported away.

The bund is designed to provide a lower RL of water between the bund and B-Dump to create the hydraulic head difference. Hence the bund contains the AMD seepage which flows out (to the south) through a dedicated pipe.

The Model 1a without the bund shown in Figure 39, shows there is no upwelling effect and that seepage flow paths travel from B-Dump to the SDTSF pond, tailings and foundation strata, as would be expected as there is nothing to retain the seeps. Note that the overall regional flow is to the east due the higher head in the west compared to the eastern side.

It can be seen the seepage flux is higher in Model 1 opposed to Model 2; this is due to Model 1 having more waste in the valley resulting in more upward flow into the bund. The comparison between the seepage Model 1 and Model 1a show the difference with and without the collection bund. The seepage losses without the bund are 570m$^3$/day verses 579m$^3$/day captured with the bund. The reason the two cases have a small difference between the total seepage is the model with the bund has a lower head directly against B-Dump resulting in slightly higher seepage. GHD consider no need to run other comparative models (or sensitivity analysis) on the Model 1a without the bund as it is clear the bund has a significant impact when installed.

Model 3 (shown in Figure 40) is a long section within Main Creek to determine if seepage can escape down the valley and exit into the SDTSF tailings storage. The results of the long section Model 3 are shown in Figure 40 and Figure 41. The flow lines within these figures show a groundwater divide occurs approximately halfway between the southern end of the B-Dump seepage collection bund and SDTSF embankment. This is occurs due to:

- The extent of the final STDF pond is large (~1.9km) and the consistent height of the western ridge (under the dumps) results in little southwards seepage in the dump area, i.e. there is very little, if any, southward hydraulic head gradient in northern end of SDTSF.
- Seepage paths are controlled by original creek beds, internal dump ramps and the “low point of the collection seepage collection bund.”
Figure 40 Model 3: Base Case Scenario

Southern most end of B-Dump collection pond

North / South Groundwater divide reverting flow to B-Dump

STSDF Embankment

Figure 41 Model 3: Base Case Scenario – Zoom in to Seepage Collection Pond
5.4.7 Sensitivity Analysis Case Scenarios

The key parameters that will influence the amount of B-Dump seepage being captured in the seepage collection pond are the water level in the SDTSF tailings pond and the permeability of key strata of tailings, B-Dump waste rock and fractured bedrock.

5.4.7.1 SDTSF Pond Level Sensitivity and Climate (rainfall)

Sensitivity analysis has been conducted for each seepage model using the base case k values shown in Table 7 for normal climate conditions (average rainfall 5.5mm/day) with SDTSF pond level of RL 296.0m (i.e. water level in SDTSF 1m below spillway invert and 0.5m head differential in the collection pond). This is considered conservative as this condition can only be achieved by applying a closure water balance using the 3 consecutive months of the driest month on record.

Furthermore a SDTSF pond level of RL 295.6m was also considered, which is only achieved using worst case permeability in the closure water balance, and then applying the 3 consecutive months of the driest month on record. As this case is worst case the rainfall (climatic conditions) were reduced to match the average rainfall in the driest month (average rainfall 0.2mm/day).

The ‘extreme dry’ conditions used to generate the water balance and resulting lower head differential cases are considered worst case; although there is a very low probability of the event occurring. Even if such an event it was to occur, its use in the modelling must be taken into context that the likelihood of such an event is considered unlikely or rare and the consequence or timeframe of seepage lost to the SDTSF catchment during such a period is very small in comparison to seepage flow over an extended time (years).

5.4.7.2 Material Permeability Sensitivity

Sensitivity analysis has also been carried out due to uncertainties of k values of the tailings, waste rock and fractured bedrock. It was done by increasing/decreasing each variable from the base case k value by an order of magnitude to worst case scenario while leaving other variables as base case values.

Table 9 summarises the case sensitivity scenarios listed in Sections 5.4.7.1 and 5.4.7.2 that have been modelled.
Table 9  Sensitivity Case Scenarios

<table>
<thead>
<tr>
<th>Case</th>
<th>Description</th>
<th>Climate Condition (rainfall)</th>
<th>SDTSF Pond Level</th>
<th>Mean Rainfall (mm/day)</th>
<th>Worst Case k(m/s)</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Base Case (Conservative)</td>
<td>Normal</td>
<td>296.0</td>
<td>5.5</td>
<td>-</td>
<td>1,2,3</td>
</tr>
<tr>
<td>3</td>
<td>Base Case (Worst)</td>
<td>Dry</td>
<td>295.6</td>
<td>0.2</td>
<td>-</td>
<td>1,2,3</td>
</tr>
<tr>
<td>4</td>
<td>Tailings with Worst Case k</td>
<td>Normal</td>
<td>296.5</td>
<td>5.5</td>
<td>1 E-06</td>
<td>1,2,3</td>
</tr>
<tr>
<td>5</td>
<td>Fractured bedrock with Worst Case k</td>
<td>Normal</td>
<td>296.5</td>
<td>5.5</td>
<td>1 E-06</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>B-Dump waste rock with Worst Case k</td>
<td>Normal</td>
<td>296.5</td>
<td>5.5</td>
<td>1 E-05</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 10 presents a summary of the calculations for the sensitivity on SDTSF pond levels in Cases 2-3 with base case permeability values and the sensitivity on permeability values in Cases 4-6 with the base case STDF pond level on both Models 1 and 2. Noting that Case 1 is the realistic base SDTSF pond / permeability which has been repeated and highlighted from Table 8 for ease of results comparison.

Table 10  Seepage Sensitivity Analysis

<table>
<thead>
<tr>
<th>Model</th>
<th>Case</th>
<th>Description</th>
<th>Seep Flux (m³/day/m)</th>
<th>Total Seep (m³/day)</th>
<th>% Seep Captured</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Captured</td>
<td>Loss</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>Base Case (Realistic)</td>
<td>0.822</td>
<td>0.005</td>
<td>579</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Base Case (Conservative)</td>
<td>0.824</td>
<td>0.005</td>
<td>581</td>
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<tr>
<td></td>
<td>3</td>
<td>Base Case (Worst)</td>
<td>0.029</td>
<td>0.002</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Tailings (Worst)</td>
<td>0.817</td>
<td>0.005</td>
<td>575</td>
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<tr>
<td></td>
<td>5</td>
<td>Fractured bedrock (Worst)</td>
<td>0.927</td>
<td>0.006</td>
<td>653</td>
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<tr>
<td></td>
<td>6</td>
<td>B-Dump waste rock (Worst)</td>
<td>0.561</td>
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<td>399</td>
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<tr>
<td>2</td>
<td>1</td>
<td>Base Case (Realistic)</td>
<td>0.564</td>
<td>0.004</td>
<td>99</td>
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<td></td>
<td>2</td>
<td>Base Case (Conservative)</td>
<td>0.566</td>
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<td>Base Case (Worst)</td>
<td>0.025</td>
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<tr>
<td></td>
<td>4</td>
<td>Tailings Worst</td>
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<td>98</td>
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<td></td>
<td>5</td>
<td>Fractured bedrock (Worst)</td>
<td>0.609</td>
<td>0.053</td>
<td>116</td>
</tr>
</tbody>
</table>

5.4.7.3  Discussion

The seepage analyses of the base case scenarios show that there is minimal impact on reducing the head differential in SDTSF and the collection bund from 1m (Case 1) to 0.5m (Cases 2), as both show 99% of seepage from B-Bump being captured in the collection pond.

Further reduction of the head differential to 0.1m shows there is a lower percentage seepage captured with 93% and 91% for Model 1 and 2 respectively. However, as this scenario (Case 3) would only occur in extreme dry conditions it has a similar lower rainfall condition applied to the model, which results in much lower total seepage (581m³/day versus 22m³/day).
In fact the reduction in the total seepage results in a lower seepage loss for the extreme dry case (Case 2 seepage lost is 0.005m$^3$/d/m x 750m = 3.75m$^3$/day total in comparison to Case 3 seepage lost 0.002m$^3$/d/m x 750m = 1.5m$^3$/day).

To put this into perspective the seepage losses in both Cases 2 and 3, the extremely low probability of such an event occurring should be considered (both Cases 2 and 3 require the driest month on record to occur in 3 consecutive months). In addition to the time period in which it would occur requires consideration i.e. the time period for the case to occur would not be the full 3 months as the pond elevation drops from 1m the start of the first dry month and does not reach the 0.1m head differential until the end of the third month.

Sensitivity analyses show that the hydraulic conductivities (permeability) of tailings, waste rock and fractured bedrock have an impact on the total seepage in the model; the changes in permeability have only a very minor impact on the ability of the seepage collection pond to capture B-Dump seepage.

### 5.5 Seepage Collection Pond

**On closure, what effect will the Main Creek seeps have on the tailings within the bund, taking into account the chemistry of the various seeps, and the potential for accelerated reactions due to the presence of ferric ions.**

This discussion should also draw on the potential effect of the addition of the OTD seeps, with particular reference to the concentration of ferric ions.

**Discuss the potential for osmotic gradients to be established through the tailings and under the bund if reactions within the seepage collection pond were to occur, taking into account the likely nature of hydraulic gradients in the immediate area.**

### 5.5.1 B Dump Seeps Effect on Tailings within the Bund

The water chemistry issues associated with this risk were addressed in Section 5.3.3 Environmental Impact on SDTSF of Not Capturing the B Dump Seeps.

The seep capture bund will be built on the SDTSF tailings mass. This means that the water within the bund will be in contact with the tailings underneath, before it flows out of the bund. The estimated B Dump seepage flow within the bund will average 11 L/s on closure (AMIRA, 2011). Given the small size of the bund catchment, and the fixed invert discharge level, the hydraulic retention time is estimated to be a few days (Appendix C, Aquatic Science, August 2013, pg6).

From a calculation of the soluble ferric iron that will be available to react (see Appendix C and Equation 1) it is anticipated that 97% of the iron entering the bund will remain as ferrous iron, or precipitate as ferric hydroxide. Only a small portion of the iron (3%) can remain in solution as the more reactive ferric ion. It is expected that there will be both dilution and an increase in alkalinity associated with the B Dump alkaline eastern side hill cover, which will contribute to increasing both the pH and the associated hydroxide concentration. This will further decrease the ferric iron concentration due to solubility constraints.
Equation 1  Potential of the captured B-Dump complex seepage to generate further acidity from the tailings mass within the SDTSF

The iron concentration entering the bund will increase due to the isolation of the ARD and diversion of clean water from the collection point, when compared to MCbDD. This will result in a reduction of average flows from 48 L/sec to 11 L/sec. Assuming the mass load of total iron remained at 14 kg/day (conservative estimate, mean load, Figure 23) the concentration of iron will increase.

\[
[Fe]_{\text{init}} = 14 \text{ kg/day} \times 10^9 / (11 \text{ L/sec} \times 3600 \text{ sec/hr} \times 24 \text{ hr/day}) \\
[Fe]_{\text{init}} = 14,800 \mu g/L
\]

The pH of the ‘MCbDD averaged 3.5 when last monitored intensively between Jan 2001 and Nov 2002. Given:

\[
pH = \log_{10}(1/[H^+])
\]

\[
[H^+] = 1/(10^\text{pH})
\]

\[
[H^+] = 3.16 \times 10^{-4} M
\]

As with the pollutants, the H\(^+\) concentration may increase by a factor of 4.4 once cleaner water is diverted. This would increase H\(^+\) concentration too approximately:

\[
[H^+] = 1.4 \times 10^{-3} M (pH = 2.85)
\]

The dissociation constant of water (\(K_w\)) at 25\(^°\)C is \(10^{-14}\) and is described by the following formula:

\[
K_w = [H^+][OH^-]
\]

Therefore, \([OH^-] = 7.2 \times 10^{-12} M\)

The precipitation of ferric iron is described by the following equation;

\[
Fe^{3+} + 3(OH^-) \leftrightarrow Fe(OH)_3(s)
\]

The solubility product for ferric hydroxide in water is \(2.67 \times 10^{-39}\)

Given the equation for the precipitation of ferric iron, the solubility will be described by the following formula:

\[
K_{sp} = [Fe^{3+}][OH^-]^3
\]

\[
[Fe^{3+}] = K_{sp}/[OH^-]^3
\]

\[
[Fe^{3+}] = 2.67 \times 10^{-39} / (6.25 \times 10^{-12})^3
\]

\[
[Fe^{3+}] = 7.2 \times 10^{-6} M
\]

\[
[Fe^{3+}] = 400 \mu g/L
\]

Upper Percentage estimate of iron as soluble ferric iron;

\[
[Fe^{3+}]_{\text{sol}} \times 100 / [Fe]_{\text{init}}
\]

\[
400 \mu g/L \times 100 / 14,800 \mu g/L = 3\%
\]

It is unlikely that the ARD generation rate from tails within the collection bund will be substantive, given the low solubility of ferric iron at the anticipated pH levels.
5.5.2 Potential for Osmotic Gradients through the Tailings and Under the Bund

GHD have provided a report addressing these issues. It is provided as Appendix A and summarised below.

Osmotic gradients occur if there is a differential in salt concentrations, which nature will try to equilibrate through flow from high to low osmotic suctions, bearing in mind that osmotic suctions occur both above and below the water table (unlike matric suctions, which can only occur above the water table since they require unsaturated conditions). However, osmotic gradient-induced flow is much slower than hydraulic gradient-induced flow (perhaps by an order of magnitude), since it is analogous to osmotic transfer. In the SDTSF, the hydraulic gradients will be much larger and more broad-reaching than the smaller and more localised osmotic gradients that may be generated, if they are at all since they require oxygen and the tailings will remain largely saturated and oxygen deficient (Appendix E, pg5).

Factors such as small grain sizes and crusts formed by hydroxide and other precipitates will also reduce the transport of ferric ion into the tailings where it can oxidise the sulphides (Appendix C, Aquatic Science, August 2013, pg9).

5.6 Isolation of Seeps during Operations

It is noted in Section 5.1 of the Peer Review Report (Appendix R) states the following: "The key elements of the design, construction and operation of the SDTSF that need to be managed to ensure that the facility does not generate acidity are, in order from the most important (4th in the list) Isolating the historical B Dump Complex acidic seeps within the SDTSF storage as the tailings level rises, by maintaining low points at the seeps with the aid of bunds, as required."

Further, Section 8.3.4.2 of the DPEMP states: "Providing the infrastructure to collect these seeps (B Dump) is critical for pre and post mine closure treatment scenarios, and for long term close-out of the SDTSF."

An explanation is required as to why isolation of the seeps as the tailings level rises, by maintaining low points at the seeps with the aid of bunds, is not considered in the DPEMP main document as a key element of the design, construction and operation of the SDTSF that needs to be managed to ensure that the facility does not generate acid.

Further an explanation is required as to why it is stated in the DPEMP in Section 8.3.4.2 that infrastructure to collect the B Dump seeps is critical for pre- and post-mine closure treatment scenarios, but is not considered further in the document.

It is also noted in Appendix I, entitled "Water Quality impacts associated with the South Deposit Tailings Storage Facility proposal", that in assessing water quality impacts the author considered a series of starter dams around the B Dump seeps to separate the seeps from the SDTSF during operation. Explain the significance of the water quality assessment having not undertaken an assessment of the current proposal, which does not appear to consider starter dams around B Dump.
When Grange first proposed the construction of a TSF below South Deposit in 2008, the concept was to construct bunds across the tailings beaches as the tailings rose within the TSF with the purpose of continually separating the B Dump seeps from the main body of tailings. It was envisaged that the bunds could be constructed on coarse tailings in a similar manner to the way Grange constructs roads across the current MCTD beaches.

However, as more detail on the operation of the SDTSF emerged during DPEMP development in 2011 and 2012, it became apparent that this would not be possible due to the rapid rate rise of tailings within the proposed SDTSF. Unlike the MCTD where the rate rise is approximately 1 metre per year, the rate rise in the SDTSF will be between 2.2 and 10 m per year (Figure 42 and Table 11). This is described in Section 8.4.2 of the DPEMP.

### Table 11 Tailings Beach Development

<table>
<thead>
<tr>
<th>Month</th>
<th>Year</th>
<th>Tails beach RL</th>
<th>Pond RL</th>
<th>Tailings Beach Rise m</th>
<th>Pond Rise m</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>200.0</td>
<td>200.0</td>
<td>200.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-Jan</td>
<td>1</td>
<td>226.0</td>
<td>223.0</td>
<td>23.00</td>
<td></td>
</tr>
<tr>
<td>1-Jan</td>
<td>2</td>
<td>230.0</td>
<td>221.3</td>
<td>4.0</td>
<td>-1.70</td>
</tr>
<tr>
<td>1-Apr</td>
<td>2</td>
<td>233.2</td>
<td>222.6</td>
<td>3.2</td>
<td>1.30</td>
</tr>
<tr>
<td>1-Jul</td>
<td>2</td>
<td>236.0</td>
<td>230.6</td>
<td>2.8</td>
<td>8.00</td>
</tr>
<tr>
<td>1-Oct</td>
<td>2</td>
<td>238.2</td>
<td>233.8</td>
<td>2.2</td>
<td>3.20</td>
</tr>
<tr>
<td>1-Jan</td>
<td>3</td>
<td>240.5</td>
<td>231.2</td>
<td>2.3</td>
<td>-2.60</td>
</tr>
<tr>
<td>1-Jan</td>
<td>4</td>
<td>248.0</td>
<td>237.0</td>
<td>7.5</td>
<td>5.80</td>
</tr>
</tbody>
</table>

Figure 42 below shows the storage curve for the SDTSF with an estimated start date of December 2013. It can be seen that between November 2014 and November 2015 the predicted annual rate rise of tailings is approximately 10 m. From 2015 to 2016 the rate rise is approximately 8 m.
The rapid tailings beach development and rise within the SDTSF means that it is not possible to construct bunds in advance of the tailings beaches.

The effect of the tailings rise in the SDTSF on the B Dump seeps will be similar to that experienced at the OTD where tailings and supernatant liquor had been deposited in the MCTD at the toe of the OTD dam wall prior to 1997 when Grange’s predecessor Australian Bulk Minerals commenced operations on site. Figure 43 to Figure 48 show that as the level of tailings has risen in the MCTD, the rise in phreatic surface within the OTD has caused the OTD seeps to rise within the OTD. They have continued to emerge from the OTD at the MCTD tailings – OTD dam wall interface. In Figure 43 the seeps can be seen emerging at the base of the OTD dam wall toe. In a similar way, the B Dump seeps will rise and hence separate bunds to capture the B Dump seeps will not be necessary.
Figure 43 shows the OTD seeps emerging into a channel at the base of the OTD wall at the level of the roadway indicated by an arrow in Figure 43.
By 2005 the OTD seeps are now emerging and being mixed with and neutralised by tailings two benches above the 1998 level.

By 2010 (Figure 46) the OTD seeps are emerging near the top of the ridge between the eastern and western seeps.

Figure 47 shows the OTD seeps emerging from the OTD dam wall in 2011.
By 2013, the OTD seeps have risen further as shown in Figure 48. Figure 48 also shows the final height of tailings within the MCTD and, as a result, the height to which the OTD seeps will rise.

As discussed in Section 8.3 of the DPEMP, between 1997 and 2013 the water quality in the MCTD has remained neutral despite the high acidity in the OTD seeps. This demonstrates that the collection of the B Dump seeps during operations is not critical to the neutralisation of the seeps by the SDTSF tailings.

‘Providing the infrastructure to collect these seeps is critical for pre- and post-mine closure treatment scenarios, and for the long-term close-out of the SDTSF’, is in reference to Grange’s recommendation to separate the B-Dump seeps from the SDTSF tailings for treatment by using a longitudinal bund (as described in the DPEMP) upon closure of the SDTSF.

The water chemistry assessments provided in the DPEMP – both in terms of the neutralisation capacity within Grange’s tailings and the potential impact on water quality in Main Creek – are not compromised by the water quality assessment considering the use of bunds during operations (starter dams). The chemical reactions do not change, the amount of neutralisation capacity does not change and the resultant water quality after mixing and neutralisation does not change. The reports attached as Appendices B to E confirm the chemistry. In addition, the test work on neutralisation of legacy acidity in the DPEMP was based on uniform mixing of the seeps and the process water. In the SDTSF, passive mixing will be relied upon to neutralise the B Dump seeps. The volume of inflowing seeps is small compared to the volume of inflowing process water and tailings (420 L/s: 11–40 L/s), suggesting that neutralisation should be rapid and complete as long as the two water sources are physically mixed. The long, narrow geometry of the SDTSF will facilitate mixing of the waters, as all water must flow down the narrow valley which will prevent any short-circuiting of inflows through the dam (Appendix B, Koehnken, 2013, pg6).
5.7 Construction Criteria for Coarse Rock Flow Through

The Peer review states: "Filter criteria will be applied between the tailings slimes and the filter, and between the filter and the alkaline flow through, to ensure that piping of fines will not occur."

Clearly state the grain size criteria and material specifications for the alkaline flow-through, to ensure the piping of fines will not occur at the filter face and alkaline flow-through interface.

Outline what monitoring and quality control measures which will be undertaken to ensure material specifications for the alkaline flow-through are maintained.

Describe what options are available to monitor for piping failure.

Describe what measures, if any, could be undertaken to halt piping, if it were to occur.

GHD have provided a report addressing these issues. It is provided as Appendix A and summarised below.

The risk for piping of ‘fines’ from the filter face material matrix into the flow through is considered low due to the filter face having a low fines content (5–10% <75 µm) based on the filter design grading envelope. In addition, the filter face material is not considered a traditional filter in that it is an order of magnitude wider than traditional filters which are typically between 0.5 m to 3 m in width. In this case, the filter face is a minimum width of 10 m but is up to 30 m wide in some sections; the same can be said for the flow-through.

However, to ensure compatibility between the filter and flow-through material, the gradation of the flow-through material has been checked using the ‘Sherard and Dunnigan’ filtering criteria as described in ‘Geotechnical Engineering of Dams’ (Fell, 2005).

Based on the criterion, the filter face material is categorised as a ‘Type 3’ base soil, the criterion applicable for protection from piping is $D_{15} F < 4 D_{85} B$. That is, the $D_{15}$ of the flow-through material shall be less than 4 times the $D_{85}$ of the entire material grading of the filter face.

As shown in Figure 49 the:

- Filter face material has a design grading envelope at $D_{85} = 10$mm to 60mm;
- Therefore the flow through material shall have a $D_{15} < 40$mm to 240mm.

Based on the grading’s taken of the A-Type rockfill onsite the average grain size of the A-Type materials used in the flow through had an average $D_{15}$ of 40mm. Advice from Grange Resources’ experience with the A-Type flow through materials is that meeting the minimum $D_{15} < 40$mm is not expected to present an issue. Notably the $D_{15} < 40$m criteria is a minimum and the $D_{15} < 240$m maximum end of the range is easily achievable. The grading envelope design for the filter and flow through materials based on the above filtering criterion is shown in the Figure 49.
During the construction process, the tipped A-Type materials are pushed down to form the filter face, thereby exposing the flow-through material, which can be checked visually for compliance with the D15 limit. If required, selected samples can be checked using photogramic software to give graining curves for the flow through materials.

The downstream water quality monitoring at MCBSD will provide data on turbidity levels which will provide evidence of any piping failures between the filter and the flow through. Piping is unlikely to occur because of the coarse size fraction of the materials used and additional measures to halt piping are not considered necessary. If any piping becomes apparent through monitoring turbidity levels Grange will review the grain size criteria and adjust the material and construction methods to prevent further piping.

5.8 PAF Cell Construction

Describe with the aid of diagrams as necessary, the location of the PAF cell within the downstream SDTSF shell with reference to Big Duffer Creek and Main Creek and indicate the direction of predicted run-off.

Briefly describe the construction of the PAF cell with reference to the location of the cell and the general topography, construction of the SDTSF embankment and requirement for handling of PAF in the first few months of construction.

The location of the PAF cell described in the DPEMP is shown in Figure 50 below. As can be seen, the PAF cell will be located on an existing clay ridge, above and away from current drainage channels.
An ‘enclosure’ will then be developed by constructing an A-type flow-through waste rock dump around the small ridge (Figure 51).

The clay on the ridge line will then be flattened to provide a compacted clay base of approximately 140 m x 120 m (Figure 52). Instrumentation will be placed in the base of the clay lining. The internal sides of the A type enclosure will be lined with clays. Once this has been completed the PAF cell will be ready to receive D-type (PAF) rocks.

The clay base will be compacted (3–5 m thick) and will initially be laid so that it slopes to the north (in an upstream direction). Once the clay base as shown in Figure 52 has been completed, including the placement of instruments to monitor oxygen and temperature, then as D-type rock is encountered in mining South Deposit it will be placed in the PAF cell. The PAF material will be paddock dumped and then compacted in layers 2.5 m thick. The waste material around this dump (yellow-orange in Figure 52 and Figure 53) will be A-type or B-type wastes.

Table 12 is repeated from the DPEMP and shows the expected quantities of waste rock, by geochemical type, to be encountered during excavation of South Deposit.

On top of the PAF material a 5 m thick, compacted clay cover will be placed and contoured which will slope in an upstream direction (Figure 54).

The waste will be compacted to minimise oxygen using a combination of truck scheduling over the waste, and roller compaction. Over the clay layer on top of the PAF waste will be 10 m layer of A-type alkaline waste rock, compacted to form a water-shedding cover in a similar manner to the B Dump water-shedding cover which achieved an average infiltration rate of $5 \times 10^{-8}$ m/s, which equates to 9% of rainfall infiltrating through the cover (Hutchison, 2009).

The intent is to drain rainfall from the PAF Cell / flow through dump in an upstream direction to join back into the main flow-through. The surface slope of the flow-through will be directed into Big Duffer Creek in case, in the long term, the upper infiltration area happens to clog. This is shown in plan view in Figure 54 where the light blue lines on the tip of the dump show the surface runoff directed to the north from where they will join the drainage channel around the dump and enter the flow through drain (dotted blue line) into which Big Duffer Creek will flow. Figure 54 also shows the surface run off channel (marked with a solid blue arrow) which will be cut around the eastern side of the flow-through. This will ensure that high flows, from the eastern catchment and also coming down the SDTSF spillway channel, are diverted past the flow-through and into Main Creek.

The PAF cell will be located approximately 350 m horizontally from the eastern edge of the flow-through waste rock dump and where flows from Big Duffer Creek will meet the surface run-off from the dumps.
### Table 12  Waste rock by Geochemical Type

<table>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A</td>
<td>BOM</td>
<td>264,396</td>
<td>415,643</td>
<td>488,970</td>
<td>559,766</td>
<td>554,611</td>
<td>567,999</td>
<td>567,762</td>
<td>565,507</td>
<td>532,256</td>
<td>510,078</td>
<td>502,742</td>
<td>488,539</td>
<td>431,110</td>
<td>371,441</td>
<td>258,394</td>
<td>206,546</td>
<td>196,601</td>
<td>164,211</td>
<td>142,088</td>
<td>103,802</td>
<td>15,045</td>
</tr>
<tr>
<td>Type B</td>
<td>BOM</td>
<td>52,694</td>
<td>126,883</td>
<td>181,539</td>
<td>216,179</td>
<td>224,001</td>
<td>220,066</td>
<td>243,150</td>
<td>256,035</td>
<td>255,813</td>
<td>232,486</td>
<td>230,139</td>
<td>242,863</td>
<td>235,012</td>
<td>210,044</td>
<td>190,097</td>
<td>110,004</td>
<td>80,008</td>
<td>79,951</td>
<td>83,046</td>
<td>86,716</td>
<td>90,068</td>
</tr>
<tr>
<td>Type C</td>
<td>BOM</td>
<td>191,741</td>
<td>182,110</td>
<td>126,809</td>
<td>80,713</td>
<td>55,189</td>
<td>44,111</td>
<td>31,571</td>
<td>13,161</td>
<td>2.018</td>
<td>2.018</td>
<td>2.018</td>
<td>2.018</td>
<td>2.018</td>
<td>2.018</td>
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</tr>
</tbody>
</table>
Figure 50  PAF Cell Initial Site
   PAF Cell Initial Site
   Main Creek
   Big Duffer Creek
   Litter Duffer Creek

Figure 51  PAF Cell Flow-through Surrounds Development
   Waste Rock Dump

Figure 52  PAF Cell Base Development
   Gradually infill flow-through and extend dump to limits as required
   Fatter and fill to create dry base
   Area (s) - millions of cubic meters
   Install instruments in base of dump
   Initially remove flow-thru through spillway
Figure 53  PAF Cell Final Surface

Figure 54  PAF Cell Runoff
5.9 Monitoring Surface Waters

Provide a map, and brief explanation, showing the location of the water flow monitoring stations that will be used for assessing the permeability of the filter face during construction; i.e. to permit correlation of flows to the upstream pond levels to back calculate the permeability of the filter face.

Provide a map clearly showing the location of all water quality monitoring sites, with reference to a table showing the parameters which will be sampled and the frequency of sampling. Clarify the sites where Grange is currently undertaking ambient baseline water quality monitoring of Main Creek and Savage River.

Note: In Section 12.5 of the DPEMP, it states that the seepage from the downstream toe of the flow through dump containing the PAF cell will be sampled. It should be clear where this site is.

The DPEMP made commitments to monitor flows at MCbSD and use this to back-calculate the permeability of the filter face. It is noted the potential for other streams to provide flows into Main Creek between the filter face and MCbSD and requested clarification on this monitoring. Figure 55 shows the flow monitoring stations that will be set up to facilitate the calculation of filter face permeability. These are shown as Q1 to Q4.

Figure 55  Flow Monitoring Stations

Grange will measure the catchment flows of Big Duffer and the Little Duffer Creek (South of Big Duffer Creek) by installing v-notch weirs (Q2, Q3) upstream of the dump extents as well as a v-notch weir at station Q4. The Q4 is a small-flow ephemeral stream which runs west-to-east below South Deposit and enters Main Creek immediately above MCbSD.
Back-calculation of Filter Face permeability (k), will be undertaken by measuring Q1 at the monitoring station, and applying empirical formula:

\[ \text{Q} = (\text{Q}_1 - \text{Q}_2 - \text{Q}_3 - \text{Q}_4) = kiA \]

A = surface area of filter face, measured from survey and upstream water level.

i = hydraulic gradient, calculated using data from piezometers installed in the embankment.

Figure 55 also shows the location of seepage monitoring for the flow through dump. The low point on the downstream toe will be developed as a monitoring point between the toe of the dump and the MCbSD monitoring station.

5.9.1 **Current Monitoring**

Main Creek and Savage River are jointly monitored by Grange and the SRRP. Ten sites are currently monitored on a monthly basis in the Savage River catchment, as shown in Figure 56 and summarised in Table 13. Six of the sites are located in the Savage River catchment above Main Creek, three in the Main Creek catchment, and one downstream of the lease site near the mouth of the Savage River (at Smithton Road). Two monitoring sites have been established in the Main Creek catchment, to capture the diffuse inputs from the B Dump, ETD and MCTD complex: one directly below the eastern side of B Dump (MCbPP) and one further downstream on Main Creek (MCbSD). Three additional sites – North Dump Drain, Centre Pit North Overflow and South Deposit Outflow – have been monitored, again, consistently since May 2011 (have previously been monitored). Monthly monitoring is also carried out at six sites which are not direct sources into the Savage River or Main Creek (Table 14). Monitoring at these sites provides a better understanding of contaminated water movement on the mine lease.

Monitoring and sampling are completed by Entura and Grange Resources on a monthly basis. Water samples are analysed by Analytical Services Tasmania, a NATA registered laboratory, for alkalinity, acidity, total suspended solids, major cations (calcium, magnesium, potassium, sodium), total and dissolved (<0.45 μm) metals (aluminium, arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel and zinc) and sulphate.

Given the shared responsibility for these sites, and in particular for legacy pollution, many sites are either shared between Grange and the SRRP or are the responsibility of the SRRP.
Table 13  Water Quality Monitoring Sites on the Savage River and Main Creek Catchments

<table>
<thead>
<tr>
<th>Site</th>
<th>Rationale</th>
<th>Flow quality Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Tailings Dam North (OTDN)</td>
<td>Direct discharges of historic contamination from the northern end of the Old Tailings Dam into Savage River.</td>
<td>Good, stable</td>
</tr>
<tr>
<td>Savage River at Pump Station (SRaPS)</td>
<td>Good long-term flow and water quality site, includes inputs from Old Tailings Dam North (OTDN), and prior to October 2006, inputs from North Dump Drain.</td>
<td>Fair to good since second water level sensor was installed</td>
</tr>
<tr>
<td>South Lens Outlet (SLO)</td>
<td>Contaminated water from site and North Dump Drain is directed into South Lens where it mixes with naturally occurring high pH and alkalinity water.</td>
<td>Fair with 10% inaccuracy due to high turbulence at the weir</td>
</tr>
<tr>
<td>Broderick Creek below Waste Rock Dump (BCbWRD)</td>
<td>Monitors performance of alkalinity flow-through drain and contribution of Broderick Cr WRD to Savage River.</td>
<td>Inaccurate flow data at higher flows (20% inaccuracy) due to backwaters from Savage River</td>
</tr>
<tr>
<td>Savage River below South West Rock Dump (SRbSWRD)</td>
<td>Indicates impact from the lease on Middle Savage River.</td>
<td>Flow is now modelled at this site, as flow record was consistently poor due to poor hydraulic control at gauging site</td>
</tr>
<tr>
<td>South Deposit Outflow (SDO)</td>
<td>Flow has been monitored at this site since May 2011.</td>
<td>Fair to good</td>
</tr>
<tr>
<td>Main Creek Tailings Dam outflow (MCTD)</td>
<td>Monitors the discharge from the tailings dam which includes seeps from the Old Tailings Dam. The MCTD discharges to Main Creek via Townsend Creek. During other periods discharge has been directed down Main Creek.</td>
<td>Fair</td>
</tr>
<tr>
<td>Main Creek below Pilot Plant (or v-notch) (MCbPP)</td>
<td>Discharges from the eastern side of the B Dump complex. Flow was originally only measured at this site during sampling events. A logger was installed on 30/03/2011 and this operated until late 2012.</td>
<td>Poor to fair</td>
</tr>
<tr>
<td>Main Creek below South Deposit (MCbSD)</td>
<td>Indicates impact from the lease on lower Main Creek before it runs into Savage River. Catchment includes seeps from the B-Dump complex and from the tailing dams.</td>
<td>Poor due to instrument non-conformances</td>
</tr>
<tr>
<td>Savage River at Smithton Rd Bridge (SRaSR)</td>
<td>Site is near mouth of river, and shows overall impact of mining inputs, and indicates what is being exported from catchment to the Pieman estuary.</td>
<td>Flow is modelled at this site</td>
</tr>
</tbody>
</table>

Table 14  Sites which are not direct sources into the Savage River

<table>
<thead>
<tr>
<th>Site</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Tailings Dam Seeps East (OTDSE)</td>
<td>Seepage of historic contamination from Old Tailings Dam into Main Tailings Dam (eastern seeps). Flow is currently not monitored as the v-notch has been buried by tailings.</td>
</tr>
<tr>
<td>Old Tailings Dam Seeps West (OTDWS)</td>
<td>Seepage of historic contamination from Old Tailings Dam into Main Tailings Dam (western seeps). Flow is currently not monitored as the v-notch has been buried by current tailings. This site is often inundated, making monitoring difficult.</td>
</tr>
<tr>
<td>Brett’s Drain North (BDN)</td>
<td>Seeps from Broderick Creek system into South Lens.</td>
</tr>
<tr>
<td>Brett’s Drain South (BDS)</td>
<td>Seeps from Broderick Creek system into South Lens.</td>
</tr>
<tr>
<td>North Dump Drain (NDD)</td>
<td>Contaminated water from historic North Dump flows to South Lens. Flow has been continuously monitored at this site since May 2011.</td>
</tr>
<tr>
<td>Centre Pit North (CPN)</td>
<td>Overflow from Centre Pit system into South Lens. Flow has been continuously monitored at this site since May 2011.</td>
</tr>
</tbody>
</table>
Figure 56
Existing Grange and SRRP Monitoring Locations
5.9.2 SDTSF Operational Monitoring

Figure 57 shows the proposed operational monitoring for the SDTSF. These include the sites around the downstream toe of the dam and the waste rock dump. A site named B Dump pond has been added to monitor the seepage from B Dump as it exits the dump. This is shown in more detail in Figure 58.

Figure 57 Main Creek and SDTSF monitoring sites
As described in the DPEMP, monitoring and review of the proposal will involve evaluation of water quality during operations. Analyses and sampling frequencies are shown in Table 15 except for MCbSD which will also include turbidity as an analytical parameter. The laboratory analysis for total and dissolved metal will encompass As, Cd, Cu, Fe, Mn, Hg, Zn, Ni, Al, B, Se, Pb and Co.

Any settlement dams utilised will be monitored weekly for sediment build-up.

The South Deposit pit and the SDTSF will be monitored weekly for water level.

**Table 15** Operational Water Monitoring Summary

<table>
<thead>
<tr>
<th>Site</th>
<th>Abbrev Site Name</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>OTD seep pond</td>
<td>OTD Pond</td>
<td>pH, Conductivity, Turbidity, Flow, TSS, Alkalinity, Acidity, Sulphate, Metals (tot.), Metals (dis.), Major Cations</td>
</tr>
<tr>
<td>MCTD Outflow</td>
<td>B-Dump Pond</td>
<td>pH, Conductivity, Turbidity, Flow, TSS, Alkalinity, Acidity, Sulphate, Metals (tot.), Metals (dis.), Major Cations</td>
</tr>
<tr>
<td>SDTSF Spillway</td>
<td></td>
<td>pH, Conductivity, Turbidity, Flow, TSS, Alkalinity, Acidity, Sulphate, Metals (tot.), Metals (dis.), Major Cations</td>
</tr>
<tr>
<td>PAF Cell (runoff)</td>
<td>PAF Cell</td>
<td>pH, Conductivity, Turbidity, Flow, TSS, Alkalinity, Acidity, Sulphate, Metals (tot.), Metals (dis.), Major Cations</td>
</tr>
<tr>
<td>Big Duffer Ck.</td>
<td>Q2</td>
<td>pH, Conductivity, Turbidity, Flow, TSS, Alkalinity, Acidity, Sulphate, Metals (tot.), Metals (dis.), Major Cations</td>
</tr>
<tr>
<td>Little Duffer Creek</td>
<td>Q3</td>
<td>pH, Conductivity, Turbidity, Flow, TSS, Alkalinity, Acidity, Sulphate, Metals (tot.), Metals (dis.), Major Cations</td>
</tr>
<tr>
<td>Unnamed Stream</td>
<td>Q4</td>
<td>pH, Conductivity, Turbidity, Flow, TSS, Alkalinity, Acidity, Sulphate, Metals (tot.), Metals (dis.), Major Cations</td>
</tr>
</tbody>
</table>
### SUPPLEMENTARY REPORT - South Deposit Tailings Storage Facility

<table>
<thead>
<tr>
<th>Location</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toe Seepage</td>
<td>Q5</td>
</tr>
<tr>
<td>Main Creek below South Deposit</td>
<td>Q1</td>
</tr>
<tr>
<td>South Deposit (pumped)</td>
<td></td>
</tr>
</tbody>
</table>

#### Legend

- **Online Remote Sensing**
- **Weekly Field Measurement when Site Established**
- **Weekly Field Measurement when Site Established transitioning to Online Remote Sensing**
- **Monthly Grab Sample and Laboratory Analysis when Site Established**

#### Metals
- As, Al, Mn, Fe, Cu, Ni, Zn, Co, Cd, Hg, B, Se, Pb

#### Cations
- Ca, Mg, Na, K

* B dump seep pond will be monitored on closure after it has been constructed. Flows in Big Duffer Creek, Little Duffer Creek and across upper surface of the flow through dump to represent the PAF Cell run off will be ephemeral.
5.10 Monitoring and Reporting During Construction

It is understood monitoring and adaptive management during construction of the SDTSF, especially during the first few months, will be critical to ensuring the success of the proposal.

Outline the milestones considered to be fundamental to the adaptive management process and the frequency and method of reporting to the EPA that will be undertaken.

GHD have provided a report addressing these issues. It is provided as Appendix A and summarised below.

5.10.1 Monitoring

Grange will utilise an internal management structure for the SDTSF to ensure adequate levels of management and supervision are adhered to and appropriate milestone reporting is undertaken (both internal and external) to detect any necessary changes required to the construction. Grange will develop an SDTSF organisational and reporting structure prior to construction commencing which defines persons responsible for each role. With regard to reporting to the EPA/ACDC where required, this will be undertaken by the Grange Superintendent, who may at his discretion delegate reporting requirements to the Site Technical Engineer or Design Engineer where appropriate.

5.10.2 Milestone Reporting

As the SDTSF is a significant project undertaken over 18 months, Grange intend to undertake regular reporting on the construction to capture, and summarise the works as executed at completion of appropriate milestone reporting points.

The milestone reports will require input from both the Grange Superintendent and the Design Engineer (GHD) and will therefore be reviewed by both parties and include a summary of the following items:

- construction progress
- QA/QC testing (including material properties, compaction and permeability results)
- construction photos
- environmental aspects/permit compliance
- an assessment of inflows and outflows of the filter face and ‘flow-through drain’ to provide an ongoing assessment on their actual performance in comparison to the expected design in order to make necessary adjustments to the materials specification or placement during construction of SDTSF.
The milestone reports are expected to be provided to the EPA, as a minimum these milestone reports would be provided for:

1. Completion of initial access road and first filter face construction at bench level 194 m (refer Stage 1A-1 TSF Plan Drawing 32-1627720-C020)
2. Completion of RL224 m bench backfill to final profile (refer Stage 1A-4 TSF Plan Drawing 32-1627720-C023)
3. Completion of RL264 m prior to TSF accepting tails discharge (refer Stage 1A-6 TSF Plan Drawing 32-1627720-C025)
4. Final stage completion RL300 m (completion of construction phase and assessment of impact on initial tailings filling on filter face).

In addition to the above key milestone reports, a final all standard Works and Executed Report complying with DPPIPWE guidelines would be submitted to the EPA/ACDC at completion of construction.

5.11 Oxygen Penetration into Tailings via the Coarse Rock Flow Through

It is noted in the Peer Review Report that as a contingency to limit oxygen penetration up through the coarse rock flow through and potentially into the tailings, a pond at the base of the flow through is mooted. This however does not appear to have been considered as an option in the DPEMP main document.

Briefly explain if a pond will be established at the base of the SDTSF outfall to limit the potential for oxygen uptake through the coarse rock flow through. If is not considered necessary, clearly explain why.

The peer review panel have reviewed the necessity of a downstream pond, below the waste rock dump, and have deemed it to be not necessary (Appendix E, Supplementary Peer Review, pg9). This is due to the saturation of the filter face, which is discussed below.

In the unexpected event that saturated tailings and water are not maintained against the filter face, the movement of oxygen through the filter face will be controlled by the thickness of the filter face, its permeability and its saturation. As described in the DPEMP (Section 6.9.2.1), the filter face will be 30 m thick, have a permeability of $1 \times 10^{-4}$ m/s and will have water and saturated tailings against its upstream face after the first year of operations.

Figure 59 and Figure 60 below were provided in the DPEMP to describe the potential movement of oxygen through a clay cap over potentially acid forming rock. They are applied here to show the limitations of oxygen movement through the filter face using the same principles.

Figure 59 illustrates the relationship between the coefficient of oxygen diffusion and degree of saturation for soils or porous media such as the filter face. It illustrates that oxygen diffusion rapidly decreases by 3 to 4 orders of magnitude as the degree of saturation increases.

Figure 60 relates the percentage reduction of acid sulphate generation rate (ASGR) to the degree of saturation and thickness of the partially or fully saturated cover. To achieve a 98%
or greater reduction in ASGR, the 30 m thick filter face would need to remain above 32% saturated throughout the year as shown by the red lines on Figure 60. This is equivalent to a diffusion coefficient of $1 \times 10^{-6} \text{ m}^2/\text{s}$ (Figure 59). If only the first 1 m of the upstream face of the filter face was saturated to at least 78% (as shown by the orange lines in Figure 60), then the ASGR would still be reduced to less than 98%.

**Figure 59**  
Coefficient of Diffusion vs Degree of Saturation for Saturated Porous Media

(from Aubertin, 2005)

![Coefficient of Diffusion vs Degree of Saturation for Saturated Porous Media](image)

**Figure 60**  
ASGR Reduction

![ASGR Reduction](image)

It should also be noted that it would be exceedingly difficult to create a sufficiently large pond downstream of the waste dump (southern toe, as per toe seepage in Figure 55). The waste dump will be ~80m high; this would require a pond of an equivalent depth to prevent oxygen entering the flow through.

The saturation of the filter face, as demonstrated above, should prevent the ingress of oxygen via the flow through, into the tailings.
5.12 Peer Review Report Inconsistencies

It is understood the Peer Review have commented on a draft DPEMP rather than the final DPEMP. Identify the elements in the proposal which have altered, and what additional information has been provided in the DPEMP since their review. Explain the significance of the peer review not having undertaken a review of the final proposal and DPEMP.

The project has not changed since the peer review in December 2012. The final submitted DPEMP included formatting changes and additional data relating to the MNES content and also to the geochemical nature of CPS and SD tailings. Given the project has remained unchanged, Grange contends that it’s not significant that the peer review didn’t review a final version of the DPEMP as no contradictory data, information or advice has been received since the peer review in December. However the peer review has provided further advice in relation to this Supplementary, this advice can be found in Appendix E and relates specifically to the key issues raised by the EPA.

5.13 SDTSF Water Quality Emission Levels

Provide water quality emission levels for the SDTSF.

Section 7.7.1 of the DPEMP describes the present water quality in Main Creek which is affected by historic acid drainage sources, inputs from the current mining operation and catchment inflows.

The expected water quality emission levels for the SDTSF will be influenced by a number of factors:

- Historical ARD pollution from the OTD via the MCTD or via direct piping of OTD seeps into the SDTSF
- Historical ARD pollution from the B Dump seeps
- Tailings discharge into the SDTSF
- Neutralisation reactions between historical ARD and the alkalinity contained in Grange’s tailings
- Residence time and settling within the SDTSF water body
- Supernatant water in the SDTSF which flows out via the spillway during high rainfall events, and then re-enters the base of the flow through waste rock dump
- Supernatant water in the SDTSF which enters the flow through channel and picks up additional alkalinity from the flow through waste rock dump downstream of the SDTSF dam wall.

During the first year when B Dump seeps discharge into the SDTSF with no tailings input, the supernatant water will acidify and then flow through the base of the flow-through, picking up some alkalinity and being neutralised to some extent. In short, there will be an improvement over the current water quality in Main Creek during the first year of operation. After this time there should be a significant improvement in water quality in Main Creek.

After the first year of operation, any SDTSF supernatant water which flows over the spillway from the SDTSF should be similar to the outfall from the MCTD with lower suspended solids.
and turbidity due to the operational differences in the two dams (shallow MCTD versus deeper SDTSF and greater residence time in the SDTSF).

The current MCbSD monitoring station downstream of the SDTSF provides water quality resulting from the B dump seeps plus some neutralisation from the current discharge from the MCTD. Hence the water quality emission levels should improve from the fluxes at MCbSD (Figure 61) to better than the current fluxes for MCTD (Figure 63). The concentrations of major metals for these sites are also shown in Figure 62 and Figure 64 respectively.

**Figure 61**  Fluxes MCbSD

![Figure 61](image)

**Figure 62**  Concentrations MCbSD

![Figure 62](image)
The water quality emission levels during the operation of the SDTSF will be measured at the MCbSD and are expected to be significantly better because metals from the B Dump seeps will become entrained in the tailings as metal hydroxides following neutralisation by the alkalinity in the fresh tailings.

As noted in Section 8.3 of the DPEMP, the discharge from the SDTSF will likely have the following characteristics, based on the present understanding of water quality in Main Creek and the proposed management of the SDTSF:

- Concentrations and fluxes of parameters which are not altered by neutralisation will remain unchanged as compared to present, and may increase as the volume of tailings disposed of in the valley increases. These parameters include soluble salts such as Ca, K, Na, SO\textsubscript{4}, F and Cl\textsuperscript{–}. Metal concentrations which are unlikely to change due to implementation of the SDTSF include Mn and Ni and possibly Zn.
- There will be a large and potentially ecologically significant reduction in Cu, Al and Fe concentrations in the discharge from the SDTSF due to these metals being neutralised and retained within the dam. Concentrations of these metals in the discharge are likely to be similar to those in the present discharge from the MCTD. This will contribute to a reduction in acidity in the outflow stream.
- The pH of the outflow from the dam will be maintained at similar or higher levels to the present discharge from Main Creek (~7.4 median).
5.14 Contingencies to ensure the SDTSF pond water does not turn acidic during operation, including temporary mill shut downs.

Describe in detail the lime dosing system including the steps that must be undertaken to reconfigure the existing infrastructure (e.g. lime storage silo, lime slurry mixing tank and delivery pipeline and pumps) to provide a viable neutralisation system for the SDTSF. Explain when this work will be undertaken.

Indicate what monitoring will be undertaken and the trigger levels used to signal a requirement for lime dosing.

It is noted in the DPEMP, that based Grange’s experience with the OTD seeps entering the MCTD, once Grange stops producing tailings for periods exceeding 72 hours then the acidic nature of the B dump and OTD seeps will reduce the pH in the water. In considering just Main Creek seeps (i.e. excluding OTD seeps) estimate how long it will take for the SDTSF pond water to turn acidic if a mill shut down occurs.

It is noted in Section 10.2.4.3 of the DPEMP, for extended mill shuts (months not days), the following measure was proposed:

Pumping water from the SDTSF or reducing (read as increasing) the permeability of the filter face to reduce the water level in the SDTSF.

Briefly explain the reasons for reducing water level in the SDTSF for an extended mill shut down.

Grange’s concentrator has an existing lime silo which feeds lime into a simple mixing tank out of which lime slurry can be fed anywhere in the plant or in this case to the SDTSF via a small off take pipeline or potentially even into the tailings pipeline which will be established from the concentrator to the SDTSF. This should take less than three months to establish, once design of pipe size and off take system has been completed, this can be designed and ready prior to first tailings being delivered to the dam.

The delivery of lime slurry could easily be achieved by adding a small pipe to take lime slurry from the mill lime slurry tank to the eastern side of B Dump. This should flow under gravity alongside the tailings delivery lines. Because tailings will not be introduced into the SDTSF until the second year of operations, final engineering and design of the pipeline and off take would not be needed until this time.

As an alternative to the use of a dedicated lime slurry delivery system, a lower capital, higher operating cost method such as direct dosing could be utilised. In the past, direct lime dosing has been used as shown in Figure 65 where the SRRP organised for a tanker to pump lime directly into the MCTD and Grange facilitated the delivery on site.
The SDTSF supernatant water body will need to be monitored for pH so that as the pH drops, lime slurry delivery can commence. Weekly pH monitoring has been proposed for the spillway of the SDTSF, however in the event that tailings are not being delivered into the SDTSF, daily pH and EC monitoring will be undertaken. This will be undertaken by upgrading the small track from the right abutment which heads down to the creek. This track would give continued access to the rising water level for monitoring purposes. The intent of the flow-through structure is to add alkalinity so for short shuts that will be sufficient to control pH in water downstream. Comparing the pH in the pond versus the MCbSD results will determine the need to add alkalinity. Once the pond pH drops to below 6.0 Grange will notify the SRRP that alkalinity addition is necessary.

Previous experience has shown that the supernatant waters of the MCTD begin to acidify during extended mill shuts (72 hours duration or longer). The acidification is driven by the OTD seeps which enter the MCTD; under normal operation these seeps are neutralised by the alkalinity present in Grange tailings. In the SDTSF it is expected that the lag phase (time between mill shut commencing and acidification of the supernatant water) will increase, as the body of supernatant water in the SDTSF will be as much as 50 times greater than that of the MCTD.

In the DPEMP, Grange suggested reducing the water level in the SDTSF during periods of extended mill shuts. The rationale for this was to minimise the interaction between B Dump seep water and the SDTSF supernatant water. Grange now believes this is not practical because the tailings rate rise will be rapid, and recommends simply adding a neutralising agent to the B Dump seeps in the event of extended mill shuts.
For extended mill shuts (months not days), contingencies can be implemented such as:

- Removing the OTD seep line from Grange tailings line and redirecting the OTD seeps into Centre Pit South, from where the acidic seeps could be transferred to South Lens using a dedicated pipeline where further neutralisation can occur.
- Adding a lime slurry to the B Dump seeps to neutralise the acidity.

### 5.15 Early Closure

**Describe the steps and sequences, including construction and material requirements that will be undertaken for early closure of the SDTSF, including a worst case scenario of closure shortly after first tailings discharge.**

#### 5.15.1 SDTSF Early Closure Scenario

The SDTSF dam and spillway will be constructed within two years of approval. However, closure of the facility is not planned for at least seventeen years. The ability of the SDTSF to hold sufficient water to maintain a water cover over the tailings is described in the DPEMP (Section 10.2.1). It is dependent on run-off from influent rainfall; filter face permeability; tailings permeability; and the permeability of the clay cover which will be placed against the filter face upstream wall above the tailings prior to the final filling and subsequent closure. Modelling indicates that the latter permeability will control the water balance. The proposed planned closure concept is to provide a minimum 2 m water cover over the tailings.

Notwithstanding this, once the SDTSF has been set up for closure, the depth of water over the tailings can be increased, if necessary, by changing the configuration of the overflow spillway to raise the invert level and widen the spillway to still accommodate potential PMF inflows.

#### 5.15.2 SDTSF Early Closure

The SDTSF is proposed to be commissioned in late 2014 or early 2015 dependent on approval and construction time, and is to remain in service until the planned mine closure in 2030.

As noted in the DPEMP, tailings will not be placed in the SDTSF until after the first year of construction. After the second year of operation (that is, after one year of tailings deposition) the SDTSF will have been constructed to final height.

Even though the final raise of the conventional earth and rockfill dam from RL280 to RL300 m would already be built if early closure occurred, the permeable filter face below RL280 m would remain exposed. Therefore, if early closure occurred, a low-permeability zone would need to be placed in front of the filter, extending from the top of the tailings against the filter to a height 2 m above the head of the tailings beach near MCTD.

In early closure, it is envisaged that ramps on the front face of the SDTSF could be cut to allow hauling of clay down to the filter face. If there was a residual pond over the tailings (which would depend on the seasonal conditions at closure) then clay could be tipped into the pond over the filter face until it became exposed. Once clay was exposed above the
water level, standard clay placed in layers with compaction could be adopted. This would then result in a low permeability ‘seal’ over the permeable filter to flood the tailings beach.

Because of the steep terrain it is expected that the tailings will flow downstream until a 1:100 beach is formed (as opposed to tailings hanging up at the furthest upstream point). If there were any residual minor tailings upstream of the main beach head (and below the proposed water cover) these could be washed into the main SDTSF storage or, alternatively, cleaned up by conventional truck and excavator operation.

Early closure beaching footprints have been plotted, based on the tailings production rate and beach slope for years 2, 3 and 4 of SDTSF operation as shown Figure 66.

Figure 66 Expected Head of Tailings Beach on 1:100 Slope

It can be seen that by Year 4 the head of the tailings beach will have reached the MCTD toe deposition point after which time that point will gradually be lifted.
From the beaching footprints, the upstream and downstream ends of the tailings beach have been calculated to determine the extents (and subsequent volume) of the exposed filter face required to be ‘sealed’ to provide a 2 m water cover if early closure occurred.

If warning of early closure was known, the height of the filter face required to be sealed could be reduced if the deposition was moved closer to the SDTSF embankment or discharge was moved to the SDTSF crest. A cost benefit analysis could be done at this time to determine the most effective course of action.

A volumetric estimate of the clay required to achieve the above listed clay faces on the filter is presented in Table 16. It is considered the volumes shown could be sufficiently sourced from site available materials.

<table>
<thead>
<tr>
<th>Closure Year</th>
<th>Tailings Level Upstream</th>
<th>Tailings Level Downstream</th>
<th>Clay Face Level Required</th>
<th>Clay Volume Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 2</td>
<td>RL240m</td>
<td>RL223m</td>
<td>RL242m</td>
<td>95,000 m³</td>
</tr>
<tr>
<td>Year 7</td>
<td>RL266m</td>
<td>RL248m</td>
<td>RL268m</td>
<td>45,000 m³</td>
</tr>
<tr>
<td>Year 12</td>
<td>RL282m</td>
<td>RL263m</td>
<td>RL284m</td>
<td>110,000 m³</td>
</tr>
</tbody>
</table>

The reduction in the clay face area between the Year 2 and Year 7 scenarios is because it is predicted that the tailings level will not have reached the RL 224m bench in the Year 2 scenario. This bench is where the alignment of the embankment changes, resulting in a wide area that would need to be covered. It can be seen that the Year 12 early closure case would require the greatest volume of clay.

The above calculations and discussions are based on the assumption that the design filter face permeability has been achieved. The same is true if the filter face permeability was higher than the design value. Another scenario to consider is the case where the filter face permeability is lower than the design value. Depending on how much lower, it is possible that no clay facing will be required.

In fact, if the filter face permeability was much lower than the design, the pond would be expected to completely fill to the spillway level. In this scenario a high pond level develops and no tailings beach would exist. This is relevant to capture of B-Dump seeps in that ponding would occur above the tailings beach level (potentially 8m above the upstream beach level), making the seepage collection bund construction difficult. In such a case two options could be considered:

- Create a hole in the filter face to expose the flow-through and control the pond level at an optimum height.
- Allow the pond to completely fill and then construct a collection bund within the waste dump to collect the seeps and transfer them to South Deposit in a similar manner as is currently proposed on final closure. This would involve cutting a track down to the water level and the digging and grouting a sump within the waste rock and cutting a channel for the discharge pipe across the face of the decant level.

All these early closure scenarios will need to be properly assessed and controls designed when the early closure requirement is first identified.
5.15.3 Early Closure Water Balance

GHD have completed a water balance in three early closure cases – after 2 years, 7 years and 12 years – to check that the proposed 2 m TWL above the maximum tailings beach head still provided adequate water cover over varying seasonal conditions. The water balance has been done from both the Bureau of Meteorology (BOM) data at Savage River dating back to 1966 (i.e. 46 years), and in the scenario of the driest month on record occurring for three months in a row.

As the clay material would likely be more permeable than tailings, it has been assumed that no tailings deposition from the crest has taken place.

The following model parameters have been applied:

- Inflow of rainfall over the SDTSF catchment (3.1 km$^2$) with a runoff coefficient of 1 for the surface area and 0.8 for the remainder of the catchment;
- No inflow from the MCTD catchment (conservative as seepage from MCTD would run into the SDTSF catchment);
- Permeability of the clay face of $1 \times 10^{-6}$ m/s with a hydraulic gradient of 1;
- Permeability of the foundations (tailings) of $1 \times 10^{-7}$ m/s with a hydraulic gradient of 0.5;
- Evaporation based on the January average from the BOM (conservative);
- Nominal 5% rainfall reduction and 5% evaporation increase to account for climate change.

The results of the early closure water balances are presented in Table 17 with graphical representations shown in Figure 67, Figure 68 and Figure 69.

### Table 17 Early Closure Water Balance Summary

<table>
<thead>
<tr>
<th>Closure Year</th>
<th>Tailings Level</th>
<th>Ave Pond Level*</th>
<th>Clay Face Level</th>
<th>Min Pond Level</th>
<th>Min Water Cover Over Tailings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Upstream</td>
<td>Downstream</td>
<td></td>
<td>BOM Data</td>
<td>Dry Months</td>
</tr>
<tr>
<td>Yr 2</td>
<td>RL240m</td>
<td>RL223m</td>
<td>RL245.0m</td>
<td>RL242m</td>
<td>RL241.6m, RL240.6m</td>
</tr>
<tr>
<td>Yr 7</td>
<td>RL266m</td>
<td>RL248m</td>
<td>RL269.9m</td>
<td>RL268m</td>
<td>RL267.6m, RL266.8m</td>
</tr>
<tr>
<td>Yr 12</td>
<td>RL282m</td>
<td>RL263m</td>
<td>RL284.8m</td>
<td>RL284m</td>
<td>RL283.4m, RL282.6m</td>
</tr>
</tbody>
</table>

*Based on the BOM Historical Data Analysis

It can be seen from the results that tailings are not predicted to be exposed under any of the cases analysed, with the minimum depth of water being 0.6m in the Year 2 and 12 Closure ‘Dry Months’ case.

It can also be seen from the graphs that in all three cases, a cover of greater than 2m (i.e. clay face underwater, water flow entering the Filter Face) is maintained for the entirety of the BOM data analyses.

This is considered an acceptable closure position.
Figure 67  Year 2 Early Closure Storage Levels

SDTSF Year 2 Early Closure - Storage Level (Historical BOM Data)

SDTSF Year 2 Early Closure - Dry Months
Figure 68  Year 7 Early Closure Storage Levels

**SDTSF Year 7 Early Closure - Storage Level (Historical BOM Data)**

- Clay Face Top Level
- Upstream Tailings Level

**SDTSF Year 7 Early Closure - Dry Months**

- Clay Face Top Level
- Upstream Tailings Level
5.15.4  B Dump Seepage Collection Early Closure

If early closure were to occur in SDTSF the B Dump seeps could still be captured using the seep collection bund concept as described in Section 10.2.1.2 of the DPEMP only lower down the valley.
At the end of the operational life of the SDTSF, the planned system for transferring B Dump seepage to South Deposit is to use gravity via a pipe buried through the SDTSF embankment. If early closure occurs, the lower level of the B Dump seepage collection pond will mean seepage transfer to South Deposit with a gravity based system is not possible. In this case a sump and pump system could be installed at the B Dump collection pond, to pump seepage to the buried pipe within SDTSF where flow would then be via gravity to South Deposit Pit or directly to Centre Pit South.

The early closure seep collection system will need to be comprised of two ponds (refer to Figure 70); with possibly two pumps. A single pump might be possible if the two bund ponds can be connected together by a delivery pipe.

**Figure 70 Early Closure Collection Bund (Year 2)**

If early closure occurred, then the most likely scenario is that the OTD seeps would be diverted to Centre Pit South via the channel between B Dump and A Dump, leaving only the B Dump seeps to be collected and pumped (minimising pumping costs).

The planned spillway level of the SDTSF will be excavated at RL297 m. In the case of Year 2 closure, the SDTSF pond would be TWL 242 m, to flood tailings at the beach head at RL240 m. Based on BOM rainfall data, on early closure at Year 2, the water level in SDTSF could rise to a maximum of RL248.8 m, which would have occurred only once since 1966 (modelled result), with the average water level being RL245 m. The higher water levels in SDTSF pond means that the collection bund heights would need to be constructed to a height capable of meeting a selected design storm event and prevent flooding in and out of the bund pond. The bunds may also need to be constructed the full length of B Dump (similar to the planned closure design) to a level to withstand the selected design flood event thereby protecting the toe from flushing.

Alternatively, a spillway could be cut through the SDTSF to suit the desired final maximum water level. In the case of closure at Year 2 of operation this would require a cutting
approximately 55 m deep through the SDTSF, allowing water to pass to the underlying flow-through drain on the eastern abutment.

Due to the large storage capacity of the SDTSF it is also possible to consider removing part of the filter face to expose the flow-through so that the selected flow event is controlled. Design work would need to be carried out to select the most appropriate option based on conditions at the time.

**5.16 South Deposit Water Quality**

In considering the potential for destratification, describe whether the South Deposit pit water chemistry is understood through the whole water column.

Explain whether the elevated copper concentrations identified in Figure 110 of the DPEMP could be a result of destratification, and whether South Deposit pit dewatering could result in a high metal loading to Main Creek.

Monthly surface monitoring of the South Deposit pit water has occurred since 2007 and depth sampling has occurred at regular intervals as well. The data from the depth samplings are presented below. The data shows that stratification of the pit water in South Deposit occurs above 30m below the surface depending on the season.

There have been some seasonal variation in the monitoring; the 2007 monitoring was conducted in winter (June) while the 2008 and 2011 monitoring was completed in December and February respectively.

The seasonal variation in the sampling is reflected in the temperature profile of the pit water (Figure 71), with water temperatures near the surface 6-8 degrees warmer in the summer monitoring. In winter (June 2007) the profile shows the waters nearer the surface are slightly colder than the underlying water with a sharp boundary at 20m below the surface.

*Figure 71  Temperature and Dissolved Oxygen Profile*
The regular monthly monitoring of South Deposit pit water over the past few years has shown the pit water to be consistent in its quality, with no evidence of destratification (Figure 73). Measured surface EC has been between 800-900 µS/cm, which is in contrast to the EC observed at depth in Figure 72.

Below 20m, the EC rises to between 1000 and 1600 µS/cm. Furthermore surface pH has consistently been above 8 during routine monitoring, whereas the pit water below 20m has a measured pH of 7-7.4 (Figure 72).
Figure 73  South Deposit Overflow Water Quality
Figure 74 and Figure 75 below provide an overview of the water chemistry at depth within the South Deposit pit. The water in South Deposit is alkaline, with alkalinity increasing with depth from 100mg/L at the surface to 200mg/L at 60m depth. Alkalinity has been consistent across all three monitoring runs and at all depths. Sulphate has also remained consistent across all three monitoring runs with sulphate at the surface of ~350mg/L, again, increasing with depth to 600mg/L at 50m.

![Alkalinity, Sulphate and TSS Profile](image)

Metals are also consistent throughout the profile. The high outliers shown for the 2011 deep (60 metre) samples have been impacted by the Nisken Sampler picking up bottom sediment. This is confirmed by the 237 mg/L value determined for TSS and the comparison to the Turbidity results.
For destratification to occur the surface water would need to become significantly colder than the underlying water. This would cause the denser surface water to sink and bring the less dense water below to the surface. Given the depth of the surface layer (10-30m deep), the small surface area of the pond and the relatively protected nature of the pit (surrounded by high pit walls), it is highly unlikely that wind action could create enough motion to destratify the pit. Therefore it is considered that destratification of the South Deposit pit water is unlikely.

Earlier sampling results from South Deposit showing elevated Copper results (Figure 110 from the DPEMP) these are the result of sampling during the development stage of the pit. During these times no effective sump was present and due to suspended solids loads, localised elevated readings of some total metals occurred. This was a sampling issue rather than a water quality issue. Since the end of mining, surface sampling and overflow samples have not shown these elevated results.
The metal loads in Main Creek are shown in Figure 20 to Figure 24. At MCbPP the creek had a median copper concentration of 2,100 µg/L, at MCbDD a median copper concentration of 3,700 µg/L and at MCbSD a median copper concentration of 180 µg/L. The median copper concentration in South Deposit since January 2005 has been 26 µg/L. Given this difference, South Deposit dewatering should not result in a high metal loading in Main Creek.

5.17 Risk to Wildlife from SDTSF Water Body

Briefly describe the potential risk the SDTSF water body may pose to wildlife, for example health risk to water birds and barrier to movement.

The SDTSF has the capacity to improve the quality of water in Main Creek from its current degraded state with a low pH and high acidity and high metal concentrations (see Figure 22 and Figure 23 for MCbPP and MCbDD) to water quality commensurate with the current MCTD supernatant water.

It is expected that the water quality in the SDTSF will be similar to the MCTD (Figure 21).

The SDTSF will occupy up to 145 ha in the Main Creek Valley along a 2 km stretch of Main Creek. The existing MCTD and OTD already provide an upstream barrier for marine/aquatic species; and with the degraded nature of Main Creek it is considered unlikely that any further impediment will be created by building the SDTSF with respect to upstream migration of aquatic species. An existing impediment to upstream migration is a 15m high waterfall approximately 5km downstream of the SDTSF forming a natural barrier to migration of Main Creek upstream of that point.

The improved water quality with the construction of an alkaline flow-through will improve the quality of water downstream of the dam and reduce the chemical barrier (reduced copper loads) for aquatic life at the confluence of Main Creek and the Savage River. This will potentially allow for easier migration of species in the Savage River. Currently there are species such as platypus living in the MCTD and consequently Grange observes that the water is not overtly toxic to all aquatic life.

The MCTD poses very little health risk to water birds, a variety of bird species have been observed living on the dam, including coastal species such as the hooded plover. The abundance of fresh water streams in the region, the alkaline nature of the supernatant water, the very low concentrations of heavy metals and regular inflows of fresh water into the catchment reduce the overall risk to water birds. Figure 76 below provides a snapshot of water quality on the MCTD, with median concentrations from January 2011 until May 2013 presented.
The water body and wet uncompacted tailings of the MCTD do adversely impact the ability of wildlife to move east to west (and vice versa) across Main Creek. However, roading / bunding across the tailings dams, the dam walls and downstream rock dump of the SDTSF provide options for wildlife to move across the Main Creek valley.
6 DoE Requirements

North Barker Ecosystem Services has reviewed the original survey work and MNES reports in the DPEMP and provided the following responses for Grange to the DoE request as listed below.

6.1 Commonwealth Survey Guidelines regarding Tasmanian Devil and Spotted-tailed quoll

6.1.1 Survey techniques

Section 11.2 indicates that against Commonwealth’s survey guidelines only two techniques out of a possible eight techniques were adopted for Tasmanian Devils and two of four for Spotted-tailed quolls. The choice of survey technique must be explained and justified.

Field research has been tailored to the action (constructing and operating a tailings storage facility) and to address appropriate questions which relate to understanding the likely impact of the proposal. This requires confirmation of presence, distribution of activity and significance of habitat and given the overlapping ranges and wide ranges utilised by devils an assessment of the impact on potential of the district caused by the proposed action.

Each of the eight techniques (underlined) are considered below.

**Scat searches** supplemented with scat hair/bone analysis provides information on the presence and apparent distribution as well as informing the diet of the animals. Prey identification can inform the preferential foraging habitats. This method is efficient, extensive and non-invasive. The scat analysis yielded positive results for the presence of both Tasmanian devils and spotted-tailed quolls.

**Track searches** supplement scat searches and can be useful in appropriate substrates such as soft sand and wet mud. It also provides corroboration of presence due to the distinctive paw prints of these species.

Both of the above methods can be and were included in all survey coverage for mapping vegetation and recording flora.

**Community liaison** was employed informally through consultation of Grange staff who reported numerous observations of devils within the mine site.

**Cage trapping** provides a means of confirming the presence of animals and is used where further information on population dynamics and health is relevant e.g. when investigating incidences of DFTD. If supplemented with microchip and recapture then it can provide robust data on densities. This method is expensive and invasive and ethics approval would usually be limited to high value research furthering the understanding of the ecology of the species or in assisting with the devil conservation program.

No additional information relevant to assessing the impact of the project would be gathered from adopting this technique and consequently it was not employed.
Spotlight surveys can also provide a means of confirming the presence of individuals. Standardised and repeatable techniques are useful for gauging long term trends in relative abundance. This method however is limited to vehicle based searching as the vegetation in this proposed projects' impact area is too dense to have any success outside these corridors. Across the mine site such a procedure is also constrained by the 24hr operational profile of the mine e.g. mobile machinery and activity which can prevent devils from moving between habitats. If attempted on foot it introduces significant safety risks to surveyors due to the inherent danger of navigating around a mine site at night across steep and difficult terrain.

No further information on the likely impact of the project will be gathered from adopting this technique. For these reasons this method was not employed.

Vocalisations are used to confirm the presence of some cryptic species, especially, birds and arboreal fauna. Playback can elicit responses. For devils in this environment vocalisation would be opportunistic and provide no information additional to what has been already collected and because of this it was not employed.

Hair tubes provide hair samples which can inform presence. Hair analysis in scats was equally effective. The use of hair tubes once again will not add to the evidence of species presence achieved by other means and so was not employed.

Remote cameras can be used as a means of confirming presence, recognising individuals and identifying the presence of (well advanced) devil facial tumours. It can also be employed to confirm activity at den sites. In this case no active den sites were identified in the habitat surveys and the presence of the species was already confirmed.

There are limitations in using this technique to quantify abundance as many images cannot be distinguished due to being of poor quality or wrong angle. Because of these issues, this method was not utilised.

Radio collar tracking (or a variant) is useful in understanding landscape occupation and location of dens. Their use could test the hypothesis that much of the environment of the SDTSF is of suboptimal habitat in contrast to the drier ridgelines and more open terrain. However this method is invasive and high risk in such challenging environments. Collar retrieval is difficult in this terrain and so collars that are designed to fall off are likely to be lost. Those that require recapture and removal risk failure. Recapturing collared individuals potentially affects animal welfare. VHF collars are unsuited as it would be extremely difficult to locate and follow individuals through this landscape where radio access is unavailable in the steep terrain and low valley floor. GPS collars are potentially more useful, though very expensive. The terrain adversely affects GPS coverage (non-existent in valleys), reducing the reliability of this method at this site.

Given the low density of the local population, there is a high probability that this method would not yield adequate data and so was not utilised.

In addition to the above surveys, habitat assessment has been undertaken of all environments: considering the presence of structures suited to providing dens including
Collectively this information can be used to create a picture of occupancy in the landscape. The highly heterogeneous habitat has informed our conclusion that the ridges and open habitats are considerably more frequently utilised by devils than the steep valley walls and creek bed surrounds which provide sub-optimal foraging and denning habitat and comprises a significant proportion of the habitat impacted by this proposal.

The relative low density of devils in this landscape and the calculated level of impact based on existing knowledge suggest that the use of more invasive and intensive sampling techniques is not justified.

6.1.2 Survey Coverage

Further it is not clear whether on-ground surveys for protected fauna have been confined to tracks and ridgelines due to density of understorey vegetation in the Main Rivulet gully or whether searches were also undertaken during the botanical survey referenced on page 7 of Appendix 7 that accessed Main Creek and its tributaries for the length of the study areas from three existing tracks. The department is aware of the dense vegetation and understorey that is deemed less suitable as habitat for devils but beyond reference to assessing the understorey of the various vegetation communities (page 374) cannot determine whether this area was systematically surveyed for threatened fauna and seeks further clarity on the expected presence / absence of listed threatened species (including features such as Tasmanian devil natal dens) within the inundation footprint around Main Creek gully.

Further detailed information including large scale maps is required to specify the areas that were physically inspected during each survey for Tasmanian devil, spotted-tailed quoll and other EPBC Act listed species in the construction and inundation areas.

Figure 77 has been included which shows the areas traversed during surveys. Where practical, two people surveyed at 5 to 10 m spacing. The figure assumes a 20 m width of coverage. In reality some areas were more widely searched where the environment seemed potentially favourable. At other times coverage was less due to the limitations imposed by the terrain and the dense nature of the understorey.
All surveys included vegetation community assessment, with select 30 m plots for flora in representative sites. Concurrently, evidence of fauna – by way of tracks, potential den sites and scats – was searched for.

Criteria used for assessing den suitability included the following during all field investigations:

- elevation
- aspect
- proximity to major drainage lines
- depth to water table
- soils (ease for burrowing)
- sun exposure (cover and density of canopy and understory precluding light reaching the ground)
- structures (log hollows, trunk hollows e.g. myrtle buttresses), rock exposure
- cover protection/exposure to view.
Figure 77  Survey Coverage

South Deposit Tailings Storage Facility approximate footprint

- Inundation and associated infrastructure (as labelled)

South Deposit Tailings Storage Facility footprint is from GHD, SOTSF Design Report, Sept 2012 and S. Kent, "SOTSF disturbance areas", Oct 2013

This is indicative of the areas surveyed. It is a combination of the 2006, 2012 and 2013 field visits. A minimum of 2 people was present on each occasion covering a minimum 20m width

The mapping has been undertaken using a hand held GPS and subjective interpretation. Consequently it should be considered indicative only.
6.1.3 Population Estimates

Whilst population estimates of one to two female spotted-tailed quoll are suggested, similar inferences on the Tasmanian devil population from the scats and other signs detected are not made. The department estimates, based on DPIPWE densities quoted in the DPEMP, that there could be 1.88 to 4.39 devils within the proposed inundation area. To assist in understanding the scale of loss within the impact area, please provide population estimates for the number of quolls and devils and their natal dens likely to be affected.

The quantification of devils to be impacted was deliberately left out from the DPEMP. This is due to the inherent assumptions required to make any such determination and the limited data from the types of habitats affected by this project. However, applying published available density data and considering the size of home ranges it is quite possible that no devils will be directly impacted and therefore there may well be no decline in devil numbers resulting from this project.

Any quantitative statement of abundance is necessarily based on a number of assumptions. The most often quoted estimate of average density of pre-disease devils in unmodified habitat ranges between 0.3 and 0.7 devils per km$^2$ (DPIPWE, 2010; SPRAT profile http://www.environment.gov.au). Much higher densities have only been found in habitats that have been modified through agricultural improvement. At Mt William in northeast Tasmania, prior to the impacts of DFTD, 250 animals were estimated to be occupying over 45 km$^2$ at which equates to more than 5 per km$^2$. This included 40 breeding females which equates to a density of 0.9 per km$^2$ (Pemberton, 1990). These artificially high numbers result from significantly higher densities of prey species, usually as a result of the creation of pasture.

Based on the evidence collected and the general acceptance of the low productivity and prey abundance of the environments around Savage River, it is likely that the density within the SDTSF is at the lower end of the range. Applying the 0.3 per km$^2$ density estimate, this equates to a total number of 0.4 devils. (area x density = number so 1.48 km$^2$ x 0.3 = 0.4 devils). This is markedly less than the interpretation made by DoE. Taking a very conservative approach (area x density = number so 1.48 km$^2$ x 0.7 = 1.04 devils, it amounts to an impact on the carrying capacity of the area of 1 devil. In reality however, the loss of suboptimal habitat associated with this project would have little effect on carrying capacity.

Quantifying impacts is complicated as devils share overlapping ranges which are understood to vary from 8 to 20 km$^2$ (Save the Tasmanian Devil website, 2009), or 4 to 27 km$^2$ (Pemberton 1990). Smaller ranges have been recorded in high productivity landscapes (Troy, 2011). It is reasonable to assume in low-density, low-productivity environments that ranges are going to be towards the larger end of the range. Consequently the footprint of the dam is likely to impact on the range of many devils but is unlikely to exceed 5% of any individual’s home range. There is sufficient plasticity in ranges and given the large size that each is anticipated to occupy, it is expected that the ranges of devils that overlap any part of the SDTSF footprint will adjust accordingly.
Figure 78  Evidence of devil activity in vicinity of SDTSF
Even accepting reports of higher densities which have, for example, 0.8–2.9 individuals per km$^2$ (MacCullum et al. 2007), the interpretation that the net carrying capacity of the SDTSF at 1 animal remains a conservative estimate.

The inference that occupancy and utilisation varies across a heterogeneous landscape such as this also suggests that the footprint is on the less utilised, and so lower density, range. Scat surveys revealed highest concentrations along the ridgeline tracks. Although this could be argued to be a consequence of sampling technique, this is refuted. The coverage of survey (Figure 77) shows that a significant proportion of the survey was undertaken off track and/or within the Main Creek valley. It is acknowledged that dense vegetation would affect visibility however the general lack of evidence of occupancy including runways and tracks suggest activity is less within the lower slopes. There is evidence of devil activity in the valley bottom in the way of scat observations. However these are generally in small numbers when compared to the observations made on the ridge track (Figure 78). At track junctions there are higher concentrations of scats including obvious latrine sites. This suggests that these are significant landscape features in devil activity, presumably where animals ranging from different directions cross each other’s paths. This provides evidence that there is heterogeneous use of the landscape. Tasmanian devils, being scavengers, are opportunistic and will learn to utilise areas of known resource abundance and to use established track networks, be it natural or manmade.

The age of scats is unknown but few are estimated to be older than 3 months. This is based on studies undertaken of decomposition of fox scats. It is expected that the scats represent a number of individuals. If devils were homogenously dispersed in the landscape and averaged 2000 ha home ranges, then within a single home range at a density of 0.3 devils per sq km there would be 6-7 devils sharing the entire landscape. If, as we have suggested, the species is heterogeneously dispersed showing preferential use of the landscape, there may be as many as 20 individual devils that utilise areas identified as being of high significance.

On-ground assessments indicated that the devil’s and quoll’s prey species favoured occupancy within the mid to upper slopes, as evidenced by tracks and scats. Denning structures and other criteria used to assess for high quality potential denning habitat was also within this area. As the impact from the SDTSF is predominantly within the lower slopes (90% of the total project area of 1.48 km$^2$ is within these lower slopes). This means the true reduction to carrying capacity could be much less than what is discussed above, meaning there will be an almost negligible reduction to the one devil’s range. However, due to the lack of scientific knowledge on the devil’s ecology to provide certainty in drawing this conclusion, it is accepted that the impact to 1 devil’s range is a reasonable albeit conservative conclusion.

On the balance of evidence and, in particular, based on the habitat recorded within the low lying areas of the steeply incised Main Creek and using the criteria listed above, the probability of natal dens being present in the low-lying inundation area is considered very low and the evidence suggests the area mapped in Figure 78 as high quality potential denning habitat is the location where dens/natal dens are most likely to be situated. Areas

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1. >70 % scats decomposed after 1 month and 90 % of scats by 3 months Fox Eradication Program, (unpublished)
identified as moderate habitat were based on the presence of structures (log hollows, trunk hollows e.g. myrtle buttresses) in one instance and the predominance of eucalypt canopy on ridgelines where elevation, aspect, exposure to sun and soils character were considered features that potentially made the site more suitable for denning. In reality on searching these areas little difference in evidence of activity, (trackways/scats) could be discerned from the areas considered suboptimal.

Devils use multiple dens often favouring one. Pemberton (1990) estimates that there is on average 3.8 dens per individual adult devil. If the lower range of 0.4 devils within the 148 ha footprint of the dam is accepted then somewhere between 1 and 2 dens are likely to occur in an area of this size assuming an even distribution of dens across the landscape. Dens are however dispersed unevenly across the landscape and it has previously been determined that the areas of the SDTSF provide suboptimal denning opportunities, so the anticipated impact remains at the lower end of this estimate.

A conservative estimate is that a single natal den at most may be located within the footprint of the SDTSF.

6.1.4 Natal Den Surveys

As mentioned above, the inundation area is assessed as containing very low quality habitat for denning/breeding. The areas where scats were observed and the predominance of tree hollows and soils suited to denning occur outside the dam footprint area, being located on the nearby ridges which will not be impacted by the proposal.

Where moderate habitat was considered potentially present in the vicinity of the spillway site, further targeted searches were undertaken in 2013. These revealed an environment of dense regrowth tea tree and eucalypt. Little evidence of devil presence was found and the habitat determined to be less suitable than anticipated based on the desktop assessment.

Given that the overall estimate of impact is conservatively put at the equivalent of 1 devil, the likelihood of locating dens in what was already assessed as low suitability habitat was not justified, especially when considering the limitations (poor ground visibility and hidden nature of natal dens).

Potentially suitable denning habitat was mapped on the western upper slopes as depicted in Figure 106 of the DPEMP. This is outside the direct impact zone. However, the potential for indirect impact could not be entirely ruled out once a conservative buffer was taken into account. A small area has therefore been nominated (Figure 153, DPEMP) for further intensive searching, accepting the limitations of locating natal dens in the field. Should any natal dens be located then the management measures associated with the pre-clearance
measures as outlined in Environmental Commitments (Devil Management Plan) will be implemented.

6.1.5 Environmental Commitments 33, 39, 40 and 41

**The DPEMP states that ‘Devils and quolls place natal dens so that they are very difficult to detect which means pre-clearance surveys are often not an efficient means of detection’ (page 410). Given this statement please discuss the purpose, practicality and efficacy of:**

- **Environmental Commitment 39 (page 437) – pre-clearance checking for natal dens.**

  Per discussion on page 297/8, please discuss the impacts of proposed clearance works (Feb-April) in the context of avoiding fatalities in copulation dens, impacts within the gestation period and during the April to July whelping period as claimed in the DPEMP. The proposed Feb to April clearing period conflicts with the department’s understanding that breeding (mating, gestation and whelping) occurs between Feb and June.

- **Environmental Commitment 33 (page 437) ‘Prepare and implement a devil management plan prior to commencement of construction. The department understands that the purpose of this plan is to minimise impacts on devils within the construction/inundation area. Further, information should be provided on the content of the plan and to explain the differences between the devil management plan and habitat enhancement program and how the actions prescribed within each will benefit devil and spotted-tailed quoll given the ultimate loss of habitat resulting from the proposed action; and**

- **Environmental Commitment 40 (and 41) protection of breeding sites by 150 m buffers. Please also describe how the stated approach for confirming den occupancy (page 297) takes account of a devil’s use of multiple dens within its range.**

**Commitment 39** – This commitment relates to the area recorded as containing potentially suitable denning habitat shown in Figure 106 of the DPEMP. It is proposed that a 150 m buffer surrounding this area containing high quality potential denning habitat has a pre-clearance survey undertaken. Whilst it is very difficult to locate natal dens (as confirmed by discussions with DPIPWE experts), especially over the broader area of SDTSF given the terrain and dense understorey and the fact that the majority of the SDTSF contains poor quality potential denning habitat, it is appropriate to focus survey effort on this smaller area within the upper slopes especially considering this area has the potentially higher quality denning habitat. Figure 153 in the DPEMP shows the location of the area proposed for a pre-clearance survey with a 50 m and a 150 m buffer zone.

The peak time to undertake den activity checks is during September to December. This is when natal dens are most likely to be occupied. Young devils have usually dispersed by early February. The proposal to clear during February (late) to May is to minimise the chances of impacting an occupied natal den where pups are present.

It must be stressed that the area noted in Figure 106 of the DPEMP is outside the direct impact zone and will not be cleared.

In addition, Grange will further reduce the risk of impacting on the breeding success of Tasmanian devils by committing to pre-clearance surveys prior to any clearance being
undertaken, with primary focus on areas identified as having habitat most likely to support denning (i.e. the buffer zone). The pre-clearance surveys will be staged as works progress to better enable the identification of devil dens. Details of this expanded pre-clearance survey method are outlined in the Devil Management Plan.

Table 18 presents the lifecycle of the Tasmanian devil and informs the thinking behind scheduling of clearance works (where possible) to minimise impact to natal dens.

<table>
<thead>
<tr>
<th>Month</th>
<th>Life cycle stage</th>
<th>Den vulnerability</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>Copulation</td>
<td></td>
</tr>
<tr>
<td>April</td>
<td>early pouch young (105 days pouch life)</td>
<td></td>
</tr>
<tr>
<td>May</td>
<td>early pouch young</td>
<td></td>
</tr>
<tr>
<td>June</td>
<td>late pouch young</td>
<td></td>
</tr>
<tr>
<td>July</td>
<td>late pouch young</td>
<td></td>
</tr>
<tr>
<td>August</td>
<td>females lactating with young in natal dens</td>
<td>NEED FOR DEN PROTECTION</td>
</tr>
<tr>
<td>September</td>
<td>in natal dens</td>
<td>CRITICAL TIME FOR DEN PROTECTION</td>
</tr>
<tr>
<td>October</td>
<td>in natal dens</td>
<td>CRITICAL TIME FOR DEN PROTECTION</td>
</tr>
<tr>
<td>November</td>
<td>in natal dens</td>
<td>CRITICAL TIME FOR DEN PROTECTION</td>
</tr>
<tr>
<td>December</td>
<td>beginning of weaned dispersal of young</td>
<td>CRITICAL TIME FOR DEN PROTECTION</td>
</tr>
<tr>
<td>January</td>
<td>weaned/ dispersal of young</td>
<td>NEED FOR DEN PROTECTION</td>
</tr>
<tr>
<td>February</td>
<td>dispersal of young</td>
<td></td>
</tr>
</tbody>
</table>

Note – Peak den activity is listed as Sept to December on the DPIPWE Threatened Species Link – Species Profile ([http://www.threatenedspecieslink.tas.gov.au/tasmanian-devil](http://www.threatenedspecieslink.tas.gov.au/tasmanian-devil))

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Grange remains committed to investigate the ecology of Tasmanian devils within the lease site comparing utilisation of the mine area and the surrounding undeveloped native vegetation. Grange also plans rehabilitation and revegetation to best suit the habitat needs of the Tasmanian devil. Grange remains committed to providing artificial den habitat within the vicinity of the SDTSF where disturbance will not occur.

To provide context for these commitments and delineate between the actual clearance of vegetation and habitat disturbance, the following is provided. There are three types of habitat disturbance associated with the proposed action:

- Vegetation clearance back to bedrock - called "Dam stripping area" in Figure 79.
- Dumping rock over existing vegetation, effectively preventing its use as habitat - called "Dump disturbance area" in Figure 79.
- Inundation zone - Upstream of the dam will which will become inundated by water and then tailings as described in Section 8.4.2. of the DPEMP.

The spillway will also be cleared to bedrock.

The PAF Dump and the two Settlement Dam Stripping areas will be cleared of vegetation in early 2014. The spillway will be cleared in late 2015.
A section through the TSF is shown in Figure 80 below. The side slopes of the Main Creek valley are too steep to safely clear ahead of dam works as described below.

**Figure 80** Cross Section SDTSF Dam Embankment

Grange will progress the flow-through up the valley at a height of 20m above the creek bed. This entails dumping a load of rock ahead of the tip face about every 10 minutes. This is a relatively slow progression with the tip head moving northwards about 30m a day until the upstream end of the TSF is reached. This then provides a working platform from which the northern side (dam stripping area) can be reached. As shown in Figure 81 the platform is used to clear any large trees, from about 6m above the platform. At the upstream end a 30m wide section is established, where the filter will be placed. This needs to be stripped to bedrock; on both sides of the valley.

**Figure 81** Northern Filter Face Platform

As the stripping is in progress, the truck fleet will then paddock dump rock material back out from the upstream end towards the pit (to the west) and a dozer will flatten these out. This will raise the platform about 2 m in height (see Figure 81). That will be repeated three times,
taking about two weeks. At that point the next 6m of vertical clearance will occur. This progression will slowly repeat in sequence until the top of the dam wall is reached.

On the southern side valley rock will be tipped directly up against the face of the hillside from the rock platform. This will disturb a maximum of 10-15 m of ground per day, over a 60-100m length. All this gradually gets repeated over the construction life of the project.

Figure 82 Southern Progression

In the dump disturbance zone (Figure 79) the dump is slowly progressed, extending the tip head at a rate of between 6 – 15m towards the south (Figure 83). The rate will be dependent on the dumping width, which also varies depending on position relative to the valley width.

Figure 83 Dump Disturbance Progression

Rates of advance will be relatively slow and will provide time for devils to move away from the working areas.

Commitment 33 nominates the implementation a Devil Management Plan (Appendix F) to ensure the risk to any devils is minimised. The aim of this document is to guide day to day operations as a result of the SDTSF project to minimise impact on the Tasmanian devil.

Commitments 40 and 41 – Pre-clearance surveys serve the purpose of reducing the risk of disturbing breeding Tasmanian devils. A buffer zone (Figure 153 of the DPEMP) has been created over high quality denning habitat to define an area for targeted pre-clearance surveys.

In addition, Grange will further reduce the risk of impacting on the breeding success of Tasmanian devils by committing to pre-clearance surveys prior to any clearance being undertaken, with primary focus on areas identified as having habitat most likely to support denning (i.e. the buffer zone). The pre-clearance surveys will be staged as works progress to
better enable the identification of devil dens. Details of this expanded pre-clearance survey method are outlined in the Devil Management Plan.

Impacts within the inundation area will not happen overnight, rather over a 12 month period. Devils will therefore vacate any dens should impacts occur within this area and move to more suitable habitat based on the altering local conditions. However ‘pre-clearance’ surveys will be conducted in area’s identified as having higher potential for denning within the inundation zone.

Any potential devil den sites identified in a pre-clearance survey will be monitored using remote sensor cameras for a minimum of 6 days to confirm whether they are being inhabited by a Tasmanian devil, during this period a 50m buffer zone will be created around the den and no other access or other form of disturbance will be permitted until the den is confirmed to not be active.

Where use of the den is confirmed the DoE and DPIPWE will be notified. The 50m buffer zone will be increased to 150m until it can be confirmed that the den is no longer active.

If a den is identified during the preclearance survey, permits will be obtained from the relevant agency to ‘take a product of wildlife’, prior to any monitoring being undertaken. Grange will consult with DPIPWE and the Devil Survey Guidelines to ensure correct practice is observed.

Grange remains committed to investigate the ecology of Tasmanian devils within the lease site comparing utilisation of the mine area and the surrounding undeveloped native vegetation. Grange also plans rehabilitation and revegetation to best suit the habitat needs of the Tasmanian devil. Grange remains committed to providing artificial den habitat within the vicinity of the SDTSF where disturbance will not occur.
6.2 Azure Kingfisher

The department concurs that the Azure Kingfisher is unlikely to have been detected during the field surveys which were restricted to Main Creek and the construction / inundation areas but is known to occur in lower reaches of the Savage River and the Pieman River into which Main Creek discharges. The department notes that the anticipated outcome of the SDTSF is improved water quality in Main Creek (and by extension downstream portions of Savage River and the Pieman River where the species occurs) but takes the precautionary view that the potential remains for impacts upon downstream populations of this species arising from high volume releases and / or decrease in water quality during construction and from unanticipated on unintentional discharges during operation. To this end, while a detailed review of water quality impacts and proposed mitigation measures has not been undertaken by the department at this stage, it is worth noting that in making a decision on approval, the department will likely require a programme of water quality monitoring (including establishment of baseline values and thresholds for remedial action) to be implemented in relation to the azure kingfisher and their downstream habitat.

Water Quality Monitoring for the azure kingfisher will be incorporated into current water management and monitoring plans and is described in more detail in Appendix G.

The consequence of the SDTSF is to lower the risk of downstream impacts by implementing current best practices, including, neutralisation of legacy ARD seeps, providing alkaline augmentation downstream of the SDTSF and providing a full height dam to minimise the risk of tailings discharge incidents and moderating the flow regime.

The objective of the water quality monitoring program will be to demonstrate that water quality in the rivers is not negatively impacted by the proposed development of the SDTSF. This will be achieved by quantifying the present ‘baseline’ condition for the Savage River downstream of Main Creek for comparison with future water quality results. The baseline will consist of quantitative results derived from water quality monitoring data, and a conceptual model which incorporates the understanding of water quality processes and conditions which have been gained over the past 22 years. Aspects of the conceptual model will include how water quality would be expected to change in the event of an extreme flow or other event (e.g. fire) that has not been captured in the existing monitoring record.

To achieve the monitoring objective, flow and water quality will be monitored at the following monitoring locations, all of which are monitored either by Grange or in conjunction with the SRRP:

- Main Creek below South Deposit (MCbSD): This is the discharge point of the tailings facility, and reflects the integrated water quality of Main Creek at the point where it leaves the mine site. The site has continuous recording flow, EC, turbidity, temperature and pH probes and is monitored and sampled on a monthly basis.

  Due to logistical and safety issues associated with accessing Main Creek it is not feasible to establish an additional monitoring site downstream of the SDTSF. This is not an issue, as all diffuse or point source discharges from the mine site enter Main Creek upstream of the MCbSD site.

- Savage River below Southwest Waste Rock Dump (SRbSWRD): This site is situated on the Savage River at a point downstream of most mining point source discharges, and
most of the diffuse sources entering the Savage River. The South Deposit Outflow (SDO) enters the Savage River downstream of this site, and some additional seeps from the historic Southwest Waste Rock dump enter the river downstream of this monitoring point, but due to safety issues it is not possible to routinely monitor the Savage River further downstream. Flow at this site is based on a rainfall runoff model linked to upstream flow gauges due to the shifting nature of the channel. The site has continuous recording pH, EC, turbidity and temperature probes, and is monitored and sampled on a monthly basis.

- South Deposit Outflow: This is the point source overflow from the South Deposit Pit which enters the Savage River downstream of the SRbSWRD site, and upstream of the confluence of Main Creek with the Savage River. It is a low volume, alkaline water source that is monitored and sampled on a monthly basis.

- Savage River a Smithton Road (SRaSR): This site is located in the lower Savage River, upstream of the confluence with the Pieman River. Water quality reflects the inputs from the upper Savage River, Main Creek, and numerous unregulated and undeveloped small tributaries. A flow model has been developed for this site based on the upstream inflows and rainfall. Monitoring will continue to be completed on a monthly basis, with physical and chemical parameters measured in situ (as well as the continuous monitoring probes) and water quality samples collected for subsequent analysis.

The monthly monitoring results from the SRaSR site will be analysed on an annual basis, with the range of results compared to the ‘baseline’. If the median value for the annual results is above (metals and sulphate) or below (pH) the 20th or 80th percentile values for the ‘baseline’, or if the 5th or 95th percentile values are outside of the existing range of the ‘baseline’ then the following actions will be implemented:

- The change in water quality will be evaluated to determine whether it represents a risk with respect to ecosystem protection. In the event the change is not considered to present a risk (e.g. change shows an improvement in water quality, or magnitude of change in parameter is not considered to increase risks to ecosystem health), no further formal action will be required, however the Company in cooperation with the SRRP may investigate the cause of the change.

- The water quality results from the SRaSR site will be evaluated with respect to the conceptual model to determine whether the recorded results are consistent with the present understanding of the river although outside of the range of previously recorded results.

- The water quality results from the SDTSF will be reviewed to evaluate the role the operation of the SDTSF may have played in altering downstream water quality.

- The water quality results from the SRbSWRD will be reviewed to evaluate whether changes to water quality in the Savage River above Main Creek could account for the observed water quality changes downstream.

- The water quality results from the SDO will be reviewed to evaluate whether changes to water quality in the discharge from the South Deposit pit could account for the observed water quality changes downstream;
The findings will be considered by Grange Resources in cooperation with the SRRP to identify appropriate mitigation measures if required.

This evaluation of results will be in addition to the existing and ongoing analysis of water quality results by Grange Resources and the SRRP which would identify any large scale sudden changes in water quality. Should a water quality event be identified which could pose a risk to the downstream environment, the company would notify the EPA and DoE.

The analysis of the annual monthly monitoring results will be completed within the first quarter of the following calendar year by Grange Resources. If all parameters are within the established background, the results will be shared and discussed with the SRRP, but no other formal report will be submitted to Government. If the annual water quality results fall outside of the established baseline, then Grange will discuss the results with the SRRP and submit a report summarising the outcomes of the investigation into the results, and proposed actions.

### 6.3 Compensatory and Contingency Measures

Section 11.6 of DPEMP further discusses environment offsets. The DPEMP alludes to other compensatory measures in the form of a Habitat Enhancement Program (HEP) which would compensate for impacts to devils and quolls from habitat loss and possibly road kill, should they be higher than expected. The potential loss of dens will be offset by the construction of supplementary den opportunities. The department is concerned that if survey effort has not been sufficient to determine dens which are by nature cryptic, it will not be possible across the 148 ha area of disturbance for animals with overlapping ranges to provision sufficient compensatory den habitat. The department is also concerned that the provision of additional artificial den sites (if accepted by devils) as proposed will have indirect impacts through the intensification of competing devils within the newly restricted home range.

Consequently, the department seeks further clarification on the contents of the HEP including its objectives, funding, experimental design, timing and other elements including how the provision of such artificial dens and any other component of the HEP will enhance the devil’s and quoll’s healthy persistence in the context of the surrounding population. Such explanation should also be provided in the context of the principles of the EPBC Act Environmental Offsets Policy (Oct 2012) and associated Guidance.

As previously mentioned it is predicted that the SDTSF will have no adverse impact on Tasmanian devils given their large home ranges and the quality of the habitat to be affected. It is acknowledged that while low quality den suitability has been assessed within the inundation area, the lack of scientific knowledge within this type of terrain means a conservative approach is warranted. An impact to 1 devil’s range (reduction to carrying capacity) has therefore been assumed.

Whether it is 0 or 1 devil, it is difficult to conceive how this loss would constitute a significant impact under the Significant Impact Guidelines of the EPBC Act. Table 85 of the DPEMP considers there to be no residual impact, with respect to having an ‘adverse impact to habitat critical to the survival of the species’. Given the discussions above about the low suitability of the habitat we would contest that the action should not trigger the need for an offset.
The Grange lease areas around the mine site at Savage River collectively occupy 3200 ha. This includes several hundred hectares of modified habitat within the 1700 ha footprint of the mine plus 1500 ha of intact forest and moorland habitats. The pipeline lease occupies an additional 1200 ha.

The proposed SDTSF makes up less than 3% of the total lease areas. Much of the balance of the lease will never be cleared and as such is excluded from other uses such as forestry and public recreation. Even if habitat clearance / modification were a threat to the species, this impact cannot be considered significant. However, both the listing advice under the Environment Protection and Biodiversity Conservation Act 1999\(^3\) and the Approved Conservation Advice for *Sarcophilus harrisii* (Tasmanian Devil)\(^4\) discount habitat clearance, modification and geographic range as significant threats to the species.

From the Listing Advice:

- “Given that Tasmanian Devils are highly mobile and can be considered generalists in terms of their habitat preferences, they are less susceptible to habitat modification than many other species” (page 4)
- “The Committee does not consider that the species’ geographic distribution is both precarious for the survival of the species and very restricted, restricted or limited. Therefore, as the species has not been demonstrated to have met the required elements of Criterion 2, it is not eligible for listing in any category under this criterion” (page 7). Criterion 2 deals with if the species “geographic distribution is precarious for the survival of the species and is very restricted, restricted or limited”.
- “While the number of mature individuals is likely to continue to decline, the Committee does not consider that the estimated total number of mature individuals of the species is limited to a particular degree. Therefore, the species is not eligible for listing under this criterion” (page 7). This statement relates to Criterion 3, which deals with the estimated total number of mature individuals being limited and the number continuing to decline at a particular rate and its geographic distribution being precarious for its survival.
- “The Committee does not consider that the estimated total number of mature individuals of the species is extremely low, very low or low. Therefore, as the species has not been demonstrated to have met any required element of Criterion 4, it is not eligible for listing in any category under this criterion” (page 7).

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From the Conservation Advice:

- Habitat clearance is not mentioned as a threat. One of the ‘potential threats’ is: “If Tasmanian Devil densities become very low there is a risk that disturbance or destruction of maternal dens, as a result of land clearance, for example, for urban development, forestry and agriculture, could affect the species’ breeding success and pose a significant threat to the Tasmanian Devil (Owen and Pemberton, 2005)” (page 2).

In summary we would note that:

- Habitat modification and geographic distribution are not threats to the species
- Species densities have not become very low so habitat clearance cannot be considered a ‘threat’.

Given the importance Section 139 (2) of the EPBC Act places on the approved conservation advice, the points raised above must be considered when assessing the impact on the species. It has been our conclusion from this information that there is not likely to be any significant impact on the Tasmanian devil or spotted-tailed quoll as a result of this proposal.

Grange has decided to not commit to a Habitat Enhancement Program, despite the company being interested in implementing the elements which it contained. This is because it is apparent that the program will not fully satisfy DoE’s expectation for offsets. Instead Grange has accepted that following precedence (conditions imposed on other mine proposals in the region) it will provide offsets of a financial nature. Consequently the company is prepared to commit the funds as anticipated in Section 6.3.3 of this supplementary.

6.3.1 Nature of Impact

The construction of the SDTSF will result in the removal or inundation of approximately 148ha of mature rainforest and other associated vegetation communities (Figure 84). The extent of each vegetation type is:

- *Nothofagus – Atherosperma* rainforest (RMT) – 107.9ha
- *Nothofagus-Phyllocladus* rainforest (RMS) – 8.6 ha
- *Eucalyptus nitida* over rainforest (WNR) – 10.3 ha
- *Eucalyptus nitida* over *Leptospermum* (WNL) – 18.7 ha
- *Eucalyptus obliqua* over *Leptospermum* (WOL) – 1.5 ha
- *Acacia melanoxylon* swamp forest (NAF) – 1.3 ha
- Previously cleared land (FUM) – 40.9 ha

As a result there will be loss of some habitat for the Tasmanian devil and the spotted-tailed quoll. The carrying capacity of the lease area for the Tasmanian devil and the spotted-tailed quoll species will be reduced accordingly. For the Tasmanian devil there will be a minor long term reduction in carrying capacity by one devil at most. For the spotted-tailed quoll the potential loss of some minor carrying capacity is not considered significant.
Figure 84  Vegetation impacted by SDTSF
Construction works will bring a temporary heightened level of noise and vibration. This may disturb habitat outside the immediate footprint of the clearance works which could extend the total area of impact and cause indirect impacts to the Tasmanian devil and the spotted-tailed quoll.

The dam construction works could result in temporary increases in sedimentation loads during construction. These could affect downstream water quality impacting on fish prey for the kingfisher, but will be controlled by measures mentioned in section 6.2.

6.3.2 What is Being Avoided and Mitigated

Direct impact on high quality denning habitat for the Tasmanian devil is being avoided by ensuring a buffer zone exists around the denning habitat identified in Figure 106 and shown in Figure 153 of the DPEMP. The implementation of a Tasmanian Devil Management Plan (Appendix F) will focus on traffic on site, timing of vegetation clearance, indirect impacts on surrounding areas and mine site interaction with the species to:

- Protect Tasmanian devils;
- Maintain the abundance and geographical distribution of Tasmanian devils;
- Minimise the impact to natal den sites and breeding activities of Tasmanian devils;
- Mitigate against any potential negative impacts on Tasmanian devils from the construction and operation of the South Dump Tailings Storage Facility (SDTSF).

Prescriptions on internal road use and traffic rules, vegetation clearance guidelines, pre-clearance denning surveys and training of staff will mitigate against impacts both direct and indirect on MNES. These are described in detail in the Devil Management Plan (Appendix F) and also in Table 85 of the DPEMP.

6.3.3 Nature of Offset Proposed

There have been recent decisions by DoE for two other mine projects in Western Tasmania: Nelson Bay (Shree Minerals) and Riley (Venture Minerals). Although many of the circumstances are different, both of those projects required offsets for impacts to Tasmanian devils and contingency measures for other listed species.

Savage River SDTSF is distinct from these other projects in that there is no change to road traffic and so the key component of impact identified for those two projects (road kill) is not relevant to this project. The SDTSF involves the clearance, disturbance and inundation of 148 ha. This compares with 119 ha for Riley and 156 ha for Nelson Bay.
Table 19 provides a summary of the mitigation, offsets and contingency measures required for the two approved projects and estimates likely determination for Savage River SDTSF by applying similar standards.

- **Devil facial tumour disease.**

Facilitation of devil facial tumour disease was identified as a potential indirect impact through increased mobility and intermingling (clearing, food waste, road kill). No compensation was imposed for Riley or Nelson Bay. This hazard is less for Savage River SDTSF (no road kill) and so no compensation would be anticipated.

- **Habitat loss.**

For Nelson Bay this was estimated to equate to the equivalent of 1.5 devils (carrying capacity loss) based on area of clearance and density of devils. The offset was required and calculated from the duration of impact (10 years) multiplied by the cost of managing an insurance population at $8,000 per annum, resulting in an offset payment of $120,000.

For Riley, the carrying capacity loss was determined to be approximately 1 devil. The loss to habitat was not deemed to be significant. Mitigation included a Habitat Management and Monitoring Plan that required pre-clearance surveys plus the creation of new denning sites along with monitoring for devil activity and evidence of DFTD using sentinel cameras.

For Savage River SDTSF a Devil Management Plan has been prepared. The intent of this document is to avoid and minimise the risk of impacting on denning habitat. No residual impact is anticipated and so no additional offsets are considered necessary as to be consistent with Riley, however if applying the decision for Nelson Bay an offset component could be required.

- **Roadkill.**

Nelson Bay has been estimated to result in an increase in road kill of 1.6 in year one and 0.6 per year for the remaining 9 year operation period of the mine which equates to a total of 7 devils. This loss required an offset of $168,000, calculated as 3 years of care at $8,000 per devil per annum.

Riley is considered to result in the impact of 3 devils per year – therefore a total of 6 devils lost to road kill over two years. Applying the same formula as Nelson Bay, the offset for Riley has been calculated to be $144,000. Burns Peak cannot be calculated the same way. The current traffic volume is estimated at 25 vehicles movements per day. Baseline road kill monitoring would not have any statistical power unless it was carried for an extended period.

There will be no road traffic resulting from the Savage River SDTSF. Changes to internal traffic will involve movements of vehicles into new areas of the mine lease.
Night time traffic will be largely limited to 200 tonne haul trucks. However traffic speed associated with the haul trucks are less than 10km/hr. The vibration and noise that precedes these vehicles will provide ample warning to animal on the road. The volumes and regularity of truck movements is such that the disturbance created will be ongoing and will reduce the element of surprise. Consequently the risk of road kill events is considered remote, road kill has not previously been recorded on site. No devils are expected to be impacted from road kill.

In conclusion, Grange will negotiate a suitable offset based on the precedence set by Shree and Riley, with further compensatory measures, again in line with precedence, in place should worse than expected outcomes occur.

It is proposed that any offset contribution is directed towards ‘The Save The Devil Fund’ who are aiming to undertake a research project utilising the University Of Sydney (Channing Hughes) to establish a long-term ecological study of the Tasmanian devil across a range of habitats in north-western Tasmania. As per the DPEMP, Grange has experience with Channing’s (University of Sydney) work, Channing undertook his own research in an area that included part of Grange’s slurry pipeline. Grange would like the offset contribution directed via ‘The Save the Devil Fund’ to this project should it proceed. Grange would again make its pipeline corridor available for said research.
### Table 19: Offset Measures, Comparison to precedents

<table>
<thead>
<tr>
<th>Measure</th>
<th>Nelson Bay</th>
<th>Riley</th>
<th>Savage River SDTSF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of impact ha</td>
<td>152</td>
<td>119</td>
<td>148</td>
</tr>
<tr>
<td>Duration</td>
<td>10 years</td>
<td>2 years</td>
<td>The SDTSF will be permanent. Calculations based on an equivalent of 20 years</td>
</tr>
<tr>
<td>Potential MNES impacts</td>
<td>Tasmanian devil, Spotted-tail quoll, Wedge-tailed eagle, Masked owl, Azure kingfisher, Australian grayling, Giant freshwater crayfish, Windswept spider orchid, large golden moths Western leek orchid, pretty leek orchid</td>
<td>Tasmanian devil Spotted-tail quoll Wedge-tailed eagle Azure kingfisher Australian grayling</td>
<td>Tasmanian devil Spotted-tail quoll Wedge-tailed eagle Azure kingfisher</td>
</tr>
<tr>
<td>Tasmanian devil DFTD</td>
<td>Potential for indirect impact to spread through intermingling. <strong>No offsets required.</strong></td>
<td>Potential for indirect impact to spread through intermingling. <strong>No offsets required.</strong></td>
<td>Potential for indirect impact to spread through intermingling. <strong>No offsets required.</strong></td>
</tr>
<tr>
<td>Tasmanian devil Habitat loss and impact to dens</td>
<td>1.5 devils. Proposed Fauna Habitat Protection Zone deemed inadequate. Other avoidance measures required including preclearance surveys, monitoring and reporting. <strong>Further offsets required:</strong> 1.5 (devils) x $8000 (annual cost) x 10 (duration of impact) = $120,000</td>
<td>1 devil. Not significant and adequately mitigated by Habitat Management and Monitoring Plan that included pre-clearance surveys, creation of new denning sites and monitoring with sentinel cameras. Further conditions relating to rate of clearance and staged rehabilitation. <strong>No offsets required.</strong></td>
<td>Assuming impact to 0.4 devil. Devil Management Plan includes pre-clearance surveys. <strong>Following Nelson Bay then offsets required</strong></td>
</tr>
<tr>
<td>Species</td>
<td>Traffic and Road kill</td>
<td>Following Riley  no offset required</td>
<td></td>
</tr>
<tr>
<td>-------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Tasmanian devil</td>
<td>82 per day yr 1 then 34 per day yrs 2-10. 1.6 devils in first year, 0.6 each year thereafter. Partially mitigated by road kill plan. Offset required - 7 (devils) x $8000 (annual cost) x 3 (years of care) = $168,000, Note total offset rounded up to $350,000 to include inflation. Contingency: $48,000 for any devil above expected impacts (7 devils)</td>
<td>No traffic on public roads. No offsets required. Negotiated Contingency.</td>
<td></td>
</tr>
<tr>
<td>Spotted-tail quoll</td>
<td>Avoidance and mitigation measures are partially effective.</td>
<td>Mitigation for devil likely to mitigate risk of road kill impacts, although an element of uncertainty remains. No offset required. Contingency: Fund 3 months of feral cat control for any stq road kill above expected (?) impacts</td>
<td>Mitigation for devil likely to mitigate risk of road kill although an element of uncertainty remains. No offset required. Negotiated Contingency.</td>
</tr>
</tbody>
</table>
| Wedge-tailed eagle      | Avoidance and mitigation measures are partially effective. No offset required. Contingency $20,000 required for Mitigation for devil likely to mitigate risk of road kill although an element of uncertainty remains. No offset required. Contingency $20,000 required for any road kill | Mitigation for devil likely to mitigate risk of road kill although an element of uncertainty remains.
<table>
<thead>
<tr>
<th></th>
<th>any road kill above expected levels.</th>
<th>above 1 in any 12 month period.</th>
<th>Negotiated Contingency.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Masked owl</td>
<td>Mitigation measures in place adequate.</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td><strong>No offset required</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Azure kingfish</td>
<td>Mitigation measures in place adequate.</td>
<td>Water quality monitoring and surface water mngt mitigate risk of downstream impacts.</td>
<td>Water quality monitoring and surface water mngt mitigate risk of downstream impacts.</td>
</tr>
<tr>
<td></td>
<td><strong>No offset required</strong></td>
<td><strong>No offset required</strong></td>
<td><strong>No offset required</strong></td>
</tr>
<tr>
<td>Australian grayling</td>
<td>Mitigation measures in place adequate.</td>
<td>Water quality monitoring and surface water mngt mitigate risk of downstream impacts.</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td><strong>No offset required</strong></td>
<td><strong>No offset required</strong></td>
<td></td>
</tr>
<tr>
<td>Giant freshwater crayfish</td>
<td>Mitigation measures in place adequate.</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td><strong>No offset required</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Windswept spider orchid, large golden moths, western leek orchid, pretty leek orchid</td>
<td>Avoidance and mitigation measures are partially effective.</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td><strong>Offset of $400,000</strong></td>
<td></td>
<td></td>
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</tbody>
</table>
6.4 Cumulative Impacts

Cumulative impacts may arise from:

- Spatial expansion of the mine that comprises impacts from the proposed SDTSF added to the extant footprint of the mine (in operation since 1967). There is also a potential for cumulative impacts arising from nearby potential future projects (e.g. Long Plains) which the proposed SDTSF may facilitate. The department acknowledges the information within Section 11.4.1 (of the DPEMP) that the Long Plains exploration does not form a part of this proposal but equally notes that the isolation of the Savage River mine in the context of the surrounding land uses would suggest that expansion of the mine (particularly within the same catchment) could have cumulative impacts upon terrestrial and aquatic MNES that would be attributed to the mine’s activities.

- The DPEMP adequately discusses the potential future Long Plains development but the supplement should discuss any other potential future facilitated impacts. The DPEMP should also expand further on how the sequence of mine expansions since 1967 has had (or demonstrated not to have had) impacts upon the surrounding populations and habitat for MNES.

- The temporal expansion of the mine through its extended life. The DPEMP supplement should contain additional info discussing how, when compared to the scenario of the existing mine closure timeline, the mine expansion as proposed will have impacts (deleterious or beneficial) upon MNES including those found on site and downstream aquatic/ aquatic dependent and riparian species and communities.

It would be helpful to have additional information in Section 11.4.1 regarding the rehabilitation undertaken of the 100 ha on site in relation to EPBC protected matters. Specifically where this area is, when did rehabilitation commence, what base-lining was undertaken at the time of commencement and at various points through regeneration to determine habitat quality, what survey techniques and methodology was used to determine this, what ongoing monitoring has occurred and what lessons have been learnt from this process that can be applied to other rehabilitation initiatives on site.

Magnetite mineralisation was discovered at Savage River in 1887. For many years, interest in the deposit centred on the copper and gold potential of the area. Adits were developed in the hillsides but no significant base or precious metal mineralisation was identified.

Exploration of the prospect was carried out by the Australian Bureau of Mineral Resources in 1956, including ground and air magnetometer surveys. Diamond drilling was undertaken in 1957 and 1959.

In 1965 Savage River Mines Limited, a joint venture of Australian, Japanese and American interests, was formed to develop the project.

The Savage River Project was operated for the full term of a 30-year lease by Pickands Mather & Co. International (PMI), an affiliate of Cleveland-Cliffs Inc., on behalf of the joint venture. To access the magnetite reserves PMI developed an open-cut mine, concentrator plant and township at Savage River. A pipeline was constructed from the concentrator plant.
to a pelletising plant and dedicated port facilities at Port Latta. Production commenced in 1966 and ranged as high as 2.4 million tonnes per annum (tpa) of iron ore pellets.

During the late 1980s, PMI approached its joint venture partners and proposed that it acquire their interests in the Savage River Project. This proposal was accepted and, shortly thereafter, PMI reduced pellet production to approximately 1.5 million tpa. PMI ceased activities at Savage River in early 1997 and ownership of the Savage River Project was transferred to the Tasmanian Government on 26 March 1997.

The mine was operated as a conventional open cut initially working the Centre Pit located south of the Savage River. Leases north of the river were granted in 1984 and the small South Lens Pit and the much larger North Pit were then developed. The centre of operations moved towards the new pits due to greater ease of mining and improved ore blending.

In March 1997, ABM purchased the assets of the Savage River Project from the Tasmanian Government. ABM and Grange merged in 2009 with the operation continuing.

The mine continues to be a conventional open cut. ABM’s operations deepened and re-configured the existing open cuts and mined several smaller satellite ore bodies that were not mined by PMI. South Deposit was first mined in 2001.

Over its lifetime, the Savage River mine and associated infrastructure has resulted in the clearance of approximately 1500 ha at Savage River.

Figure 86 shows this footprint and also identifies areas that are in the process of rehabilitation (estimated to occupy over 100 ha). There is also more than 250 ha within this footprint that has not been cleared and retains the original forest cover.

Most of this clearance and rehabilitation occurred prior to 2008 and so predates the listing of the Tasmanian devil as a Matter of National Environmental Significance. The legislation is not retrospective and so these impacts cannot be considered as cumulative under the EPBC Act.

Tasmanian Devil – Based on the estimated loss of 1500 ha of vegetation since 1966, and assuming densities of 0.3 to 0.7 devils per square kilometre, the carrying capacity may have declined by 4.5 to 10.5 devils. The low density of the population known to occur within the form of vegetation in the region would suggest that this impact is at the lower end of this estimate.

However, the mine site is not vacated by Tasmanian devils. They are regularly observed on site and have been recorded denning under buildings in the past. Devils become acclimatised to human activity and it is well recognised how they can inhabit in association with anthropogenic disturbances. Devils present in the Savage River area have been raised in an environment characterised by noise and visual disturbances. The individuals are not likely to be adversely affected by further operations. Modified environments and revegetated habitats are likely to support elevated numbers of prey.
A reduction in carrying capacity for the spotted-tailed quoll is also likely to have occurred. However, taking into account its larger range, the impact will have been much less.

Wedge-tailed eagles are still present within the wider landscape; however, there is no historical data to show they have been breeding within the Savage River mine. Past impacts are more likely to have been from wildfires that impacted on tree suitability for nesting and would have occurred prior to 1999 (Pre EPBC Act).

The water quality emanating from the site has had the capacity to impact on the azure kingfisher and the Australian grayling. By the end of 1996, the two streams which traverse the mining lease, the Savage River and Main Creek, were adversely impacted by mining. Acid rock drainage (ARD) was considered to be one of the main water quality issues at Savage River. Waste rock dumps containing material from the southern pits, particularly the Centre Pit South, were considered most prone to acid leaching. Cu and Ni both exceeded the ANZECC (1992) guideline value for soft waters below the mine site.

The Pieman River Monitoring Program data showed high metal concentrations in the Savage River (Koehnken 1992) with all metal concentrations (with the exception of Fe) increasing as the Savage River flows through the mine site and then decreasing before the Savage River/Pieman River confluence. The median Cu concentration was over 25 times the ANZECC (1992) recommended value for soft waters just below the mine site with maximum Cu concentrations 3–5 times higher than the median concentrations. Davies (1995) suggests that these high Cu concentrations were a major reason for the degraded aquatic ecosystem below the mine. Main Creek flows south from the Main Creek Tailings Dam to eventually join Savage River approximately 12km downstream. The water quality determined about 5 km downstream from the tailings dam, was poor with a median pH of 4.5 and concentrations of Cu, Mn and Ni all well above the ANZECC(1992)/USEPA(1988) guideline values.

A study of the downstream effects of the mine was commissioned by PMI in 1995 and reported in Davies (1995). The following conclusions were made:

- The faunal diversity and abundance at riffle and edge habitats in the upper Savage River is similar to other unimpacted streams of the region.
- The faunal communities of the Savage River have suffered severe impacts consistent with major changes in water quality and sediment characteristics.
- The major impacts are associated with the river reach between Broderick Creek and some 30 km downstream of the mine road bridge.
- Little recovery is occurring downstream from the ameliorative action of inflowing tributaries.
- The degree of impact is sufficiently severe to eliminate up to 90% of the major taxa (families) of aquatic macroinvertebrates and to decrease overall abundance by up to 99% in the reach downstream of the confluence with Main Creek.

It is unlikely that impact has occurred to aquatic MNES such as the grayling or azure kingfisher since the EPBC bill which commenced in 2000. The grayling face a natural barrier (large waterfall) downstream of the SDTSF site on Main Creek. Legacy ARD pollution will have had some form of impact to water quality; however, the species are still known to be present within waterways downstream of Savage River.
Early mine closure would still result in the current ARD issues improving due to the construction of the alkaline flow-through waste rock dump buttressing below the SDTSF proper. This could potentially improve water quality further downstream and therefore potentially further increase the habitat range for a number of MNES (i.e. Australian grayling/azure kingfisher). In recent years, sea eagles and cormorants have been observed utilising the Savage River both upstream and downstream of the mine indicating successful improvement in water quality to the point that fish have periodically recolonised.

The remediation work carried out on site by Grange and the SRRP has had a positive impact with water quality criteria set by the EPA now being met in the Savage River downstream on the mining lease. With the configuration of the proposed SDTSF to neutralise legacy ARD seeps in Main Creek and to add additional alkalinity to downstream waters, the longer the STSF operates, the longer the downstream environment for azure kingfishers and graylings is improved.

As noted by DoE, Grange adequately discusses the potential future Long Plains development. Grange has no other expansion plans in the region and hence facilitated impacts from other ore sources are not expected to occur. The ore at Savage River is shown in Figure 85. There are three areas recognised on the basis of magnetic intensity: North Pit which forms the bulk of ore sourced for Grange’s life of mine plan; South Deposit (shown as Southern Anomaly in Figure 85); and Centre Pit. The ore bodies are enclosed within a highly sheared, strike faulted belt of mafic, ultramafic schist and mylonite. The lack of other magnetic anomalies in the immediate Savage River area mean that alternate ore sources are unlikely to exist. The magnetic anomalies at Long Plains and Rocky River indicate that other magnetite resources exist but these are significant distances from Grange’s magnetite concentrator at Savage River and may not prove viable to mine even if there was an ore reserve present in either location.
DoE noted that it would be helpful to have additional information in Section 11.4.1 (of the DPEMP) regarding the rehabilitation undertaken of the 100 ha on site in relation to EPBC Act protected matters. Specifically where is this area, when did rehab commence, what base-lining was undertaken at the time of commencement and at various points through regeneration to determine habitat quality, what survey techniques and method was used to determine this, what ongoing monitoring has occurred and what lessons have been learned from this process that can be applied to other rehabilitation initiatives on site.
Figure 86  Savage River Mine Footprint and Rehabilitated Areas
Figure 86 above shows some areas where revegetation and rehabilitation have occurred at Savage River. All of this predates the EPBC Act. None of these areas were subject to baseline studies, or ongoing monitoring. The areas in Figure 86 clockwise from top left are:

- Pipeline Corridor – natural revegetation of disturbed land alongside the pipeline corridor. This demonstrates the rapidity of natural regrowth in this soil and climate and suggests that providing conditions for this to occur may be more successful than forced rehabilitation.
- Old Tailings Dam (OTD) – this dam wall was sprayed with seed before 1996 by the previous mine operators.
- The former Savage River township – the township area was cleared and rehabilitated by Grange in 1997 in conjunction with the SRRP. This involved removing buildings and infrastructure, providing a clay/soil base and planting suitable (local) seedlings complemented with seeding and an ongoing weed management program.
- South West Rock Dump which was constructed in the early 1990's – the top levels of the legacy SW Rock Dump were capped with compacted clays by Grange in 2001 and 2002 and were then planted with seedlings and a short-term organic substrate.

Looking at the growth on SW Rock Dump and in areas where natural regrowth has occurred, the most important factors for successful vegetation growth or regrowth at Savage River seem to be providing suitable growing media, ideally enhanced by protection such as the provision of slash and an ongoing weed and predator management program.
7 Public Submission

Grange understands that a single public representation was made in regard to the DPEMP. The points made in the representation are noted below along with Grange’s comments.

7.1 Potential for and management of piping in the dam

Notes that traditional dams can usually track rates of seepage to assess potential failure.

The following options were raised:
What options are available to monitoring for piping failure.
What could be done given the proposed quantity of waste rock on the downstream side of the dam if piping were to occur.

Suggests that to limit piping failure perhaps a concrete wall should be installed rather than a filter face.

The SDTSF is being constructed to ANCOLD standards and in addition has a waste rock dump buttressing the downstream section of the dam. The risk of failure is very low by international standards.

A concrete wall would not allow water to pass through into the alkaline flow through thus reducing water quality benefits downstream. The cost of a concrete wall would also mean that the SDTSF would not be viable and the mining operation at Savage River may need to close due to lack of available tailings storage space.

The issue of piping was discussed in Section 5.7 Construction Criteria for Coarse Rock Flow Through.

7.2 Tailings Geochemistry

Considers that processing off site materials e.g. Long Plains, should be fully characterised, and involve a separate risk assessment, as the geochemistry of the SDTSF could change.


It seems that while the mine is functioning as a whole there is alkalinity being added from fresh tailings or from the mining operations. But as the DPEMP states there would be "adverse consequences" if either of these ceased; the systems (if present) to manage these risks across the operation are unclear.

The proposal for a TSF does not involve additional inputs other than described in the DPEMP.

There is no current ore reserve at Long Plains nor anywhere else that could feed into Grange’s concentrator and provide feed to the SDTSF.

The Appendices missing from the Aquatic Science report form part of the report in Appendix P of the DPEMP and are noted as such.
The risk of the mine ceasing to operate and hence to stop adding alkalinity to the Main Creek and Savage River systems are real. Redirection and or treatment of the OTD seeps would be required if the mine were to stop operating. This is currently the case for the MCTD. The SDTSF proposal does not change this status.

### 7.3 Earthquake Risk

*Geoscience Australia has a limited record of earthquakes in the vicinity of Tasmania, over the last century (Shown in a figure not reproduced here). It is unclear whether the MCTD or the OTD have the same capacity as the SDTSF to withstand earthquakes.*

*Does stacking these dams in the same catchment change the earthquake risk profile of the SDTSF, i.e. if the OTD failed could it cause the MCTD and subsequently the SDTSF to fail.*

As noted in Section 6.9 of the DPEMP, the SDTSF has been designed to ANCOLD standards which include assessment for appropriate earthquake loadings. Grange understands that the MCTD and the OTD, which are sited above the SDTSF in the catchment, were also built to such standards. The OTD, in particular, is part of the legacy pollution on site and is under the control of the Crown via the SRRP. At Grange's request the SRRP has had OTD assessed at which time it was determined to be safe.

### 7.4 SD Water Quality – Destratification

*The following questions were raised:*

*Is the water chemistry understood through the whole water column?*  
*Could the elevated copper concentration identified in Figure 110 of the DPEMP be a result of destratification?*  
*If so, could South Deposit dewatering result in a high metal loading to Main Creek.*

This has been addressed in Section 5.16 South Deposit Water Quality.

### 7.5 Waste Rock Characterisation

*The representation notes that ‘nearly one fifth of the waste rock from South Deposit was potently acid forming.*

*Has enough modelling and assessment been undertaken to adequately characterise the resource and waste rock around South Deposit.*

Grange has previously mined South Deposit and understands the resource and waste rock around the resource. When South Deposit was first mined between 2000 and 2004, the waste rock models estimated that 20% of the waste would be PAF (D-type). Reconciliation during mining showed that 19% of the waste was PAF. This was mainly found to the west of the western ore lens. The current mine plan for South Deposit shows that 2% of the total waste rock is expected to be PAF. Given the previous reconciliation Grange is confident of these figures.
6.6 Sediment Control

The following concerns were raised:

Piling muddy waste rock into Main Creek is likely to cause a significant sediment discharge;
and

Given the incident of 11 March 2013, there does not seem to be enough consideration of sediment control during construction and operation of the SDTSF dam.

The construction of the dam will see similar techniques and sampling methods employed to that used to construct the Broderick Creek flow through. This has not resulted in high TSS loads during construction or operation. There is a water quality monitoring station located at a point that will be downstream of the dam and there is a good record of baseline conditions in lower Main Creek, this will provide real time data for managing turbidity and changes in water quality as it occurs. Regular water sampling and analysis will be conducted at the points noted in the DPEMP.

The high turbidity event in the Savage River on or before the 11 March 2013 was caused by an isolated extreme rainfall event in the upper Savage River catchment and was not influenced in any way by the Savage River Mine.

7.6 Use Unclear on Closure

Future Land Use in unclear. Will the SDTSF dam be suitable for recreational purposes.

Are there any positive aspects from storage of tailings in a dam, such as a future resource.

Considers that if tailings are discharged down a valley, then it would be more difficult to recover.

The SDTSF has not been designed to be suitable for recreational purposes and in part the relatively shallow water cover over the tails would preclude recreational uses.

The storage of tailings in dams is designed to prevent the oxidation of sulphides. Future resource opportunities normally occur when the ore bodies being processed contain valuable metals that are not extracted by ore processing. The Savage River magnetite ore body does not contain any recoverable quantities of such metals. It is therefore not expected that any recovery will occur.
7.7 Closure Strategy

The following issues were raised with regard to the closure of the SDTSF and MCTD:

- The closure strategy for the MCTD and the SDTSF seem uncertain, i.e. a minimum 2 m deep permanent water cover and / or covering with depyritised tailings. How thick will the covering of depyritised tailings be?
- It will be a challenge to maintain the necessary water cover once mining has stopped, especially during summer when there will be limited inflows, whilst also ensuring the water level is at least 0.5 m above the B Dump collection pond.
- There seems to be some disparity between the Environmental Protection Notice requiring a 1 m water cover over the MCTD, and a recommended 2 m water cover.
- The DPEMP indicates there were stability issues with regard to the South Deposit pit. Will South Deposit pit become a water holding dam? Are approvals required for this water storage?

Grange has committed to a minimum of 2 m water cover over the tailings on closure and has provided water balance models in the DPEMP and in this Supplementary (Section 5.15.3 Early Closure Water Balance) to show that this will be achievable other than during the three driest months on record if experienced back to back. After this time inflow would again cover the tailings to a greater depth. Grange would consider the use of depyritised tailings if research and trials were to show that this was feasible. Any cover would be required to provide the same result or better than the 2 m water cover.

The current operating EPN requires a 1 m water cover over the MCTD at closure. Grange is proposing a 2 m water cover for the SDTSF at closure.

Stability issues within the South Deposit pit are the result of the mining process. There has been no failure within the pit since mining ended. The South Deposit pit does and will in the future hold water. It is not a water holding dam and does not require approval as a water storage under relevant legislation as it is not situated in a watercourse.

7.8 Fauna

Concerned that there is a risk to wildlife of establishing large standing water bodies, either as a barrier to terrestrial fauna or health risk for water birds.

This has been addressed in Section 5.17 Risk to Wildlife from SDTSF Water Body.

7.9 Greenhouse emissions

The following issues were raised:
Consider further assessment could determine the loss of carbon from forest clearing and neutralisation reactions.
The DPEMP estimates "assuming a 35 Mt SDTSF dam mass, losing 700 tpa due to neutralisation". Representor considers some of the loss will be CO2.
Consider blasting is also likely to be a significant contributor to greenhouse gas emissions. Suggests it isn’t possible to determine the cumulative (additive or synergistic) effects without considering the pros and cons of the operation as a whole.

Carbon ‘loss’ will be negligible from land clearance and neutralisation reactions. Up to 145 ha will be either cleared or submerged by the construction of the SDTSF, the logs with
merchantable value will be removed for further use, mostly as speciality timbers, and no timber/vegetation will be burned, therefore much of the carbon will be sequestered. Grange does recognise that the dam will prevent the existing vegetative communities taking up more carbon; however, once the mining of South Deposit – including the associated waste rock dumps and haul roads – is complete the area will be rehabilitated as per Grange’s standard for Closure and Rehabilitation and the Environmental Rehabilitation Plan. This rehabilitation will be monitored to ensure adequate germination of all plant species seeded and should eventually offset the disturbance caused by the construction of the dam. Ultimately only the tailings dam water body, pit walls and some PAF cells in waste rock dumps will remain un-vegetated.

Grange also recognises that the neutralisation reactions will release some carbon dioxide back into the atmosphere. Based on current acidity loads Grange expects approximately 4,000 to 6,000 tonnes of CO$_2$ per year over the next 15 years could be released to the atmosphere from neutralisation reactions in the SDTSF as legacy ARD is mixed with Grange tailings.

It should be noted that 60% of the total acidity is already neutralised through a similar process in the MCTD and therefore the increase by this project will be negligible. Grange contends that the environmental benefits of neutralising the acidic seeps far outweigh the negative effects of carbon dioxide emissions, neutralisation of both seep sources should contribute to a much improved biological outcome for Main Creek and remove a chemical barrier from the Savage River (at the confluence of Main Creek and Savage River). Currently the chemical barrier would be most pronounced during the drier months if the MCTD is not decanting (in which case acidic seeps from B dump become a higher proportion of total flows).

As the SDTSF will be built using waste rock from the mining operation there will be no increase to greenhouse gas emissions from blasting due to the construction of the dam.
7.10 Proposal Alternatives

The representor notes the following:
The SRRP newsletter 4 June 2012 outlines a strategic direction towards the use of thickened tailings and further research and development of the carbonate neutralisation reactor.
The SRRP indicate that best practice may have been to use thickened tailings which would give greater tailings storage and less habitat loss than the proposed SDTSF.

The representor makes the following comments:
The use of thickened tailings and further research and the development of a carbonate neutralisation reactor would be limited by the SDTSF proposal.
The SDTSF proposal sees to force the SRRP to install additional infrastructure that they may not have the resources to maintain.

The representor notes that the Peer Review seem supportive of the proposal, which states “the SDTSF proposal utilising the alkaline and NAF waste rock to be excavated from the South Deposit Pit extension, is the optimal approach for the Savage River Mine and for the SRRP.” The representor comments that this opinion is not on all the relevant aspects, but parts of the preferred design and geochemistry. The representor further comments that it may be the optimal approach for the Savage River mine, being the cheapest option, but questions whether it is the optimal approach for the SRRP.

Further work on thickened tailings and carbonate neutralisation is not limited by the SDTSF proposal. Since the SRRP 2012 newsletter to which the representation refers, the SRRP has received further reports on the viability of thickened tailings. These are referred to in the DPEMP and have shown that the production of thickened tailings is not economically viable currently.

The SRRP has noted that co-treating the legacy seeps in the SDTSF represents the best value for money for the SRRP, as it offered a low-cost method to treat the ARD for a further 20 years.

The construction of the OTD gravity-fed transfer scheme (or something similar) would have been required regardless of the SDTSF project, in order to close the MCTD and minimise the long-term risk posed by the OTD tailings. The legacy ARD seeps emanating from the OTD will need diversion from the MCTD by the SRRP, by late 2016, regardless of whether the SDTSF proceeds.

7.11 OTD and B Dump Seeps

There is a significant likelihood that seepage from the OTD and B Dump will speed up acid drainage generation in the SDTSF, with a risk of serious environmental harm and liability for the Tasmanian community.

The current MCTD successfully treats the OTD seepages during normal mill operations. It therefore follows that with the transfer of the OTD seeps and the tailings outfall to the SDTSF a similar situation will be in place. The added input from the B dump seeps is expected to be handled by the spare alkalinity in the system.
7.12 Water Quality and Ecological Studies

Notes that the DPEMP states "...ecological receptors will include significant aquatic, marine and terrestrial species and habitats." Suggests that the study should extend further then Main Creek and look at water chemistry and ecology within Savage River and beyond.

Considers that, given the impacts from the 11 March 2013 incident extended to Corinna, a broader study sees necessary.

Notes that a number of studies included in the DPEMP do not extend to the present, i.e. are potentially out of date. For example, Figure 6 only extends to January 2012.

The following issues were raised with regard to Figure 6 of the DPEMP, copper concentrations in Savage River:

- The location was not clearly specified (i.e. on a map)
- If this is to demonstrate the water quality of the receiving environment (from Main Creek) then further characterisation is required; and
- The units are total mg/L, which is not particularly meaningful without total suspended soil or dissolved phase concentrations.

Notes that the SRRP has set environmental targets based on toxicological studies conducted back in 2001 (Davies 2001). With regard to this study, it is unclear what species were used or if there are more recent studies.

The water quality data in the DPEMP concentrates on Main Creek because this is the primary recipient of water from the proposed SDTSF and also will benefit the most from the water quality improvements the SDTSF will provide. The DPEMP notes water quality in the Savage River as well as improvements in that water quality in the past decade. Davies (2001) undertook an eco-toxicological study commissioned by the SRRP. The targets developed by that study remain the environmental targets of the SRRP and have been endorsed by the EPA Board.

Biological monitoring is conducted every 3-4 years by the SRRP. This has shown a gradual improvement over time in Main Creek. This is presented in Figure 25 and Figure 26 for Fish and Ceriodaphnia.

Figure 6 in the DPEMP is the Savage River at Pump Station Site (SRaPS) and its approximate location can be seen in Figure 56 of this supplementary. Historically pollution from North Dump and the OTD North Slot have entered the Savage River upstream of this site, the North Dump Drain diverted the pollution from North Dump to South Lens where it is treated. There are no mining activities on the river upstream of this monitoring point.
7.13 Hazard Standards and Environmental Management Systems

Notes that the DPEMP states while a number of major hazard standards have been drafted up these have yet to be fully implemented at the Tasmanian operations.

Commented that, for an operating mine it is surprising that Grange only intend to undertake aspects of the ISO 14000 family of standards, when they surely should have a functional environmental management system.

ABM Cares and later Grange Cares provided functional Environmental Management Systems (EMS) that meet the requirements of the ISO 14000 series. ABM Cares was developed after operations recommenced in 1997, this transitioned to Grange Cares when Grange merged with ABM in 2009. Grange is now developing an integrated Safety and Environmental Management System (SEMS) which will meet requirements of the ISO 14000 series, but will focus primarily on the areas that are core components for Grange’s operations. The new SEMS will have 11 key standards, from which Grange procedures, compliance, audit tools and operating procedures will be re-developed to align with the standards which will set down best practice environmental management, and will require Grange to review and revise practices at regular intervals over the life of the SEMS.

To fully comply with the Work Health and Safety Act 2012 which came into effect in Tasmania from 1 January 2013 Grange has developed major hazard standards within the SEMS and is now working on the standards for the environmental side of SEMS.

7.14 Monitoring and Maintenance

The following concerns were raised:

- Grange seems to have budgeted for a five-year post-closure monitoring and maintenance program rather than a consideration of work/costs in perpetuity.
- Table 84 for instance indicates annual weed management would be $4k while annual water monitoring $25k; while there are other ongoing costs such as dam inspections and maintenance.
- It isn’t clear if Grange is undertaking continuous ambient water quality monitoring downstream.
- Grange’s capacity to monitor, assess and report incidents is under question, as evidenced by a recent Tasmanian Times article, where an incident involving the release of a large quantity of turbid water in 11 March 2013 was only reported to Authorities in 14th March 2013, following complaint from the public.

Grange has committed to complying with the current EPA requirements regarding mine closure. Grange anticipates that these standards will have changed by 2030 when the operation is currently scheduled to close.

7.14.1 Grange’s ability to monitor

Grange has a sophisticated method to log and track environmental incidents, the intranet-based Grange Resources Integrated Database (GRID), which provides a reliable and easy means of recording and investigating incidents of all natures, including environmental incidents. Since GRID was implemented, Grange has seen a steady improvement in the way
incidents are reported and investigated internally. Grange is aware of its obligation to report incidents to the EPA within a specified timeframe and complies.

Grange and the SRRP (jointly) have a network of real-time water monitoring stations situated at key points on the mine site, logging key parameters such as flow, turbidity, pH and conductivity in real time. The data is provided to both Grange and the SRRP through an Entura website. This data is reviewed daily (previous 24 hours) by mining operations, with rainfall, turbidity and flow in the Main Creek and Savage River catchments of particular interest and concern. Sites on the Savage River upstream of operations, the outflow of Broderick Creek, the outflow of the Main Creek Tails Dam and Main Creek at South Deposit form the basis of the daily review. Any anomalies are investigated and, if need be, an incident report raised. Data from these monitoring stations was provided to the EPA as part of the investigation into the tailings dam incident.

7.15 Risk Assessment

The following comments were made:

Leopold’s matrix (Table 42) might be appropriate for preliminary work, but not in a final DPEMP, unless the components in the matrix related to specific sections in the report.

The risk assessment in Table 43 uses different criteria to that in Table 72. Table 43 is simplistic. Some of the items and comments are unclear. For example, aspect 2.1 identifies potential issues from greenhouse gas emissions from combustion engines, with the consequence as "addition to global warming. Tasmania is a greenhouse positive state with hydro power." Further clarification is required.

Despite most controls, it is apparent that there will be a medium risk of environmental harm resulting from this project.

Grange believes the risk assessments carried out for the DPEMP were standard practice. They included preliminary assessments to identify environmental aspects and issues, follow-up assessment to evaluate the potential impacts and those impacts remaining after mitigation measures had been applied, and engineering risk assessment on the actual dam and its construction. The project was also subject to a high level Peer Review process.

7.16 Goldamere Pty Ltd (Agreement) Act 1996

Notes that the Goldamere Pty Ltd (Agreement) Act 1996 refers to the "leased land means the land of an area not greater than the subject of mining lease no. 44M66 and supplemental leases SL1 to SL12." If these mining leases do not exist what parts of the Goldamere Pty Ltd (Agreement) Act 1996 are still relevant.

‘Leased land’ is defined in the Goldamere Pty Ltd (Agreement) Act 1996 which in part states:

“leased land means the land of an area not greater than the subject of mining lease no. 44M66 and supplemental leases SL1 to SL12 (inclusive) granted to PMI (unless otherwise agreed by the Crown) which is or will be the subject of the mining lease issued or to be issued to ABM (and any renewal thereof) under Part 4 of the Mineral Resources Development Act 1995. ”

The Goldamere Pty Ltd (Agreement) Act 1996 applies to ABM’s (and now Grange’s) current mining lease 11M/2001 which covers the area described above.
7.17 **Best Practise Environment Management**

The DPEMP states the operation is to be managed in accordance with best practice environmental management (BPEM). Perhaps Grange are trying their best and looking to BPEM, but perhaps not the best example of best practice in mining.

Grange under Goldamere, its EPN and EMPCA 1994 is required to operate to Best Practice Environmental Management.

7.18 **Grange and State Responsibilities With Respect to ARD and Water Quality**

The following comments and questions were raised with respect to responsibility for AMD and water quality:

- The separation between Grange and State responsibilities for acid mine drainage is not clear.
- Grange seems to be manoeuvring for co-treatment at the SDTSF, to eventually pass to the State.
- Given the State have limited capacity for finding mining remediation, this wouldn’t be a good deal.
- From the SRRP’s initials $24 million (from 1997) the DPEMP infers the remainder would not be able to find acid drainage treatment in perpetuity. While the proposal would defer some of the treatment options for the SRRP, ongoing costs of the SRRP (research projects etc.) are likely to drain the remaining funds, until there is not SRRP.
- If a natural source of water could speed up Grange’s tailings going acidic, such as from a swamp, wouldn’t Grange be responsible for diverting that water, building a barrier or adding alkalinity to their water/tailings.
- If the State uses South Deposit pit to treat acid drainage, does this divest Grange’s responsibilities.
- While Grange acknowledges that the downstream water quality is a concern they claim they have no legal responsibilities for mitigation of water quality impacts.

The following comments were also made:

- For the abandoned mines that the State has responsibly, the State should be able to decide whether or not to take action. If Grange places the Main Creek Tailings Dam (MCTD) where there are acidic seeps, the seeps should be managed by Grange, and not be a mechanism for Grange to try and divest responsibilities.
- In considering the context in which this statement was given, it is likely that the representor meant the "South Deposit Tailings Storage Facility: and not the Main Creek Tailings Dam".

Section 8 of the *Goldamere Pty Ltd (Agreement) Act 1996* notes:

8. The EMPCA, the Land Use Planning and Approvals Act 1993, the Resource Management and Planning Appeal Tribunal Act 1993 and any other Environmental Legislation is to apply and to be applied to the Project on the basis that –

(a) ABM is not responsible, and is not to be held responsible, for any contamination, pollutant or pollution on, beneath or emanating from the Leased Land which has been caused or introduced to the Leased Land by Past Operations; and
(b) ABM is not responsible, and is not to be held responsible, for any contamination, pollutant or pollution on, above, beneath or emanating from the Leased Land which is or has been caused or introduced to the Leased Land on or after the commencement of the Agreement by PMI or the Crown or any person performing work for PMI or the Crown; and

(c) a term, condition or restriction imposed in any Authorisation given to ABM in relation to the Project must not require ABM to meet measurable environmental standards in respect of water quality, soil contamination or any other criterion which may be affected by contamination or pollution caused or introduced to the Leased Land before the commencement of the Agreement, but should impose management requirements which are based on the principles in paragraph (a), Best Practice Environmental Management and the principles in clause 5 of the Agreement.

The Goldamere Act provides in effect that Grange cannot be made responsible for dealing with the consequences of the previous pollution.

### 7.19 Abandoned Mines Trust

The Rehabilitation of Abandoned Mine Lands Trust Fund could conceptually be another State group to undertake works, however their budget has been significantly reduced to where it would struggle to resource the sites it has already taken on, let alone other legacies.

As the SDTSF is part of an existing mine which is being operated by Grange Resources and the legacy areas of the mine are being remediated through a partnership between Grange and the SRRP, and because the SRRP has its own budget, this comment is not applicable to the proposal.

### 7.20 Bond

It is unclear whether the financial provision (bond) held by the State against all of Grange’s environmental liability is $2.8 million or if this is just for the SDTSF.

Notes that the bond seems too small against the potential liability.

The principal financial assurance held by the State for the Savage River mine has been set under the provisions of the *Goldamere Pty Ltd (Agreement) Act 1996* and in accordance with the *Environmental Management and Pollution Control Act 1994*. 
7.21 Peer Review

The following comments were made with regard to the peer review:

- The peer review may have commented on a draft DPEMP rather than the final DPEMP.
- The peer review report seems to provide endorsement of GHD’s work rather than providing technical details. It showed pictures of a coal mine, but how about calculations? ... If they designed it right, build it right and operate it right and it works as it was intended, then it should be alright?

- World precedents for the SDTSF concept identified by the Peer Review panel include examples, but the success of these is unclear. Discharging tailings or images of people panning discharging tailings, as may be the case in New Guinea, may not be the look of BPEM that would be acceptable in Tasmania.

- An intriguing aspect of the peer review is an endorsement of a number of Grange personnel, apparently critical to the success of the project:
  - Stephen Kent actually from Caloundra Environmental Pty. Ltd. (Caloundra). The credentials and role of Caloundra are unclear, assumedly substantially responsible for the preparation and submission of the DPEMP, the references (section 15) only lists Caloundra as solely responsible for a noise and lighting survey.
  - Bruce Hutchison, Senior Geotechnical Engineer, with considerable experience.
  - Ross Carpenter, General Manager Mining and Projects, for six months (previously unemployed for 9 years?) and Daniel Lester, Environmental Officer, for three years.

- The review specifies a commitment from Grange Management and owners is important. Who these are in unclear although the recent Grange policies show Ben Maynard is the General Manager (operations); or has been for about three months.

Issues regarding the timing of the Peer Review were addressed in Section 5.12 Peer Review Report Inconsistencies.

The reviewers – Professors Williams and Wilson and Dr Taylor – have almost 80 years of combined experience in mining, major civil construction and ARD related areas. They also have a long association with site personnel through the conduct of independent reviews for the SRRP since 2002. Grange respectfully suggests that their endorsement of the experience and skills of Grange personnel is valid.

Stephen Kent worked for ABM at Savage River Mine from 1996 until 2005 as HS&E Manager and subsequently has been the principal environmental consultant for the mine.

Ross Carpenter has been with the company for a considerable time but has been in his current role for 6 months and has extensive experience in Mining and Mine Management.

Ben Maynard is another who has been in the company since 1997, working in IT, Geology and more recently as Technical Services Manager, before becoming the General Manager in March 2013.

Grange Resources (Tasmania) Pty Ltd, formerly called Goldamere Pty Ltd, Australian Company Number 073 634 581, is an Australian proprietary company limited by shares.
Grange is a subsidiary of Grange Resources Ltd which is a public company listed on the Australian Stock Exchange.

**7.22 Grange Personnel**

It seems the team playing a key role to the operation has only limited experience, which is of concern if the mine moves into its closure phase.

As with all companies, Grange staff changes from time to time. Key personnel in the construction and operation of the SDTSF have been working with and for the company at Savage River since 1998.

**7.23 Clarity of DPEMP report**

Notes that there is substantial replication between the appendices and the body of the DPEMP.

Comments that this replication makes it difficult to separate the content of individual consultant reports, from an overall synthesis of issues and risks and what Grange Resources Pty Ltd (Grange) have done and intend to do.

Notes that many of the replicate figures are difficult to read, and that the different styles give a lack of cohesion.

The Appendices to the DPEMP contain the studies and engineering design associated with the project. Of necessity, the contents of these studies form a significant part of the DPEMP in describing the project, the baseline environment, the impact of the project and the mitigation of impacts.
8 REFERENCES


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9 LIMITATIONS OF REPORT

Purpose of Report

Caloundra Environmental Pty Ltd (‘Caloundra Environmental’) has prepared this document titled ‘Grange Resources (Tasmania) Pty Ltd; Savage River Mine; Development Proposal and Environmental Management Plan; South Deposit Tailings Storage Facility’ (the ‘Report’) for the use of Grange Resources (Tasmania) Pty Ltd (the ‘Client’).

Limitations of Report

The Report must be read in light of:

- the readership and purposes for which it was intended;
- its reliance upon information provided to Caloundra Environmental by the Client and others which has not been verified by Caloundra Environmental and over which it had no control;
- the limitations and assumptions referred to throughout the Report;
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