HONEYMOON PROJECT

PROPOSED

RADIOACTIVE WASTE MANAGEMENT PLAN

Radiation Protection and Control Act 1982
Licence to Mine or Mill

<table>
<thead>
<tr>
<th>DATE</th>
<th>VERSION/REVISION</th>
<th>APPROVED</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 2006</td>
<td>Draft – for submission with licence application</td>
<td>Brian Lancaster</td>
</tr>
</tbody>
</table>
## CONTENTS

1. **INTRODUCTION**  
2. **RADIOACTIVE WASTES**  
   2.1 Solid Wastes  
   2.2 Liquid Wastes  
   2.3 Gaseous and Airborne Wastes  
3. **WASTE MANAGEMENT**  
   3.1 Solid Wastes  
   3.2 Low Level Radioactive Waste Disposal Facilities  
   3.3 Liquid Wastes  
   3.4 Managing Liquid Wastes  
   3.5 Airborne Emissions  
   3.6 Equipment Failures  
   3.7 Temporary Suspension of Operations  
4. **MONITORING PROGRAM**  
   4.1 Environmental Monitoring Program  
   4.2 Operational Monitoring Program  
5. **AUDIT AND REPORTING PLAN**  
   5.1 Audit  
   5.2 Quarterly Report  
   5.3 Annual Report  
   5.4 Wellfield Plans  
   5.5 Solid Radioactive Waste Disposal Facilities  
   5.6 Incident Reports  
6. **CLOSURE AND REHABILITATION STRATEGY**  
   6.1 Residual Chemicals and Organic Materials  
   6.2 The Process Plant  
   6.3 Wellfield  
   6.4 Uncontaminated Equipment & Buildings Outside the Process Plant Area  
   6.5 General Scrap/Rubbish  
   6.6 Disposal Sites  
   6.7 Rehabilitation  
   6.8 Monitoring  
7. **REFERENCES**  

APPENDIX 1  
Modelling  
APPENDIX 2  
Incident Reporting Procedures
1 INTRODUCTION

This Radioactive Waste Management Plan (RWMP) has been prepared as supporting documentation for the licence application under the Radiation Protection and Control Act 1983 for the Honeymoon Uranium Project. The document has also been designed to meet the requirements of the primary licence condition: Code of Practice and Safety Guide on Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing (2005). A final RWMP will be submitted to the EPA for approval prior to authorisation for construction of the plant and wellfield.

The Honeymoon project is expected to have a life of at least six years and may extend to twenty years. It is anticipated that this document will be modified as the project progresses and more is learned about the effectiveness of the proposed waste management plans. In particular the plans for the final site clearance, rehabilitation and monitoring are expected to be determined in greater detail once operating experience is available.

The Radioactive Waste Management Plan will be reviewed annually in conjunction with the EPA and, if necessary, modified as required.

Further information on the environmental aspects of the Honeymoon projects is detailed in the Honeymoon Uranium Project Environmental Impact Statement (EIS) and supporting documentation. In particular the EIS details the extensive baseline monitoring of the Honeymoon environment. Additional descriptions of the existing environment and the proposed mining operation are contained in the Mining and Rehabilitation Program prepared for PIRSA in relation to the mining lease.

2 RADIOACTIVE WASTES

The Honeymoon project will generate solid, liquid and gaseous low level radioactive wastes. Solid and liquid radioactive wastes will be retained and managed on site. A monitoring program will prevent materials from leaving the site until they have a clearance certificate showing that the surface radioactive contamination is below the limits set by the relevant authority. Gaseous and airborne emissions will be controlled to levels which will no present a hazard to employees or the general public.

The sources of low level radioactive wastes from the Honeymoon are listed below.

2.1 Solid Wastes

- Drill cuttings
- Geological samples and or cuttings;
- Soil contaminated by spilled radioactive materials;
- Plant and wellfield filters;
- Dried solids and sludges from the solvent extraction circuit
- Equipment such as pumps, valves and piping with internal surface contamination;
- Equipment such as drilling bits, water sampling pumps, and sampling probes with external surface contamination
- Laboratory wastes;
- Contaminated clothing such as overalls, gloves, and boots; and
- Other low level wastes or contaminated material.

2.2 Liquid Wastes
• Wellfield bleed stream;
• Wellfield airlift water;
• Drip tray contents in the wellfield;
• Runoff from the wellfield and plant areas;
• Solutions left in mined out areas of the aquifer;
• Plant wash down water;
• Shower and wash water from contaminated change rooms;
• Laboratory waste water; and
• Unplanned releases of liquids.

2.3 Gaseous and Airborne Emissions

• Radon released from disposal pond;
• Radon released during well development;
• Radon released in the process plant;
• Dust in emissions from the drying and packaging plant; and
• Dust from dried spillage

3 WASTE MANAGEMENT

All waste management activities will be carried out in accordance with written Standard Operating Procedures which will form part of the Project’s quality assurance program.

3.1 Solid Wastes

During production solid radioactive wastes will arise from process wastes produced in the plant, from drilling the ore body, from laboratory assay procedures, from consumables such as protective clothing and filter elements and from equipment maintenance and replacement. There is also the possibility that on occasion soils contaminated by spills and leaks will have to be collected and disposed of. These contaminated materials are to be segregated from other waste materials and disposed of in suitable low level waste repositories.

Solids effluent production from the process plant will principally be from solution clarification. A small amount will also result from the wash-down of floors. A portion of these waste materials - approximately 50% - will be sent to the retention pond along with wash down waters where it will be stored under water until the termination of the project, then buried in the pond or in appropriately designed waste facilities. The remaining 50% will be separated in the plant, neutralised as necessary, then disposed of in a low level radioactive waste disposal facility.

Drill cuttings will be buried adjacent to the drill holes. All other solid radioactive waste materials will be disposed of in specially designed low level radioactive waste facilities. Materials awaiting disposal will be accumulated on a covered, bunded pad adjacent to the retention ponds before being transferred to a low level radioactive waste facility.

3.1.1 Process Wastes

Total process solid waste production from the plant is estimated to be approximately 50 tonnes per year. Approximately 75% of this material will be sediments, scale and spillage from the process equipment. It will be pumped out to the retention ponds where it will be retained until the
completion of the project. The remaining 25% will arise from “crud” formation in the solvent extraction process.

During solvent extraction a complex mixture of solid, organic and aqueous material forms at the interface between the organic and aqueous phases. It is commonly referred to as “crud”. Conventionally this material is removed from the solvent extraction settlers, filtered to recover the organic and aqueous components leaving a damp solid residue for disposal. During the field leach trials at Honeymoon cruds formed in both the extraction and stripping settlers. The cruds were considered difficult to handle. As techniques for handling the crud were not fully investigated, further work will be required during the early stages of commercial production to establish the necessary techniques. It is believed that the conventional filtration approach will be adequate.

Cruds separated by filtration will be neutralised then sealed in 200 litre steel drums for eventual disposal in a low level radioactive waste disposal facility.

3.1.2 Drill Cuttings

A small fraction – less than 10% - of the cuttings produced when wells are drilled will contain radio nuclides. Cuttings will be disposed of in a pit adjacent to the drill hole. A mud pit will be excavated prior to drilling which will accept both the drilling mud and drill cuttings from the drill rig. The cuttings will settle out while the mud will be recirculated. Once the hole has been completed the cuttings in the pit will be covered with the material excavated from the pit to providing at least 0.6 metres of cover. The cover will be compacted under the wheels of heavy machinery before being abandoned. Replacement of original stockpiled soil and revegetation will complete the rehabilitation process

Modelling of this procedure along with field measurements have shown that this method ensures that the exposure of employees and the general public are well below safe limits.

3.1.3 Geological Samples

Geological samples are taken for a variety of purposes – assay, lithological examination, mineralogical examination, laboratory testing etc. At Honeymoon samples are only taken from core holes and core holes are rarely drilled. Samples are normally derived by splitting the core, retaining part of the core on site and shipping the remainder off site for examination or testing. The core retained on site is stored in a segregated area for low level radioactive waste. The samples shipped off site are suitably packed and checked for surface activity to ensure they are safe to handle before being cleared to leave the site.

Once the core samples are no longer required they will be disposed of in the low level waste disposal facility. Waste from the samples shipped off site will be accepted for disposal at the Honeymoon site.

3.1.4 Maintenance Wastes

Plant and wellfield maintenance will produce a range of contaminated waste materials such as pipes, valves, gaskets and unserviceable equipment. Wherever possible such materials will be decontaminated for recycle, however in most cases it is expected that the materials will have to be disposed of on site. The materials will be decontaminated on a wash down pad which drains into the retention ponds. Those materials which are adequately decontaminated will be segregated for possible recycle.
The smaller contaminated items will be collected and stored in 200 litre steel drums ready for disposal. Larger contaminated items will be disposed of directly in a low level radioactive waste disposal facility. These wastes will be held in a temporary storage area – a covered and bunded holding pad – prior to disposal.

### 3.1.5 Miscellaneous Solid Wastes

Small amounts of radioactive wastes will be produced during the operation of the wellfield, the process plant, and the laboratory. Specially marked bins – 200 litre steel drums – will be provided in various locations throughout the site for collecting these waste materials. These bins will be routinely checked and when full will be transferred to the holding pad prior to disposal in a low level radioactive waste facility.

### 3.1.6 Contaminated Soils from the Plant and Wellfield

Soil which has been in contact with mining or process fluids as a result of spills or leaks will be radiometrically surveyed. A decision will then be made in consultation with the EPA to either leave the soil in place or remove it for burial. If it is to be removed for burial it will be promptly excavated and temporarily stored in a bunded area. The pile of contaminated material will be covered to prevent dusting. At the appropriate time the material will be disposed of in a low level radioactive waste disposal facility.

### 3.2 Low Level Radioactive Waste Disposal Facilities

#### 3.2.1 Retention Ponds

The retention ponds will be located above the 100 year flood plane and constructed in accordance with the EPA guidelines for “Wastewater and evaporation pond construction” They will be approximately 5 metres deep, constructed with a base of compacted clay and a 2 mm thick polyethylene liner. At the conclusion of the project the solids accumulated in the ponds along with other solid wastes arising from decommissioning will be buried. Depending on the activity of the solids, burial will either be in the decommissioned pond itself or in specially constructed disposal pits. The wastes to be buried in the pond will be covered with at least 300 mm of compacted clay, the liner folded over the top of the compacted clay; a 2mm HDPE membrane will be placed to completely cover the compacted clay; a further one metre of clay will be spread over the top of the membrane; and the pit will be capped with one metre of soil to sit at least 300 mm above the surrounding landscape and will be profiled to avoid pooling and conform with the local topography. The disturbed area will then be revegetated as part of the site rehabilitation program. On closure, each pond will have an internal inspection line to detect water intrusion and provision for an external monitoring bore to detect movement of contaminated liquid from the pond.

#### 3.2.2 Solids Disposal Pits

During the operating phase of the project the solid low level radioactive wastes which are generated – predominantly maintenance wastes and miscellaneous solid wastes - will be permanently disposed of by burial on site in appropriately designed pits. These disposal facilities will be located in an area which is level, is above the 100 year flood plane, is not subject to stream erosion and is comprised of relatively impervious clays. The soils of the Honeymoon area will be surveyed to identify suitable sites and the choice of the disposal areas made in consultation with the EPA.

As the solids waste will accumulate relatively slowly and as it is undesirable to hold radioactive wastes for extended periods the wastes will be regularly disposed of in a series of facilities. Waste
awaiting disposal will be accumulated in an interim storage area which will consist of a covered, bunded pad located adjacent to, and draining into the retention ponds.

The waste disposal facilities will be small pits approximately 10 metres long, 10 metres wide and 5 metres deep. Deeper pits may be required for more active wastes. The walls of the pits will be lined with a 2mm thick high density polyethylene (HDPE) membrane which will extend at least one metre across the floor of the pit. The floor of the pit, including the extension of the liner will be covered with at least 300 mm of compacted clay. The floor of the pit will slope towards one corner, which will act as a sump.

Arrangement of the wastes in the pits will depend on the type of waste to be disposed of. Generally, drums of waste will be arranged around the perimeter of the pit, stacked no more than two high. Other wastes will be stacked in the centre of the pit and loose materials such as contaminated soil will be spread to fill the interstices.

When a pit has been filled with wastes, soil will be spread over the waste to fill any remaining voids; approximately 300 mm of clay will be spread over the waste and compacted; the liner will be folded over the top of the compacted clay; a 2 mm HDPE membrane will be placed to completely cover the compacted clay; a further one metre of clay will be spread over the top of the membrane; and the pit will be capped with one metre of soil to sit at least 300 mm above the surrounding landscape and the edges profiled to conform with the local topography. The disturbed area will then be revegetated as part of the progressive site rehabilitation program. Each pit will have an internal inspection line to detect water intrusion. The disposal pit area will have provision for monitoring bores to detect movement of contaminated liquids from the pits.

The site of each abandoned pit will be appropriately marked and recorded.

3.3 Liquid Wastes

The mining solutions that remain in the mined out areas of the ore body will be left in place.

Liquid wastes streams which arise from routine plant and wellfield operations will be contained and will be directed to the retention ponds from where they will be disposed of by injection into the basal sands of the Eyre Formation. Spills, runoff and other unplanned but anticipated liquid wastes will be contained within the wellfield and/or the process plant by bunding and transferred to the solids retention ponds as necessary. Unanticipated leaks or spills are to be contained by temporary bunding then transferred to the retention ponds as necessary. The retention ponds will be lined with compacted clay and fitted with high density polyethylene liners and a leak detection system.

3.3.1 Overproduction

In the Honeymoon wellfield the production well pumping rate is greater than the injection rate. This ensures the maintenance of a positive hydraulic gradient towards the production wells and thereby prevents excursions of leach solution from the wellfield. To avoid unnecessary drawdown of ground water from overlying aquifers and undesirable dilution of the leach solution, the overproduction is limited to 0.5% to 2% of the injection rate, with an average rate of approximately 1%.

The overproduction is removed as a ‘bleed’ stream from the barren solution after removal of the majority of the dissolved uranium in the process plant. It will be directed to the retention ponds and will be disposed of by reinjection in to the Basal Sands of the Eyre formation.
3.3.2 Waste Water

Water is used within the plant area to wash down equipment and vehicles, to wash down spills within the plant and for change-room shower, washing and laundry water. These waste streams pass via sumps to the retention ponds from where they will be disposed of by reinjection into the Basal Sands of the Eyre formation.

3.3.3 Reverse Osmosis Brine

Production of potable water by a reverse osmosis plant for camp and process requirements will result in a discharge brine stream. The discharge brine will contain ground water salts separated from the potable water at concentrations comparable to Basal Sands ground water. This brine will be pumped to a disposal well.

3.3.4 Well Airlift Water

Water produced during the airlifting of water from newly drilled wells will be transported to the retention ponds. The water will then be reinjected into the Basal Sands of the Eyre formation. Modelling of the exposure of employees during the air lifting predicts that the dose rate will be below 0.0004 mSv/h (Appendix 1).

3.3.5 Drip Tray Water

Waters caught by the wellfield drip trays will be collected periodically and transferred to the retention ponds.

3.3.6 Runoff

Rainfall at the Honeymoon site is infrequent and most falls do not result in any runoff. Any rainwater runoff from mining areas during or following a rainstorm will be prevented from escaping the well field by a series of bunds which will drain the runoff to low points for collection. Any rainwater captured will either be evaporated or collected and removed to one of the solids retention ponds. The location of the bunds, which will be progressively constructed as the wellfield is developed, will be determined as part of the wellfield development program.

3.3.7 Spills

The plant, trunklines, and wellfield will be bunded to contain spills. Spills within the bunded areas of the plant and wellfield will be collected and transferred to the retention ponds. Spills of contaminated water beyond the bunded areas will be contained (if possible) by temporary bunds then collected and removed to the retention ponds.

Standard operating procedures will be developed for the plant and well-field which minimise the potential for accidental releases of process liquors.

3.3.8 Excursions of Solutions from the Mining Zone

Mining solutions are retained within the mining zone by over production as noted above. This technique, supported by flow modelling and a monitoring program will ensure that excursions are minimised; that excursions which do occur are detected early; and that prompt corrective action is taken if and when excursions do occur.
Monitor wells will be installed in and above the basal sands surrounding the mining zone to detect changes in ground water quality and thus give an early warning of any horizontal or vertical excursion of mining solutions. The monitor wells will be spaced 125 m apart to comply with specifications detailed in the Environmental Impact Statement (Southern Cross Resources 2000). Authorisation will be sought for changes to monitor well locations. A map indicating monitor well locations will be provided annually at the time of licence renewal.

An excursion is defined from the guidelines of the US Nuclear Regulatory Commission (NUREG—1569, 1997) viz:

*An excursion will be deemed to have occurred if any two excursion indicators in any monitor well exceed their respective Upper Control Limit (UCL), or a single excursion indicator exceeds its UCL by 20%.*

Based on NUREG recommendations, four parameters have been selected as indicators; pH, conductivity, sulphate concentration and uranium concentration. These are all parameters that can be simply and rapidly determined in the site laboratory. Control limits will be set in consultation with the EPA. Excursions will be reported as Incidents (see below).

Experience gained during the operation of leaching trials at Honeymoon suggests that excursions can be readily corrected by increasing the amount of overproduction in the vicinity of the excursion. This technique, guided by flow modelling will be used to correct any excursions encountered at Honeymoon.

### 3.4 Managing Liquid Wastes

All liquid wastes from the plant and the wellfield will be directed to a retention pond. From there they will be disposed of intermittently by re-injection into the basal sands of the Eyre Formation via approved disposal wells, and in accordance with the conditions of Mining Lease 6109. Monitor wells will be used to ensure that the reinjected solutions are retained within the basal sands. Mining solutions which remain in mined out areas will be left in place. Proposed disposal well and monitor well locations are shown in figure 3.1.

Overseas experience with acid ISL indicates that natural attenuation will eventually return the liquid wastes and mining solutions in the Basal Sands to pre-mining conditions. However it is not possible to predict the time frame. A review of environmental impacts of acid in-situ leaching conducted by CSIRO Land and Water for the South Australian Government recommends this management approach. Existing groundwater baseline conditions will be established prior to the commencement of liquid disposal.

Long term monitoring of closed out wellfields and liquid waste disposal locations will be conducted as required, to determine the composition and movement of the liquid waste disposal plume.
3.5 **Airborne Emissions**

The Honeymoon project will produce small quantities of airborne radioactive wastes which will arise from the radon emissions from various process solutions and from radioactive dusts produced in the product drying plant and possibly from the dusting of dried spillage.

### 3.5.1 Radon

Radon will be produced from three main sources:

- ground water discharged during drilling and well development.
- circulation of pregnant and barren solution through the plant;
- bleed streams discharged into retention ponds;

Radon release and dispersion modeling produced during the EIS process along with measurements made during test plant operations have established that radon levels will be low within the plant and mining area and will not present any hazard to employees or the general public (Appendix 1).

Piping and valves will be sealed. Therefore, operating wells will not release radon; however, once the pregnant solution reaches the process plant, radon will be released at various stages of treatment. It is expected that the majority of dissolved radon will be released as the pregnant solution enters the first storage tank. This tank along with all other relevant storage tanks and process vessels will be vented through plant stacks by means of radon extraction systems.
Solutions in the plant ponds will contain dissolved radon which will escape from the surface of the ponds. In addition solid residues, water and salt precipitates in the solids retention and storage ponds will contain radium from which radon gas will be generated as a product of radioactive decay. The ponds are expected to be only a minor source of radon.

By controlling the pH of the solutions in the ponds, precipitation and accumulation of radium-bearing solids will be minimised. Radon releases will also be minimised by maintaining a water cover over solids in these ponds.

3.5.2 Dust from drying and packaging dust extraction systems

Uranium containing dusts will be produced in the yellowcake drying and packaging area of the process plant. The area will be equipped with dust extraction systems which will vent emissions through a bag house and a high efficiency filter. This will ensure that virtually all airborne particulates are removed from the waste streams before they are emitted through a stack above the drying facility. Routine particulate sampling in the drying and packaging areas along with sampling of stack gases will ensure that particulate levels are appropriately managed. Modelling of dust emissions predicts that the emissions will not pose a hazard to employees or the general public (Appendix 1).

3.5.3 Dust from dried spillage

Standard operating procedures will require that all plant spillages be promptly washed down to avoid drying.

Contaminated soils which have been stockpiled for disposal will be covered to reduce dusting and will be disposed of by burial as soon as is practical.

3.6 Equipment Failures

The Honeymoon plant and wellfield will be fitted with instrumentation and programmable logic controllers. These instruments will be programmed to detect equipment and pipeline failures and to respond by safely closing down the operation. Personnel will be trained to follow safe close-down procedures should it be necessary to override the automatic equipment.

3.7 Temporary Suspension of Operations

Should it become necessary to temporarily suspend operations:

- All equipment will be shut down and placed on a ‘care and maintenance basis’
- All aqueous solutions will be drained from the plant to the retention ponds
- Sufficient solution will be retained in the ponds at all times to prevent drying out
- Sufficient pond volume will be maintained at all times to store process solutions
- Excess solutions will be injected into the Basal Sands
- Organic reagents will be retained in the plant storage tanks
- Appropriate monitoring programs will continue
- Progressive rehabilitation will continue.
4  MONITORING PROGRAM

The Honeymoon monitoring program has two objectives. One is to monitor environmental radiation levels so that radiation doses to members of the public can be assessed; the other is to monitor the operation of site waste management process and facilities to ensure they are operating satisfactorily.

4.1  Environmental Monitoring Program

<table>
<thead>
<tr>
<th>Impact</th>
<th>Area</th>
<th>Method</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employee exposure, general public exposure</td>
<td>Wellfield</td>
<td>Survey of gamma ray dose rate</td>
<td>Prior to new wellfield Development</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>After closure of wellfield</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Passive monitoring for radon</td>
<td>Continuous - Quarterly</td>
</tr>
<tr>
<td></td>
<td>Equipment or material that come</td>
<td>Monitor alpha surface</td>
<td>Before further use</td>
</tr>
<tr>
<td></td>
<td>into contact with radioactive</td>
<td>Contamination &lt;0.4Bq cm².</td>
<td></td>
</tr>
<tr>
<td></td>
<td>items</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>North Mining Lease</td>
<td>Passive monitoring for radon</td>
<td>Continuous - Quarterly</td>
</tr>
<tr>
<td></td>
<td>South Mining Lease</td>
<td>Passive monitoring for radon</td>
<td>Continuous - Quarterly</td>
</tr>
<tr>
<td></td>
<td>East Mining Lease</td>
<td>Passive monitoring for radon</td>
<td>Continuous - Quarterly</td>
</tr>
<tr>
<td></td>
<td>West Mining Lease</td>
<td>Passive monitoring for radon</td>
<td>Continuous - Quarterly</td>
</tr>
<tr>
<td></td>
<td>Accommodation Area (Occupants are</td>
<td>Passive monitoring for radon</td>
<td>Continuous – Quarterly</td>
</tr>
<tr>
<td></td>
<td>to comprise the Critical Group as</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>defined in the Code of Practice &amp;</td>
<td>RDP PAEC</td>
<td>Two months per Quarter</td>
</tr>
<tr>
<td></td>
<td>Safety Guide)</td>
<td>High volume sampling for radium, uranium and thorium</td>
<td>Quarterly</td>
</tr>
<tr>
<td></td>
<td>Plant</td>
<td>Passive monitoring for radon</td>
<td>Continuous – Quarterly</td>
</tr>
<tr>
<td></td>
<td>Solids Retention Pond</td>
<td>Passive monitoring for radon</td>
<td>Continuous – Quarterly</td>
</tr>
<tr>
<td></td>
<td>Yarramba Station</td>
<td>Passive monitoring for radon</td>
<td>Continuous – Quarterly</td>
</tr>
</tbody>
</table>
## 4.2 Operational Monitoring Program

<table>
<thead>
<tr>
<th>Impact</th>
<th>Area</th>
<th>Method</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excessive amounts of radioactive waste in temporary storage awaiting disposal</td>
<td>Solid radioactive waste temporary storage area</td>
<td>Estimate quantity</td>
<td>Annually</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Periodically to determine need for permanent disposal pit</td>
</tr>
<tr>
<td>Retention ponds</td>
<td>Note sludge volume</td>
<td></td>
<td>Annually</td>
</tr>
<tr>
<td></td>
<td>Grab Sample for radionuclide assay</td>
<td></td>
<td>Annually</td>
</tr>
<tr>
<td>Solid radioactive waste disposal facility</td>
<td>If water present, sample Ra-226, U-238, Th-230</td>
<td></td>
<td>Quarterly</td>
</tr>
<tr>
<td></td>
<td>Survey of gamma ray dose rate</td>
<td></td>
<td>Prior to and on closure</td>
</tr>
<tr>
<td>Radioactive waste leaving site</td>
<td>Despatch</td>
<td>Monitor alpha surface contamination &lt;0.4Bq cm(^2).</td>
<td>Before leaving site</td>
</tr>
<tr>
<td>Spread of mining solutions into surrounding aquifer areas</td>
<td>Mining perimeter monitor Wells</td>
<td>Tape and probe for water level</td>
<td>Fortnightly</td>
</tr>
<tr>
<td></td>
<td>Collection of water samples for pH, conductivity, sulphate and uranium determination</td>
<td>Fortnightly site lab</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Collection of water samples for pH, conductivity, sulphate and uranium determination</td>
<td>Quarterly NATA lab</td>
<td></td>
</tr>
<tr>
<td>Upper aquifer monitor Wells</td>
<td>Tape and probe</td>
<td>Fortnightly</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Collection of water samples for pH, conductivity, sulphate and uranium determination</td>
<td>Fortnightly site lab</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Collection of water samples for pH, conductivity, sulphate and uranium determination</td>
<td>Quarterly NATA lab</td>
<td></td>
</tr>
<tr>
<td>Spread of contaminants beyond bunded wellfield</td>
<td>Affected drainage areas</td>
<td>Surface sediment grab samples radium 226, uranium, thorium</td>
<td>Pre-production to establish a baseline; then Annually</td>
</tr>
<tr>
<td>Increased levels of radioactive components in ponds and disposal areas</td>
<td>Disposal Well Monitor Wells</td>
<td>Tape and probe for water level</td>
<td>Fortnightly</td>
</tr>
<tr>
<td>Seepage and soil contamination</td>
<td>Solids retention ponds monitor wells</td>
<td>Probe for evidence of seepage</td>
<td>Fortnightly</td>
</tr>
<tr>
<td></td>
<td>Disposal well re-injection liquids</td>
<td>Grab sample for pH, conductivity, sulphate uranium and radium</td>
<td>Quarterly</td>
</tr>
<tr>
<td></td>
<td>Total volume disposed of</td>
<td></td>
<td>Quarterley</td>
</tr>
<tr>
<td>Leaks and soil contamination</td>
<td>Pipelines</td>
<td>Visual leak detection</td>
<td>Daily</td>
</tr>
<tr>
<td>High level of dust emission</td>
<td>Drying and packing area exhaust system</td>
<td>Stack sample to determine yellowcake dust levels</td>
<td>Quarterly</td>
</tr>
</tbody>
</table>
5 AUDIT AND REPORTING PLAN

5.1 Audit

Each year Southern Cross Resources will audit its operations against the RWMP and EMMP requirements. The results will be reported to the EPA and PIRSA as part of the Honeymoon Project Annual Environment Report. Every three years an audit will be run by independent auditors.

5.2 Quarterly Report

Results of monitoring conducted under this program will be reported quarterly at the first ISL Operators meeting following the end of each quarter. Copies will be presented at the meeting to representatives of the EPA, PIRSA, and Department of Administrative and Information Services - SafeWork SA.

5.3 Annual Report

Results of monitoring for each calendar year will be presented in summary as part of the Honeymoon Project Annual Environment Report. Copies of this report will be submitted to the Director – Radiation Protection Division (EPA) and to Chief Inspector of Mines (PIRSA) no later than 30 April the following year. The report will include a report on the performance of the waste management systems.

5.4 Wellfield Plans

Wellfield plans showing the location of bunding, current production, disposal and monitor well locations will be provided annually to the EPA at the time of licence renewal.

Any changes to monitor well locations will be noted at the quarterly ISL Operators meeting.

5.5 Solid Radioactive Waste Disposal Facilities

The Director Radiation Protection Division (EPA) will be notified in writing when a radioactive solids disposal facility is to be constructed. The notification will specify the location of the facility. When the facility is closed the EPA will be provided with a closure report which will include a listing of the general nature of the contents of the facility, confirmation of approved construction and results of surface dose rates measured across the closed facility.

5.6 Incident Reports

Incidents that require reporting under the OHS&W Act 1986, the Dangerous Substances Act 1979 and the Environmental Protection Act 1993 will be reported as normally required under those Acts.

The reporting of incidents involving the unplanned release of radioactive process materials, radioactive liquids or radioactive wastes will be consistent with the recommendations of the currently approved (Bachmann) reporting procedures (Appendix 2).
6 CLOSURE AND REHABILITATION STRATEGY

The steps to be taken when closing down the Honeymoon site will be developed and revised as experience is gained with the operation of the site and with the progressive rehabilitation program. The strategy outlined below is the first step in this process.

At the conclusion of operations quantities of organic solvent-extraction reagents, unused chemicals and organic cruds will be disposed of. The plant will be decontaminated, demolished and the equipment and resulting scrap will also be disposed of. The wellfield will be decommissioned. Uncontaminated buildings and facilities outside the process area will be removed. Finally the disturbed areas will be rehabilitated.

6.1 Residual Chemicals and Organic Materials

6.1.1 Materials to be disposed of

There will be residual chemicals, organic solvent-extraction reagent and organic-contaminated solvent-extraction cruds stored at the Honeymoon site at the conclusion of mining.

The residual chemicals are expected to include sodium hydroxide, sodium carbonate, sodium chlorate, concentrated sulphuric acid along with smaller amounts of hydrochloric acid, and possibly ferrous sulphate, barium chloride and lithium chloride. In addition there will be small quantities of a variety of laboratory reagents. Careful management of the project will allow the chemical inventory to be run down as the project approaches the end of its life. It is expected that the total inventory of residual chemicals will be no more than a few tonnes.

The solvent extraction reagent consists of di2ethyl-hexyl phosphoric acid (DEHPA), alamine 336 and tri butyl phosphate (TBP) dissolved in a high flash point kerosene carrier. The active reagents amount to about 10% of the total ie the reagent is about 90% kerosene. There will be up to 500 cubic metres of this organic mixture at the Honeymoon site at the conclusion of the project.

The organic mixture will contain approximately 2ppm U₃O₈ – about the same concentration found in soils. There are no assays available for other radionuclides in the organic.

The cruds will contain variable amounts of the organic solvent-extraction reagents along with iron hydroxide precipitates, gypsum precipitates and waxy residues from the solvent extraction process. The cruds will have a variable, but relatively high uranium content – possibly as high as 5 grams per litre.

6.1.2 Disposal

Commercial disposal options for the chemicals and the organic reagent are available. The chemicals can be sold or disposed of through normal commercial waste disposal channels. Disposal of the solvent extraction reagents through normal commercial channels will not present any difficulties provided there are no unanticipated radioactive components in the solvent.

More information on the composition of cruds will be required before the plan for their disposal can be finalised. However it is likely that they can be treated conventionally by filtration and the damp residue buried on site in an approved low level radioactive waste facility.
6.2 The Process Plant

The Honeymoon process plant will consist of a number of fibre reinforced plastic vessels (FRP) and steel vessels, inter connecting pipe work, pumps, mixers and associated electrical cabling all located within a large steel framed building. Adjacent to the process plant will be other facilities which provide the plant with power, water, air and fire fighting services. There will also be wellfield control centres – small steel buildings containing control equipment - located some 200 metres from the process plant.

6.2.1 Piping

The wellfield and process plant will contain high-density polyethylene (HDPE) piping, poly vinyl chloride (PVC) piping and steel piping. HDPE piping will be used for carrying mining solutions to and from the well field, PVC piping will be used for process piping within the process plant and steel piping will be used for acid lines and for water reticulation.

HDPE pipe
Large diameter HDPE pipes (up to 450 mm diameter) used for carrying the bulk flow of solutions to and from the wellfield control centres will be cut up and buried on site. Smaller diameter HDPE piping between the wellfield control centres and the wellfield (up to 150 mm diameter) which has been buried at a depth of approximately one metre will be flushed with water and left in-situ. All other HDPE pipe will be cut up and buried on site. As the process pipe may be contaminated with uranium, appropriate safety measures will be followed when handling the polyethylene pipe.

PVC pipe
All PVC pipe from the process plant will be cut up and buried on site. Appropriate safety measures will be followed when the pipe is being handled.

Steel pipe
Steel pipe will not be exposed to uranium bearing process solutions. Water pipes will be handled in the same way as structural steel. Acid lines will be thoroughly checked and flushed before they are dismantled. The steel pipe will be recycled as scrap.

6.2.2 Vessels

The majority of process vessels in the plant will be of FRP construction. Some will be of steel or stainless steel construction.

FRP vessels
FRP vessels will be decontaminated where necessary, cut up and buried.

Steel vessels
Acid, chemical and water tanks will be either sold or offered to the landowners at zero cost - as is, where is. Thickeners, which will have been exposed to uranium slurries, will be decontaminated and sold, if possible. Alternatively they will be cut up and disposed of as scrap.

6.2.3 Major Equipment

Major equipment will be decontaminated and sold.
6.2.4 Minor Equipment

Minor pieces of process equipment such as filters, pumps, mixers and associated motors may contain minor amounts of uranium which cannot be removed. These minor pieces of equipment will be stripped from the plant put in an unserviceable condition and disposed of by burying on site.

6.2.5 Electric Cable

Electric cable will be stripped from the process plant and checked for contamination – uncontaminated cable will be sold, contaminated cable will be buried on site.

6.2.6 Steelwork

Before demolition special attention will be given to the decontamination of areas where dried yellowcake has been produced or handled as these areas may have accumulated dust deposits in or on the steelwork.

Structural steelwork will be demolished and where possible the steel will be recycled. Demolition and recycling will be contracted out to appropriately qualified contractors.

Steel will be checked (scanned) by Southern Cross Resources as it comes down and directed into three piles -

one to be shipped;
one to be decontaminated (by Southern Cross Resources); and
one to be buried

The demolition contractor will remove all uncontaminated and decontaminated steel from site for recycle as scrap steel. Any contaminated steel will be buried on site under Southern Cross Resources supervision.

Steel decontamination will be limited to washing and scrubbing. More aggressive techniques such as sand blasting will not be used.

6.2.7 Other Process Plant Materials

Organic overflow tanks will be checked for contamination and if cleared will be filled in and abandoned. If they are contaminated they will be broken up and buried with other contaminated waste

Mobile equipment which is contaminated will be buried on site

Lightly contaminated scrap will be buried on site

Residual aqueous solutions containing uranium will be reinjected into the abandoned wellfield.

Below ground calibration pits which have been used for instrument calibration and which contain a total of 12kg U₃O₈ will be sealed up and abandoned.

Depending on the final activity levels, scales, evaporites and similar contaminated residues will be disposed of either in the solids retention pond or on site in an approved disposal facility.
6.3 Wellfield

Wells no longer required for monitoring or production purposes will be filled with cement to a point approximately 0.5 m below the surface. The well head will be removed by cutting the casings off at the level of the cement. Monitor wells will be treated in the same way, but some will be retained for the continuing monitoring of the aquifer. This will be determined in conjunction with the regulatory authorities.

The wellfield control centres will have the internals stripped out and buried. The buildings will be recycled.

Any contaminated soil will be collected and buried.

6.4 Uncontaminated Equipment & Buildings Outside the Process Plant Area

All infrastructure facilities will be dismantled and removed as soon as practicable after the conclusion of operations at the Honeymoon site. The infrastructure, including the office complex and camp, will be transported to another location.

6.5 General Scrap/Rubbish

Concrete will be broken up and buried without decontamination

Exotic plants will be removed

Diesel contaminated areas will be excavated, the contaminated soil buried and the area back filled

Any residual rubbish or scrap will be buried

6.6 Disposal Sites

Four types of burial pit may be required. The first will be the lined solids retention ponds which will be used for the disposal of low level radioactive wastes. The ponds may not be sufficiently large to contain all waste materials from a commercial plant so a second disposal site may be required to take lightly contaminated materials such as the concrete from the process plant, pumps, motors, scrap steel and other such construction materials. A third and deeper pit may be required for some contaminated materials. A fourth pit will be required to take uncontaminated materials such as concrete.

All burial pits which receive contaminated material will be consistent with the recommendations of the Near Surface Code (NHMRC 1992). They will be appropriately lined with HDPE membranes and compacted clay and will be covered with an appropriate thickness of clay and soil and the surface profiled to prevent pooling and conform with the local topography.

6.7 Rehabilitation

After a final radiological survey and clearance the large disturbed areas will be spread with stockpiled topsoil (where this has been stripped), scarified, seeded with appropriate native species and left to re-vegetate. Smaller areas will be scarified and left to seed and revegetate from
surrounding vegetation. Further details of the rehabilitation program are provided in the Mining and Rehabilitation Program.

6.8 Monitoring

Monitoring of fluid migration and water quality will continue for a period of at least seven years following the closure of the mine. The monitoring program will be developed jointly with the regulatory authorities.

7 REFERENCES


Southern Cross Resources Australia Pty Ltd, 2006: Honeymoon Project Mining and Rehabilitation Program

Southern Cross Resources Australia Pty Ltd, 2005: Honeymoon Project Draft Radiation Management Plan
APPENDIX 1

Modelling

Radon and radon decay products concentrations

Dispersion from the radon ventilation stack

The modeling outlined below is taken from the Honeymoon Uranium Project – Environmental Impact Statement.

Modelling of radon dispersion at Honeymoon is a relatively simple task because the major release of radon will occur from the plant ventilation stack which will discharge at least 10 m above the ground level. Therefore, it is possible to consider a point and continuous radon release from the plant. The atmospheric dispersion model MILDOS is the standard straight-line crosswind-integrated Gaussian plume model. The NUREG/CR-2011 report (NUREG, 1981) description of the model has been adopted to provide for the air dispersion methodology used in this work.

The ground level air concentration of radon, $A_{Rn}$ (Bq/m$^3$), and/or radon daughters at a receptor, which is downwind a distance, $X$ (m), and crosswind from a source of radon emission which effective height of emission is $h$ (m) is given by:

$$A_{Rn} = \frac{Q f}{\left[(\frac{3.14}{2})^{0.5} \sigma_z WV (\frac{3.14}{4})\right] \exp(-h^2/(2 \sigma_z)^2) \exp(-\sigma_{Rn} t)}$$

where $Q$ (2.8 million Bq/s) is the radon release rate, $\sigma_z = a X (1 + b X)c$ is the vertical dispersion coefficient empirically described by Briggs, 1974 and Gifford, 1976, $WV$ (m/s) is the wind velocity and $f$ is the wind frequency within the 45° sector in the specified direction. The second exponential considers the decrease of radon in the plume due to its decay.

The ground level radon activity in air downwind from the plant ventilation stack was calculated for the wind velocity of 2 m/s and the wind frequency of 0.2 within the specified direction (Bureau of Meteorology, 1998). The constants $a$, $b$ and $c$ were adopted from NUREG, 1981 for the neutral atmospheric stability Class.

The PAEC of radon daughters was calculated considering the above ground level radon activity in air and the radon equilibrium factor, $EF$:

$$PAEC = \frac{ARn EF}{3700}$$

$EF$ was approximated by $EF = 1 - \exp(-0.0003 T)$ where $T$ (s) = $X/WV$.

The average incremental radon concentrations and the PAECs of radon daughters were calculated as a function of a distance from the plant ventilation stack.

The predicted increase in radon decay products at the nearest habitation, Yarramba Homestead, is approximately 0.8 nJ/m$^3$. This magnitude of increase will be very difficult to detect against the typical natural concentrations in the area of 0.036 µJ/m$^3$ (36 nj/m$^3$). The dose resulting from inhalation of this slightly increased radon decay product concentration at Yarramba Homestead is approximately 7.7 µSv/y or less than 1.0% of the annual public dose limit of 1 mSv.
**Well Development**

During well development approximately 50,000 litres of ground water containing radon are airlifted to the surface at a rate of about 10 l/s. The water is sent to a small holding pit located 20 to 50 metres away from the area where drillers are working. The maximum level of radon in the waters has been calculated to be approximately 20,000 Bq/l.

Assuming that all of the radon in the ground water is released as it enters the pit and considering the pit to be a point source the modeling procedures outlined above can be applied. The exponential term which allows for radon decay can be ignored as the time available for decay is quite small.

At a radon release rate of 200,000 Bq/s the dose rate 20 to 50 metres downwind from the pit is predicted to be about 0.0004 mSv/h.

**Long-lived dust alpha activity concentrations outside the plant**

Modelling of atmospheric dispersion of product dust discharged from the drying plant stack is based on the same methodology as above:

\[ a = \frac{Q f}{[(3.14/2)0.5 \sigma z WV (3.14 X/4)] \exp(-h^2/(2 \sigma z^2))} \]

This dispersion formula does not take into account the plume depletion due to the deposition of product dust. The uranium alpha activity source-term was considered for the release rate of 1 Bq/s of \(^{238}\text{U}\) from the drying plant stack. The analysis predicts the crosswind average ground level activity of \(^{238}\text{U}\) in air as a function of the distance from the plant in the specified direction.

The predicted increase in \(^{238}\text{U}\) concentration at the nearest habitation, Yarramba Homestead, is approximately 70 nBq/m\(^3\). The predicted increase on the Barrier Highway, at Mingary Creek, is less than 35 nBq/m\(^3\). These increases are within the levels of variation for the typical natural concentrations in the area and would not be routinely detectable. The resulting dose at Yarramba Homestead will be of the order of 4.7 \(\mu\text{Sv/y}\).
APPENDIX 2

Incident Reporting Procedures

CRITERIA AND PROCEDURES FOR RECORDING AND REPORTING INCIDENTS AT SA URANIUM MINES

INTRODUCTION

This reporting procedure addresses those incidents involving the unplanned release of radioactive process materials, radioactive liquids or radioactive wastes associated with the physical and chemical processing of uranium ores.

Incidents that require reporting under the OHS&W Act 1986, the Dangerous Substances Act 1979 and the Environmental Protection Act 1993 shall be reported as normally required under those Acts.

The aim of this procedure is to ensure compliance with conditions attached to the Licence to mine or mill radioactive ores issued under the Radiation Protection and Control Act 1982, and to ensure radiation exposures to workers, members of the public and the environment are as low as reasonably achievable.

All written reports of incidents shall be made on the approved Incident Report Form.

It is proposed that:

a) The attached reporting procedure is applied as part of the radiation management plan for uranium mining operations, approved under Clause 8 of the Code of Practice on Radiation Protection in the Mining and Milling of Radioactive Ores 1987 (or as amended).

b) The efficacy of the procedure should initially be reviewed within 12 months. The review will take account of any changes in mine operations, technical difficulties encountered, the interaction of this procedure with the requirements of other applicable Acts and Regulations, and the appropriateness of current recording and reporting levels. The procedure should be regularly reviewed thereafter.

In applying the proposed reporting procedure, it is acknowledged that processing plants, wellfields, evaporation ponds, tailings dams, etc are ‘disturbed’ operational areas and will be subject to an approved clean up and rehabilitation program at the completion of the project. The reporting procedure places emphasis on events which may result in unplanned release of radioactive process materials, radioactive liquids or radioactive wastes to the ‘undisturbed environment’, or any unplanned exposures to workers or members of the public.

The procedure is considered ‘generic’. Other site-specific requirements may also be applied to particular operations as necessary.
REPORTING AND RECORDING PROCEDURE

The following recording and reporting conditions are to be applied:

A. GENERAL REQUIREMENTS

Report
- Any defect, due to design or malfunction, discovered in the mine, mill, plant, equipment or working procedure, that is likely to lead to an urgent change in plant, equipment or work procedure in order to keep radiation doses as low as reasonably achievable.
- Release, or loss of control of radioactive process materials, liquids or wastes, leading to the accidental exposure of a worker to radioactive materials through inhalation, ingestion or significant contact.
- Unplanned dispersal to the atmosphere of any radioactive process materials through failure of a section of the plant or by an abnormal event (e.g., fire or explosion).

Record
- The results of an investigation which reveals any defect, due to design or malfunction, discovered in the mine, mill, plant, equipment or working procedure, that is likely to cause a significant increase in radiation exposure, together with the causes and resulting actions taken.

B. UNDISTURBED ENVIRONMENT

Report
- Unexpected degradation or defect in the ISL trunklines, Tailings Retention System (TRS) pipelines and structures, pipelines or structures associated with Evaporation Ponds or Storage Ponds that, unless remedied, is likely to lead to a reportable release of radioactive process materials, liquids or wastes.
- Any unplanned release of radioactive process materials, liquids or wastes to the undisturbed environment.
- ISL mining fluid underground excursions.
- Release of radioactive process materials, liquids or wastes which enter or threaten to enter an ephemeral watercourse.

Record
- Any unplanned release to the surface of more than 10 m$^3$ of natural groundwater.

C. ISL WELLFIELDS

Report
- Any unplanned release of more than 10 m$^3$ radioactive liquids.

Record
- Unplanned release to the surface of more than 10 m$^3$ natural groundwater.
- Any unplanned release of more than 1 m$^3$ of radioactive liquids.
- Unexpected degradation or defect in ISL lateral lines that, unless remedied, is likely to lead to a reportable release of radioactive liquids.

D. PROCESS PLANT

Report
- Any release of uranium concentrate outside secondary containment.
- Release of more than 50 m$^3$ of radioactive process materials, liquids or wastes beyond secondary containment, but contained within the engineered controls of the plant perimeter.
- Unplanned release of more than 2 m$^3$ uranium concentrate within secondary containment.

Record
• Unplanned release of radioactive process materials, liquids or wastes, of more than 50 m$^3$ into secondary containment or result in filling of more than 50% of secondary containment volume.
• Release of more than 10 m$^3$ of radioactive process materials, liquids or wastes beyond secondary containment, but contained within the engineered controls of the plant perimeter.
• Unplanned release of more than 0.2 m$^3$ of uranium concentrate within secondary containment.

E. TRS, CORRIDORS AND PIPELINES

Report
• Unplanned release of more than 50 m$^3$ radioactive process materials, liquids or wastes within TRS bunded areas and pipeline corridors.
• Unexpected degradation or defect in the TRS or evidence of leakage from Evaporation Ponds or Storage Ponds that, unless remedied, is likely to lead to a reportable release of radioactive process materials, liquids or wastes.

Record
• Unplanned release of more than 10 m$^3$ radioactive process materials, liquids or wastes within TRS bunded areas and pipeline corridors.