Consultancy report

Radioactive Waste Store Feasibility Study - Stage Three

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REPORT

Radioactive Waste Store Feasibility Study - Stage Three

Prepared for

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<table>
<thead>
<tr>
<th>9</th>
<th>Limitations</th>
<th>9-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Bibliography</td>
<td>10-1</td>
</tr>
</tbody>
</table>
List of Tables, Plates & Appendices

**Figures**

2.1 Interim Store and Commonwealth Criteria 2-1
2.2 Potential Interim Store site at Olympic Dam – Oblique Aerial 2-3
2.3 Potential Interim Store site at Olympic Dam 2-4
2.4 The Roxby Downs Census Region 2-5
2.5 Potential Interim Store site at Radium Hill 2-12
2.6 Potential Interim Store site at Radium Hill - Aerial 2-13
2.7 The Unincorporated Pirie Census Region 2-14
2.8 View of the potential site for the Interim Store as Radium Hill 2-16
2.9 Radium Hill Surrounds 2-17
2.10 Radium Hill Geological Plan as defined in 1973 2-20
3.1 Proposed Borehole Configuration 3-3

**Tables**

1.1 Categories of Radioactive Waste 1-3
3.1 NHMRC 1992 Code Repository Site Selection Criteria 3-1
3.2 NHMRC 1992 Code Design Requirements 3-4
3.3 Near Surface Repository Site Selection Criteria – Olympic Dam 3-6
3.4 Near Surface Repository Site Selection Criteria – Radium Hill 3-11
5.1 Public Consultation 5-7
5.2 Timetable for the Approval Process 5-8
7.1 Recommended Management Model 7-1
7.2 Cost Comparison for Interim Store Locations (not including GST) 7-4
7.3 Cost Comparison for Interim Store and Disposal (not including GST) 7-6
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALARA</td>
<td>As low as reasonably achievable</td>
</tr>
<tr>
<td>ANSTO</td>
<td>Australian Nuclear Science and Technology Organization</td>
</tr>
<tr>
<td>ARPANSA</td>
<td>Australian Radiation Protection and Nuclear Safety Agency</td>
</tr>
<tr>
<td>Bgl</td>
<td>Below ground level</td>
</tr>
<tr>
<td>CEO</td>
<td>Chief Executive Officer</td>
</tr>
<tr>
<td>DEP</td>
<td>WA Department of Environmental Protection</td>
</tr>
<tr>
<td>DoE</td>
<td>WA Department of Environment</td>
</tr>
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<td>DoH</td>
<td>WA Department of Health</td>
</tr>
<tr>
<td>EIS</td>
<td>Environmental Impact Statement</td>
</tr>
<tr>
<td>EPA</td>
<td>South Australian Environment Protection Authority</td>
</tr>
<tr>
<td>GAB</td>
<td>Great Artesian Basin</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographic Information Systems</td>
</tr>
<tr>
<td>ILRW</td>
<td>Intermediate level radioactive waste</td>
</tr>
<tr>
<td>LLRW</td>
<td>Low level radioactive waste</td>
</tr>
<tr>
<td>LILRW</td>
<td>Low level and intermediate level radioactive waste</td>
</tr>
<tr>
<td>NHMRC</td>
<td>National Health and Medical Research Council</td>
</tr>
<tr>
<td>Short-lived ILRW</td>
<td>ILRW with a half-life of less than about 30 years</td>
</tr>
<tr>
<td>OD</td>
<td>Olympic Dam</td>
</tr>
<tr>
<td>PER</td>
<td>Public Environmental Report</td>
</tr>
<tr>
<td>PIRSA</td>
<td>Department of Primary Industry and Resources South Australia</td>
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<tr>
<td>PPPs</td>
<td>Public Private Partnerships</td>
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<tr>
<td>QA</td>
<td>Quality assurance</td>
</tr>
<tr>
<td>Qld</td>
<td>Queensland</td>
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<tr>
<td>SA</td>
<td>South Australia / South Australian</td>
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<td>URS</td>
<td>URS Australia Pty Ltd</td>
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<tr>
<td>WA</td>
<td>Western Australia</td>
</tr>
<tr>
<td>WAC</td>
<td>Waste acceptance criteria</td>
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</tbody>
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Executive Summary

Background

The principal aim of South Australia’s Radiation Protection and Control Act 1982 is to protect the people and the environment of South Australia (SA) from the harmful effects of radiation. The Minister for Environment and Conservation, the Hon. John Hill, is responsible for implementing and executing this Act. In the execution of this Act, he has delegated certain powers, roles and functions to the Chief Executive of the Environment Protection Authority (EPA) and to officers of the EPA’s Radiation Protection Division.

In August 2002 the SA government announced that the EPA would conduct an audit of radioactive material for which the SA government is responsible. Officers of the Radiation Protection Division conducted the audit in 2003, and the SA Radiation Protection Committee endorsed the resulting report, which was released in December 2003. The audit involved approximately two person-years of EPA resources, with inspections extending over a 7-month period.

On 15 November 2004, URS Australia Pty Ltd (URS) was engaged to conduct a study and report to the EPA on the feasibility of the SA government establishing a store for the safe handling, packaging and interim storage of radioactive waste.

The Stages 1 and 2 studies determined that:

- the quantity of waste within the scope (to year 2050) is up to 100 m$^3$ (in conditioned, packaged and stacked form) and is manageable;
- the design of an Interim Store is a relatively minor engineering challenge;
- the planning approval process is relatively well defined and achievable;
- there are a number of potential sites that meet the selection criteria;
- there are a number of management models that could successfully be employed to operate and regulate the store;
- the risks associated with a store are far lower than those presented by the existing arrangements; and
- the costs are manageable and reasonable given the magnitude of the risks.

The Stage 2 study thus concluded that a single Interim Store is a feasible option for safely managing existing and future radioactive waste in SA.

The Extension Study

This extension to the feasibility study investigated:

- the feasibility of locating the Interim Store at one of two sites identified in the Stage 2 Report - Olympic Dam (OD) and Radium Hill;
Executive Summary

- the feasibility of near-surface disposal of radioactive waste at these sites; and
- options for long-term management of radioactive waste that is not suitable for near-surface disposal.

Store location

Potentially suitable locations have been identified at both OD and Radium Hill for developing an Interim Store.

Two potential sites were identified at OD that meet all the criteria, one on the surface within the Special Mining Lease to the north of the current airstrip, and one deep underground in an unused (or purpose built) development drive. Both sites have very low risks, but the underground option would have significant advantages over all other options considered.

A potential site was identified at Radium Hill that meets all the relevant selection criteria, although there may be some security issues that would need special attention. It was also noted that the current population levels and its downward trend indicate that the sustained availability of nearby infrastructure and service providers may not be reliable. The Radium Hill site presents an additional radiological risk to construction workers, which is well understood and can easily be mitigated by appropriate off-site accommodation and well designed work procedures.

In both cases, the quantity of waste to be managed remains the same because the landowners would prefer to keep their existing waste and the Interim Store arrangements separate.

Disposal

The assessment of disposal options focused only on LLRW (low level radioactive waste) and short-lived ILRW (intermediate level radioactive waste) because long-lived ILRW is not suitable for near-surface disposal (and is not covered by a relevant Australian Code of Practice). Therefore a small Interim Store for long-lived ILRW is an inherent component of any LLRW and short-lived ILRW disposal option for SA.

Disposal would take place in accordance with the NHMRC 1992 Code, probably in boreholes. The option of disposing of waste in an existing repository was considered at both locations and found to be inappropriate.

A near-surface repository site was identified at OD that appears to easily meet all of the criteria, however further assessment would be required of its geochemical and geotechnical properties to inhibit migration of radionuclides, and also for design purposes. It should be noted, however, that this uncertainty is mitigated by the unsuitability of the local groundwater for either stock or human consumption, and also the groundwater cone of depression caused by the existing underground development or possible future open pit. Long-lived ILRW would need to be stored in a suitable facility, which could be built adjacent to the boreholes.

Disposal underground at OD was also considered, within the existing OD underground development. A potential suitable general area of the underground development was identified, at the north-west extremity...
Executive Summary

of the deposit. It was considered that this would be a suitable option for disposal of LLRW and short-lived ILRW. Long-lived ILRW would need to be kept in managed storage, which could be in the same area, until a suitable long-term disposal option becomes available.

Radium Hill has a history of radium and uranium mining, and a legacy of incomplete rehabilitation and some surface contamination from uranium tailings. The surface disposal location selected for a potential site appears to meet all the NHMRC criteria, however further assessment would be required for groundwater, which may be relatively shallow, has been used for human consumption, and has potential for future agricultural use. The further assessment would need to include the site’s geochemical and geotechnical properties to inhibit migration of radionuclides, and also for design purposes.

The history of the Radium Hill site and the presence of the nearby tailings dam and LLRW repository, and the remaining uranium and radium ores, and the underground development, would potentially place significance restrictions on future land uses of the site and its surrounds. It is not considered that the development of a near-surface repository would require the need for significant additional restrictions.

Options for Long-Lived ILRW

The near-surface disposal Code is not applicable to long-lived ILRW, a code for which is not expected in Australia for some years. When published, such a Code could be used to develop a solution for the disposal of South Australia’s long-lived ILRW.

Pending development of a suitable Code of Practice, and availability of other options, the long-lived ILRW could be held in managed storage at surface facilities at either OD or Radium Hill, or underground at OD.

Regulatory Processes and Timeframes

As noted in the Stage 1 Report, an Interim Store proposal may not trigger the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), as the quantity of radioactive waste to be managed may be below the threshold regarded as “excessive”, as defined in the Act.

In addition, if the SA Government were to commit that the Store would be managed in the future such that the threshold is not reached, it would appear that the long-term use of the Store would also be outside the EPBC definition. It is recommended that the EPA seek legal advice as to whether the Store will be a nuclear action, and thus whether a referral is required.

If the legal advice was that the EPBC Act is triggered, an “accredited assessment process” could be sought, in which the SA government would manage the assessment as long as the Commonwealth is satisfied that standards will be met.

There are some specific land ownership/legal issues relating to the two sites, all of which are expected to be able to be resolved in cooperation with the landowners.

There are minimum periods for public consultation specified in both Commonwealth and SA planning laws, and there are inherent uncertainties as to the length of time needed to conduct the environmental
Executive Summary

assessment. It is therefore very difficult to plan a timetable for the approval process. A conservative timetable is presented that indicates that it could take up to 2 years to complete the approval process, construction of the facility, and the transfer of waste to the facility.

A suitable Emergency Response Plan should be in place for potential incidents that could occur during conditioning, transport, interim storage, construction and disposal. These procedures should include events such as accidents, protest, terrorism and sabotage.

Auditing and Verification Systems

In order to ensure that the operation of the facility is safe and sustainable, it was recommended that the recognised relevant standards be implemented for the facility. It was also recommended that the appropriate international standard be used to develop the auditing program.

It was recommended that the audit team should consist of: an independent audit team leader; the regulator; and one other SA government representative from either the health or environment areas. At least one of the audit team should have specific expertise in radiation protection and the management of radioactive materials.

Techniques for verification are discussed, as well as radiological and environmental check-monitoring.

Management Options and Costs

The recommendations relating to management options made in the Stage 2 report were assessed against the possibility of siting a facility at OD or Radium Hill. Most of the recommendations remain unchanged, however, the following refinements are recommended:

- If the OD site were selected, it is recommended that the facility be operated by OD for a fee that covers land use and management costs; and
- If the Radium Hill site were selected, it is recommended that the facility be operated by a government Department independent of the EPA.

It is noted that the perception of regulatory independence would be greater if the operations were managed by a non-government agency such as OD.

Costs were also assessed, both for an Interim Store and a combination Interim Store and repository, located at both OD and Radium Hill. The assessment indicated that costs would be higher for the Radium Hill location for both scenarios, and that security at Radium Hill would not be as good as for OD. At OD, the security and cost of the underground option would be superior to the surface option.

Thus on a security and cost basis, the OD site would be preferred. Furthermore, the underground site would be the preferred site at OD.
Executive Summary

Overall Conclusions

This extension study investigated:

- the feasibility of locating the Interim Store at one of two sites identified in the Stage 2 Report - Olympic Dam and Radium Hill;
- the feasibility of near-surface disposal of radioactive waste at these sites and underground at OD; and
- options for long-term management of radioactive waste that is not suitable for near-surface disposal.

This study has determined that:

1. sites exist at both OD and Radium Hill that appear to be suitable for locating an Interim Store;
2. the existing information base for an environmental assessment for OD is much more comprehensive than that available for Radium Hill;
3. based on the information available, sites at OD and Radium Hill may also be suitable for near-surface disposal of LLRW and short-lived ILRW, and at OD for underground disposal of LLRW and short-lived ILRW;
4. the development of a surface repository at either OD or Radium Hill for LLRW and short-lived ILRW would also require the development of a small Interim Store for the long-lived ILRW, pending a suitable long-term disposal option becoming available;
5. the development of an underground repository at OD for LLRW and short-lived ILRW could involve a small Interim Store for the long-lived ILRW underground, pending a suitable long-term disposal option becoming available;
6. the OD surface repository site has many advantages over the Radium Hill site and is preferred;
7. the underground disposal / storage option at OD is the lowest-cost option, and has security and monitoring benefits, and is the overall preferred option;
8. limited other options are available at present for the management of long-lived ILRW;
9. as noted in the Stage 2 report, other potential locations may be suitable should either the OD or Radium Hill options be determined to be unsuitable; and
10. all options have political and community sensitivities that would need to be appropriately addressed.
1.1 Background

The principal aim of South Australia’s Radiation Protection and Control Act 1982 is to protect the people and the environment of South Australia (SA) from the harmful effects of radiation. The Minister for Environment and Conservation, the Hon. John Hill, is responsible for this Act, and has delegated certain powers, roles and functions to the Chief Executive of the EPA and to officers of the EPA’s Radiation Protection Division.

In August 2002 the SA government announced that the EPA would conduct an audit of radioactive material for which the SA government is responsible. The Minister for Environment and Conservation requested the EPA to undertake the audit, with particular emphasis on material designated as waste, and to determine the nature and volume of the material and whether it was safely and securely stored.

The audit was conducted by officers of the EPA’s Radiation Protection Division. Its report on the audit (EPA 2003) was endorsed by the SA expert body on radiation protection issues, the statutory Radiation Protection Committee. The report was released in December 2003.

Two of the key recommendations for the future management of radioactive waste in SA, (Nos. 8 and 9) were:

- That the government undertake a rigorous feasibility study of options for future management of South Australia’s radioactive waste and that this study be commenced as soon as practicable.
- That the government investigate the feasibility of establishing a facility for the safe handling, packaging and interim storage of waste pending the establishment of appropriate facilities for long-term management.

On 15 November 2004, URS was engaged to conduct a study and report to the EPA on the feasibility of the SA government establishing a store for the safe handling, packaging and interim storage of radioactive waste. The study is being conducted in three stages. The stages and their topics, as well as the scope of the study, are described below.

1.2 Feasibility Study Topics

The Feasibility Study (the study) topics comprise:

**Stage 1**

1. Review the quantities and types of radioactive waste under SA legislative control that are likely to require interim storage now and into the future.

2. Develop site selection criteria for an Interim Store, consistent with international best practice for safety and protection of people and the environment.

3. Develop design and structural criteria for the Interim Store, consistent with international best practice.
4. Define processes and procedures that would need to be addressed, including the stages (and timeframes) from pre-construction to operational to rehabilitation, including critical regulatory issues and public consultation.

**Stage 2**

1. Develop feasible options for locating an Interim Store, including a single purpose-built store, and the use of a number of stores.

2. Identify options for management of an Interim Store, including government agency and public/private company.

3. Identify potential risks and benefits for people and the environment of using a purpose-built Interim Store compared with the current storage arrangements, including transport of wastes to and from stores, and operations at the stores.

4. Determine the costs associated with establishing and running an Interim Store, and compare with those associated with the current storage arrangements.

**Stage 3 (Extension to the feasibility study)**

1. Store Location - study the feasibility of locating the Interim Store at:
   a. Olympic Dam; and
   b. Radium Hill.

2. Disposal - study the feasibility of near-surface disposal of radioactive waste at the above sites, including the following options:
   a. a new suitably engineered repository;
   b. the use of an existing or proposed site operated for the disposal of waste from current operations.

3. Other radioactive waste - develop options for long-term management of radioactive waste that is not suitable for near-surface disposal.

**1.3 Feasibility Study Scope**

The scope of the study is significantly different from that of the Audit and is described in detail in the Stage 1 Report. In summary, the scope of the study includes:

- registered sealed sources (Category B or S in Table 1.1);
- unsealed radioactive material (very low level or Category A); and
- miscellaneous radioactive material (Category A, B or S).
Introduction

The study does not include:

- uranium product, tailings and other radioactive materials resulting from past, current or future mining or processing activities;
- radioactive material in the process of being transported (including storage in transit) or already disposed of; and
- radioactive material under Commonwealth jurisdiction (as described in the Audit).

**Table 1.1 Categories of Radioactive Waste**

<table>
<thead>
<tr>
<th>Category / Classification</th>
<th>Type</th>
<th>Initial Destination</th>
<th>Final destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very low level</td>
<td>Short &amp; long lived</td>
<td>User disposal</td>
<td></td>
</tr>
<tr>
<td>Low level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Short &amp; long lived</td>
<td>Interim store, or suitable for immediate disposal in a near-surface repository</td>
<td>Disposal in a near-surface repository</td>
</tr>
<tr>
<td>B</td>
<td>Short &amp; long lived</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Short lived¹</td>
<td>Interim store</td>
<td>Deeper burial in accordance with ARPANSA Guidelines (yet to be published)³</td>
</tr>
<tr>
<td>S</td>
<td>Short lived²</td>
<td>Interim store</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Long lived</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High level</td>
<td>Not present in SA</td>
<td></td>
<td>Deep geological disposal</td>
</tr>
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</table>

¹ All long-lived intermediate level wastes are Category S.
² There are some Category S wastes that will decay to Category B status within the operational life of the Interim Store. These can then be reclassified and go to the near-surface repository.
³ It assumed that this waste will go to deeper underground disposal, however this does not form part of any existing studies or management plan.
2.1 Introduction

Stage 1 of this study described site selection criteria that should be considered for finding a suitable location for an Interim Store. Stage 2 of the study applied the criteria and recommended that there are a number of potential sites that meet the selection criteria. These included OD and Radium Hill.

The OD and Radium Hill areas, shown in Figure 2.1, are assessed in this report with respect to these criteria.

**Figure 2.1 Interim Store and Commonwealth Criteria**
2.2 Olympic Dam

2.2.1 Background

Western Mining Corporation Ltd discovered the OD deposit in 1975. Later drilling confirmed a resource of more than 2000 million tonnes of ore containing copper, uranium and other metals. The company later became WMC Ltd (WMC), which became 100% owned by BHP Billiton in July 2005. OD is now Australia’s largest single underground mine and minerals processing operation, and is located some 580 km north of Adelaide.

The township of Roxby Downs was purpose built to service the OD project and is now a community of about 4000 residents. Roxby Downs has become a regional centre with many facilities, including educational, health, sporting, leisure, shopping and cultural facilities. Roxby Downs is located 16 km south of the OD site.

The OD deposit is reported to be the world’s fourth largest known copper resource, the world’s largest known uranium resource (about 39% of world’s known reserves), and a significant gold-silver producer. Currently OD produces 9.4% of the world’s uranium and is the 17th largest copper producer. Although known mainly for its uranium production, OD is primarily a copper mine, with some 70-75% of revenues from copper, about 20-25% from uranium and 5% from gold and silver.

The Uranium Information Centre (UIC 2005) reports that OD has enormous reserves of ore, with over 390,000 tonnes of contained uranium oxide, so that even with the increased rate of production, reserves are sufficient for over 70 years. The OD project is thus likely to be operational for many decades ensuring the presence of people and operational infrastructure during the proposed 50-year lifetime of an Interim Store.

There is a legal framework setting out the relationship between the SA government and BHP Billiton through the Roxby Downs (Indenture Ratification) Act 1982, which was updated by an Amendment Act in 1996. The OD operation is located on freehold land wholly owned by BHP Billiton, within a Special Mining Lease established under Section 19 of the Indenture. The Municipal Lease for the township of Roxby Downs is located immediately to the south of the Special Mining Lease. The airstrip and Olympic Dam Village is located within the Municipal Lease.

It should be noted that the site visit by the project team to OD and the discussions with WMC in relation to this study occurred prior to the takeover of WMC by BHP Billiton. Thus any conclusions reached in this study in relation to OD, and which the SA government would wish to pursue, would need to be taken up with BHP Billiton. Any company discussions that relate to OD during the preparation of this report thus relate to WMC, and this is noted as such as appropriate in the text.

2.2.2 Potential Interim Store Site Description

Surface Site

A number of potential surface site locations in the vicinity of the OD processing plant and mine were considered during the study. Particular account was taken of potential impacts on OD operations, both present and proposed. BHP Billiton are currently undertaking a Feasibility Study into increasing OD’s copper production from the present level of 225,000 t/a to between approximately 500,000 to 600,000 t/a. This Feasibility Study includes consideration of expanded underground operation or open pit operation.
WMC assisted in the site selection process in discussions and by allowing URS to view a concept layout for the proposed expansion, which showed the extent of the possible open pit, overburden rock storage and tailings areas, and new processing plant and associated infrastructure.

A general potential area unlikely to be affected by future operations was identified to the north of the existing processing plant, and to the east of the existing tailings storage facilities, however access to this area would be through the processing plant area. Areas to the eastern part of the Special Mining Lease would be largely taken up by the proposed open pit and overburden rock storage area. The areas to the south-west of the existing metallurgical plant would be taken up by the new metallurgical plant.

The general area considered to be most suitable for siting the Interim Store, with minimum potential impact on existing and proposed future operations, was on the southern side of the Special Mining Lease, to the north of the Olympic Dam airport.

A potential site for an Interim Store is indicated in Figures 2.2 and 2.3. The site is approximately 250 m north of the current airstrip and 250 m west of the wide vehicles access road to OD. The wide vehicles access road by-passes the main gate, and is normally locked. The wide vehicles access road is entered from the road to the airport. Alternatively, the potential site can be accessed by passing through the OD main gate, and taking a sharp left turn about 1 km later, into the wide vehicles access by-pass road.

The particular location identified is relatively clear of vegetation, on the northern side of a sand dune, on an area raised above the inter-dunal swale, and which would therefore be unaffected by rainfall events. Access is by an existing track to a previous dustfall gauge site. The site would require minimal clearance and site works. The existing access track would need some upgrading.

**Figure 2.2 Potential Interim Store site at Olympic Dam – Oblique Aerial (To North)**
Underground

The existing underground development workings are in excess of 200 km long, and there is potential for some of these drives to be suitable for locating an Interim Store. As a result of the Feasibility Study being conducted on a major expansion of the mine, possibly involving moving to open cut techniques, there is considerable uncertainty about the future of the underground development.

At the northern end of the orebody, however, the size depth and grade of the ore is such that it is extremely unlikely that it will be disturbed by a possible future open cut pit. Thus at this end of the orebody and at depth, there are parts of the existing underground development, particularly redundant exploration drives, that may remain undisturbed for the life of the Interim Store, that would be suitable for the interim storage of radioactive waste. The potential underground site would be at some depth, for example the rail haulage level is some 740 m below ground level (bgl).

If this option were to be pursued, further discussions would need to be held with BHP Billiton to identify any potential development drives that may be suitable, and also to determine the preferred size and form of container. For example, a 1.8x1.2 m container 1.0 m high, fabricated from stainless steel for long life, may be preferred for ease of handling underground. The containers could be moved in the future, should the development drive chosen be required for future mining operations.

At present, stainless steel containers are fabricated to order at the OD Waste Management Centre, utilising cathode plates (used for electrorefining and electrowinning copper) that have reached the end of their service.
life. Thus the containers could be fabricated at the OD operations site, utilising waste material generated on site.

Each 1.8x1.2x1.0 m size container could accommodate six standard 210 L drums (dimensions approximately 572x880 mm). Based on an average net storage of approximately 0.16 m$^3$ per drum, each container could accommodate about 1 m$^3$ of waste material, and total gross weight per container for a maximum drum weight of 300 kg would be up to about 2 t. Depending on packing efficiency, approximately 22 such containers would be required to contain the existing total waste quantity of 22 m$^3$.

If no particular existing drive was considered suitable, a new drive could be developed specifically for the Interim Store, into an area of low mineralisation and which is unlikely to be mined in the future. The indicative cost for a new drive as indicated by WMC is approximately $3,000/m, thus a new dedicated 50 m drive (which should be adequate for a 50 year Interim Store) would cost some $150,000, not including the cost of installing a suitable security gate across the entrance.

### 2.2.3 Interim Store Selection Criteria

**Population Density**

On the most recent Census Night (August 2001) there were 3,814 people (including overseas visitors) in the Roxby Downs region as indicated below in Figure 2.4. This represents an increase of 1,144 people (42.8%) since the 1996 Census, continuing the trend from the 1991 Census.

The OD site is 16 km north of the Roxby Downs town centre. There is construction camp accommodation for BHP Billiton personnel and contractors at Olympic Dam Village (ODV), adjacent to the airport, and the accommodation numbers could rise significantly in the short-term should the proposed further expansion proceed. ODV is about 5 km south of the processing plant. It is noted that ODV is not a permanent settlement.
Even with significant population growth in Roxby Downs over the next 50 years, it is very unlikely that it will be necessary for anyone to live permanently near the potential Interim Store sites.

Furthermore, compared with communities in other locations in Australia, the Roxby Downs population is well informed about radiation issues, and accept the fact that the existing operations produce and manage large quantities of LLRW. Thus from a population density point of view, either the surface or underground sites are well suited to hosting an Interim Store.

**Security**

**Surface**

In the 2001 Census, in the Roxby Downs region 209 people were employed in the Manufacturing industry, 139 were employed in the Construction industry, 158 were employed in the Retail Trade industry, 209 were employed in the Property and Business Services industry, 111 were employed in the Education industry and 73 were employed in the Health and Community Services industry. It is therefore likely that security services could be arranged via service providers in Roxby Downs.

Another option may be OD itself, which employs its own security staff. A security program could be designed in consultation with OD that is compatible with its existing and future security plans. The costs of these services could be part of a contractual arrangement between OD and the relevant SA government Department that has been designated as responsible for the waste.

Thus it is very likely that cost-effective security services could be arranged to ensure the security of the Interim Store.

**Underground**

It would not be practical for an independent firm to provide security services to a portion of the underground development, so the only viable option would be for OD to provide these services. As discussed above, these services could be part of a contractual arrangement between OD and the relevant SA government Department.

**Cultural or historical significance**

Extensive Aboriginal heritage studies and consultation with Aboriginal groups was undertaken by WMC prior to the first EIS, in 1982 / 83 (Kinhill Stearns Roger 1982). Further consultation and heritage studies were undertaken during the Expansion EIS in 1996 / 97 (Kinhill Engineers 1997). In addition to these periods of intensive studies and consultation, there has been ongoing consultation with Aboriginal groups since 1982 / 83. In particular, prior to any new development within the Special Mining Lease or elsewhere, the relevant Aboriginal groups are consulted, and a site visit and sign-off procedure is employed to ensure that sensitive areas are avoided.

Such a procedure would need to be undertaken for the Interim Store. Whether this consultation process would be undertaken using BHP Billiton procedures, or under separate State procedures, would depend on any land tenancy arrangements to be discussed by the SA government with BHP Billiton.
**Water table**

The hydrogeological regime at OD is very well known, and is described in detail in the 1997 EIS (Kinhill Engineers 1997). The OD mine is developed beneath a regional aquifer system that occurs in the sedimentary rocks of the Stuart Shelf. The surface sediments are generally up to 10 m thick and are underlain by the Andamooka Limestone, which is a pale dolomitic limestone extending to depths of 40-60 m at OD. The limestone exhibits karstic features and has minor occurrences of perched aquifers. Groundwater salinities are in excess of 20,000 mg/L making it unsuitable for either stock or human consumption.

The Andamooka Limestone overlays deeper aquifer zones within the quartzites and sandstones of the Arcoona Quartzite and Corraberra Limestone. The static water levels are generally less than 50 m bgl. The groundwater salinities of the Arcoona Quartzite are in the range of 20,000-40,000 mg/L. The water contains sodium chloride and high concentrations of sulphate (5,000 mg/L), as well as detectable levels of naturally occurring uranium and radium.

The Olympic Dam breccia complex itself has little primary porosity. Although the potentiometric head in the breccia complex is similar to that of the Arcoona Quartzite, the groundwater transmissivities are at least several orders of magnitude lower. The breccia complex groundwater is similar to that of the Arcoona Quartzite, except that upper band salinities are higher, up to 95,000 mg/L, naturally occurring heavy metals such as lead and zinc are higher, and the breccia complex groundwater also contains detectable levels of naturally occurring uranium and radium.

Overall the local groundwater is considered unsuitable for either stock or human consumption, and its principal potential beneficial use is for use in mining and minerals processing. The OD mine has created a deep cone of depression into the local groundwater table, and groundwater local to the mine drains towards the mine, and into the mine development workings. This mine water is collected and pumped to the surface, where it is utilised in a number of ways, including for dust suppression and drilling.

The Interim Store, if on the surface, would be fully bunded and the waste contained, and would have no effect on local groundwater. If the Interim Store were located underground, it would be below the Andamooka and Arcoona aquifers, in a breccia rock matrix that has areas of high mineralisation, including uranium and other radionuclides. For either option, it is considered that potential impacts on groundwater would be minimal.

**Rare Fauna or Flora**

Information on flora and fauna data was obtained from the OD Expansion EIS (Kinhill Engineers 1997).

The dune and swale areas, in which the potential surface Interim Store could be located, are generally dominated by Acacia woodland and tall shrubland vegetation on the dune ridges, merging into low chenopod shrubland vegetation in the dune swales. The vegetation of the area has been degraded for over a century by past land use and introduced herbivores, particularly the European rabbit. The degradation slowed following the removal of domestic stock by WMC in 1986, and the release in 1996 of Rabbit Calicivirus Disease.

Fauna species of particular conservation significance in the region include five mammal species, twenty-one bird species and five reptile species. The plains rat, plains-wanderer and possibly the woma python are of conservation significance either nationally or internationally. Most vertebrate species are naturally low in
abundance in this arid environment. All vertebrate species recorded before the 1983 EIS were still present during preparation of the 1997 EIS.

The potential impact of the proposed Interim Store on flora and fauna, in the context of the existing development at the OD site, is expected to be negligible.

**Seismic, tectonic or volcanic activity during operating life**

Figure 3.3 of the Interim Store Stage 2 Report (URS 2005b) showed the geological fault locations, earthquake sites since 1840, and the earthquake risk coefficient for SA. It was noted that the earthquake data shown in the figure was not able to discriminate between actual earthquakes and earth vibrations caused by industrial activities such as blasting. Thus many recordings in the vicinity of mine sites would be expected to have been due to blasting.

The earthquake risk coefficient is published by Geoscience Australia. The areas of higher seismic risk relate to a predicted gravity acceleration coefficient of 10% or greater in a 50 year period; medium risk is 5 to 10%; and low risk is less than 5%. The OD area is within the medium risk zone.

The Interim Store Stage 1 Report (URS 2005a) discussed the design criteria that would be used for the Interim Store. In summary the Interim Store would be designed in accordance with AS/NZ 1170 Part 4: Earthquake Actions. The consequences of a severe earthquake, should it occur, would be of minor concern given the nature of the waste, and its conditioning and containment.

**Flooding during operating life**

In the OD region, the Bureau of Meteorology has been collecting weather data from Woomera since the 1940s and Andamooka since the 1960s. Annual rainfall is recorded to be 175 mm at Woomera, with a highest recorded monthly rainfall of 191mm in March, and 179 mm at Andamooka, with a highest recorded monthly rainfall of 231mm, also in March (PPK Environment & Infrastructure 2002).

WMC have also recorded climatic information since 1980 (Kinhill Engineers 1997). In the period 1980-95, the average annual rainfall at OD was approximately 200 mm, however this period included two years of high rainfall events, and the long-term annual average rainfall is estimated from Bureau of Meteorology information to be 160 mm (Kinhill Engineers 1997). Kinhill Engineers estimated the 1 in 100 year storm event intensity to be 204 mm/hr (5-minute), 10.1 mm/hr (12-hour) and 2.16 mm/hr (72-hour).

In high rainfall events at OD, water seeps rapidly into the sand dunes and tends to pond in the swales, where it may remain for some days or even weeks. Thus it would be inappropriate to locate a surface Interim Store in the swales. Equally, a location on a sand dune would be undesirable from the point of view of vegetation clearance and visual impact.

As noted in Section 2.2.2, the particular location identified is relatively clear of vegetation, on the northern side of a sand dune, on an area that is raised above the inter-dunal swale, which therefore would be unaffected by rainfall events. In addition the proposed Interim Store would be bunded, which would also provide protection against rainfall events.
**Transport**

**Surface**

Olympic Dam is accessible by road and the distance from Adelaide is about 580km. The route from OD to Adelaide is currently used regularly to transport uranium oxide concentrate product for export.

The potential surface site would require some minor road works to connect the store with the wide vehicle access road, a distance of about 250 m (Section 2.2.2). This roadwork would be minor because it would need to be functional for a relatively short period during construction and initial operations, and then every 5 years or so during transfer campaigns.

**Underground**

The underground site would use the same existing surface infrastructure as the surface option, and would not require any additional road infrastructure. Specialised trucks and cranes may be required to transport waste from the surface to the underground store location, if standard 6 m length shipping containers were used for transporting the waste. However if 1.8x1.2x1.0 m stainless steel containers were used (as described in Section 2.2.2), it is understood that the existing trucks and cranes used within the OD mine would be suitable.

**Land ownership and tenure**

**Surface**

The Special Mining Lease land is owned freehold by BHP Billiton.

If the surface site were to be pursued, discussion would need to be entered into with BHP Billiton to determine land ownership and tenure options. In previous discussions with WMC, the company stated their requirement that any arrangements make would need to make clear that the site is responsibility of the State, and that the waste stored is owned by the State. The key land tenure alternatives appear to be:

- to excise the Interim Store site from the Special Mining Lease, to State ownership; and
- for the State to enter into a lease arrangement with BHP Billiton for use of the Interim Store site.

Both of these alternatives provide a feasible way of ensuring secure tenure for the life of the store. The SA government would need to discuss potential tenure options with BHP Billiton.

**Underground**

For the underground option, the SA government would need to pursue discussion with BHP Billiton on a possible 50 year lease of space within the underground mine development.

**Land Uses**

The Special Mining Lease of some 18,000 ha is owned and managed by BHP Billiton. The mine, smelter and infrastructure currently occupy about 5 percent of the Olympic Dam Special Mining Lease. The Special
Mining Lease, and the adjacent 11,000 ha Municipal Lease, have been de-stocked of sheep and cattle since 1986.

2.2.4 The Quantity of Radioactive Waste

As noted above, WMC stated their requirement that any arrangements make would need to make clear that the site is the responsibility of the State, and that the waste stored is owned by the State. OD would not utilise the Interim Store, and would retain its existing approved facilities for radioactive waste storage. Thus the quantity of waste to be secured in the store will be unchanged from that described in the Stage 1 Report.

2.2.5 Potential Risks to People and the Environment

The risk assessment presented in the Stage 2 Report applies generally to the OD site option.

The surface site is within the OD Special Mining Lease area, although it is close to the southern boundary. OD has a comprehensive environmental monitoring program set out in an Environmental Management Manual, which is reviewed and updated every three years. The Manual includes monitoring requirements for flora and fauna, air quality, groundwater and environmental radiation. The results of this comprehensive monitoring program are reported to the SA government and are made public.

For the underground option, the potential environmental risks are reduced, as the store would be further isolated from the environment, being at considerable depth (some 740 m bgl) and within or immediately adjacent to an existing radioactive ore body. However, in the future, it is likely that the location would be in an area for which mine ventilation may no longer be in place, and thus personnel accessing the area may require breathing apparatus. Any personnel accessing the area would be subject to a radiation protection program.

2.3 Radium Hill

2.3.1 Background

The Radium Hill Uranium Mine and Low Level Radioactive Waste Repository Management Plan Phase I report (PIRSA 2004) provides a comprehensive discussion of background, past and present operations at Radium Hill, and this report largely provided the information in the following discussion.

Uranium mineralisation was discovered at Radium Hill in 1906 and by 1911, 600 tonnes of ore had been mined, producing a few hundred milligrams of radium and several hundred kilograms of uranium. The early workings included 5 shafts but due to economics, they were abandoned before the end of WWI.

In 1944, a new program began. By 1952, the ore reserves had been proved to be large enough for economic extraction of uranium. Later a township capable of accommodating over 1000 people was built. Water was piped from Broken Hill, and electrical power came from Morgan. A rail link was established to connect the mine with the Broken Hill to Port Pirie line, allowing crushed ore to be sent to Port Pirie for processing.

In 1954 full-scale mining was commissioned and operated by the SA government. The mine was decommissioned in 1961/62 and rehabilitated to the standard of the day. This included removal of much of
the infrastructure and sealing the underground development, but it did not include rehabilitation of the main tailings impoundment.

PIRSA (2004) indicates that over subsequent years (up to 1981), erosion resulted in the movement of some material from the tailings impoundment. In 1981, action was taken to cover these impoundments with local soil material, and to establish a low-level radioactive waste repository within the impoundment.

The tailings dam at Radium Hill contains some 225,000 t of tailings and some 233 m$^3$ of LLRW, which was placed on top of the tailings dam in the period 1981-1998. The LLRW material disposed of primarily comprises material and equipment from the testing of radioactive ores, and contaminated soil. The last deposit in the repository was made in 1998.

The Radium Hill site is characterized by natural features that are conducive to the interim management of radioactive waste. These features include the following:

- very low annual precipitation rate;
- very high annual evapo-transpiration rate; and
- limited up-gradient drainage area with a potential of generating run-on to the site under extreme precipitation conditions.

2.3.2 Potential Interim Store Site Description

An additional important consideration for locating an Interim Store within the Radium Hill area is the mineral potential that still exists in the area. A possible location that is in an area not affected by possible future activities is shown in Figure 2.5.
The possible identified location is immediately to the north of and adjacent to the previous Support Buildings area. The Support Buildings area is to the north of the ‘line of lode’ that runs generally east-west (Figure 2.6). The deposit dips to the south, away from the identified location. The location is thus in a previously disturbed area, and is close to existing access roads.

If a site survey were to show that there is inadequate space available in the area indicated in Figure 2.5, other potential suitable locations are available in the area along the northern Repository Reserve boundary, either to the west or east of the suggested site. Alternatively the Reserve boundary could be regazetted, 100 m to 200 m the north-west.
2.3.3 Interim Store Selection Criteria

Population Density

On Census Night in August 2001, there were 340 people (including overseas visitors) in Unincorporated Pirie region (the area shaded green in Figure 2.7) which encompasses Radium Hill. This represents a decrease of 27 and 152 people since the 1996 and 1991 Census respectively. The nearest townships are Cockburn, Olary and Yunta. The area is characterised by a sparse population - approximately one person for every 110 km$^2$. The closest residence to the Radium Hill site is 20 km away.
This shows that the region surrounding Radium Hill is very sparsely populated, thus ensuring that very few people would be adversely impacted upon by the presence of an Interim Store. The population trend is currently downwards indicating that there is potential for the area to remain sparsely populated for the duration of the Interim Store project. Note that the current population levels and this downward trend indicate that the sustained availability of nearby infrastructure and service providers may be unlikely.

**Security**

There is nobody living permanently at the site and the nearest permanent resident is located 20 km away. In the region, the 2001 Census indicated that: 3 people were employed in the Manufacturing industry; 13 in Construction; 9 in Retail and in Education; and none were employed in the Property and Business Services or the Health and Community Services industry.

Thus the potential for the provision of local, reliable and experienced security services is relatively poor. This would mean that remote security monitoring technology may need to be employed. While this is feasible, any security breach would be addressed somewhat slowly. This slow response time needs to be considered in the context of the potential security risks, and given the absence of tools and lifting equipment, the absence of flammable and combustible materials, the strength and mass of the filled storage containers, the response time may be acceptable.

**Cultural or historical significance**

A search of the Australian Heritage Places Inventory website and the Australian Heritage Database revealed no information on sites of significance.
PIRSA 2004 reported that there is a long Aboriginal history (the Wiljakali tribe) in the Radium Hill area. The tribe typically lived in small nomadic family groups, with their movements dictated by the seasonal conditions. No formal archaeological studies have been conducted within the area.

In 1990 the Radium Hill Historical Association (then known as the Radium Hill Community Association) was formed. The key objectives of the Association are to establish and preserve the historical and cultural heritage of the former Radium Hill town, Pioneer’s Cemetery, and Heritage Museum. Over the years, the Association has organised a number of reunions at the town site, and the rehabilitation of the cemetery.

Given the small footprint and the proposed location of the Interim Store it should be possible to establish the store with minimal impact on local heritage.

**Water table**

Information on groundwater in the area is not comprehensive, and further verification would be required to confirm the following discussion. Five bores were installed in 1982 within 3 km of the mine site, which indicated that the standing water level is 6-12 m below surface.

PIRSA 2004 reported that the groundwater in the area is 55 m below the surface and moving slowly towards Lake Torrens with salinity increasing from 35 000 ppm towards 100 000 ppm total dissolved solids. Within the mine site, early mining reports from the mid 1920s indicate that a reasonable supply of water was located within the then main shaft at 13.7 m, which presumably was a perched fresh water aquifer. Also of note was that in very dry conditions this water was used for drinking.

The Stage 1 Report recommended that “The water table in the area should be at a sufficient depth below the planned disposal structures to ensure that groundwater is unlikely to rise to within half a metre of the floor, and large fluctuations in water table are unlikely.” From the information above and the rainfall data discussed below, it is unlikely that the water table would rise to within 5 m of natural ground level. While there is no information available to assess temporal fluctuations in groundwater level, the low rainfall and the very large excess of evaporation make large fluctuations unlikely.

**Rare Fauna or Flora**

There are no proclaimed National Parks and Wildlife Reserves within the Radium Hill district. The area is located largely within the Flinders Lofty Block of the Interim Biogeographical Regionalisation of Australia (version 5.1), spilling over into the Broken Hill Complex. No systematic flora and fauna surveys are known to have been undertaken within the Radium Hill area.

Within the mine site, the most noted tree species is the pepper tree (*Schinus molle*). The area has been used for grazing for over 150 years. The condition of the native vegetation is generally poor, suffering from the harsh climate (and periodic drought) and stock trampling and grazing. The site selected as a potential location for the Interim Store has very limited flora and habitat potential (Figure 2.8).

The Stage 1 Report recommended that “The site should not be in an area which has special environmental significance, or which is the known habitat of rare fauna or flora.” The site selected and the surrounding area has been extensively previously disturbed and is considered to be very likely to meet this criterion.
Interim Store Location

SECTION 2

Figure 2.8 View of the potential site for the Interim Store as Radium Hill

Seismic, tectonic or volcanic activity during operating life

Radium Hill is located in the medium seismic risk area of SA, i.e. in the area which has a predicted gravity acceleration coefficient of 5 to 10% over a 50 year period. The Australian Standard for earthquake loading (AS1170.4, 1993) would be used in the design of the Interim Store. No issues are foreseen in the design of a suitable Interim Store at the site.

Flooding during operating life

PIRSA (2004) reported that Radium Hill itself is a low ridge (about 5 m above the surrounding plain) approximately 1 km in length. The area is generally flat to undulating, with a minor slope to the south. The surface drainage of the mine site is directed towards the south and southwest, flowing into the nearby Olary Creek. A number of small dams were built along some of the minor tributaries leading into Olary Creek. Figure 2.9 shows the drainage lines in the vicinity of the site.
Figure 2.9 Radium Hill Surrounds

Source: PIRSA 2004
The general climatic conditions are hot, very dry summers, cool to mild winters, and low rainfall. A weather station was set up during the main mining period (January 1951 to December 1961) and a record daily rainfall and evaporation exists for the period. Longer-term recording stations within proximity of the Radium Hill area were located at Broken Hill to the northeast and Yunta to the west.

The mean annual rainfall (data from the Radium Hill weather station) over this 11-year period was 233 mm. The peak daily rainfall was typically about 40 mm with one peak of about 85 mm. Annual evaporation for the same period was 2580 mm.

The Broken Hill and Yunta monitoring stations both have records dating back to the late 1890s and show the highest 24-hour rainfall event as 139.4 mm at Broken Hill and 112.3 mm at Yunta. The mean annual rainfall for all records at Broken Hill and Yunta is 255 mm and 236 mm, respectively. Rainfall can occur throughout the year, but extreme rainfall events are more likely in summer.

Figure 2.9 shows that the potential location chosen for the Interim Store in elevated above nearby drainage lines and some 2 km from Olary Creek. The data indicates that high rainfall events are relatively rare, and the peak magnitude is likely to be 120 mm in 24 hours. This indicates that flooding would be relatively rare and probably confined to the vicinity of the main drainage lines and creeks.

**Transport**

The two main options for transport to Radium Hill from Adelaide are via:

1. the Main North Road and Gawler Bypass then along the Barrier Highway; or
2. Route 1 and then turning off near Crystal Brook via Peterborough to the Barrier Highway.

Radium Hill Mine is located on Maldorky Station and access to the site is from the north via Tikalina Station. The site is located about 5 km from the Barrier Highway and is accessed via an irregularly maintained dirt road.

The quality and reliability of the dirt road is such that a specific maintenance program may be required before the commencement of construction of the Interim Store, and before each storage campaign.

The available routes are such that there would be no significant additional risks presented by transporting waste to the store. Furthermore, the transport of waste would be so infrequent and inherently safe as to present no significant risk to the drivers and the general public en route to the store.

**Land ownership and tenure**

The Radium Hill site is on SA Crown Land, and is vested with PIRSA. In 1975, a 247 ha rectangular area (portions of Pastoral Blocks 961 and 1192) was gazetted as being exempt from operation under the provisions of the Mining Act. In 1981, the same area was gazetted as ‘Reserved for Purposes of a Repository for Low Level Radioactive Wastes’.
No mining leases are current within the general area, but much of the area surrounding the mine site is covered by two exploration licences. These licences do not include the area exempted under the Mining Act covering the actual repository site and main mine development.

The ownership and tenure of the land is considered to be compatible with the needs of an Interim Store.

**Land Uses**

The Radium Hill Mine site and surrounding land is located on Maldorky Station and includes portions of Pastoral Blocks 961 and 1192. The main land use is sheep grazing for wool production.

PIRSA 2004 reported that soils within the area are considered well-drained shallow sandy loam of relatively low fertility. Groundwater is slightly alkaline (pH 7-8), contains elevated levels of Radium (2-10 Bq/L) and is relatively saline (8860-41000 mg/L).

From a geological point of view, the Radium Hill area has potential for gold, uranium and other metals, the economics of which are dependent on market prices. As described above, there are no current mining leases within the general area, but much of the area surrounding the mine site is covered by two exploration licences (base metals including zinc, lead, silver, copper and gold). These licences do not include the repository area exempted under the Mining Act.

Figure 2.10 shows the uranium orebodies as defined in 1973 (PIRSA 2004). Modern exploration, extraction and processing methods have improved greatly since 1973 and it is possible that further economic deposits may be found in the vicinity. Information on the location and shape of known orebodies was used in selecting the site for the Interim Store.

The possible location is within the exempted area and away from areas that might be impacted upon by future mining of known orebodies. The store footprint would be relatively small and would have an insignificant impact on any future agricultural or recreational activities.
Figure 2.10 Radium Hill Geological Plan as defined in 1973

Source: PIRSA 2004
2.3.4 The Quantity of Radioactive Waste

The tailings dam at Radium Hill contains about 225,000 t of tailings and 233 m$^3$ of LLRW, which was transferred by PIRSA from Port Pirie and placed on top of the tailings dam in the period 1981-1998 (PIRSA 2004). The LLRW primarily consists of material and equipment from the testing of radioactive ores, and contaminated soil.

While there are other potential legacy projects being considered by PIRSA in which rehabilitation might consist of moving bulk LLRW to another location, the Radium Hill site is not currently under consideration. Note that bulk waste is not within the scope of the Interim Store.

Thus the quantity of waste that would need to be stored at an Interim Store located at Radium Hill is the same as that described in the Stage 1 Report, i.e. up to 100 m$^3$.

2.3.5 Potential Risks to People and the Environment

PIRSA 2004 conducted a detailed risk assessment of the Radium Hill site as it stands today. This assessment showed that the site does not currently present a significant radiological hazard to occasional visitors (gamma dose <0.3 mSv for full-time occupancy of up to 1 week, compared with the general public limit of 1mSv/y).

The data quoted in the PIRSA report would not be acceptable if they were applicable to construction of an interim store that took more than 3 weeks to complete and the workers remained on site entirely (24/7) during that period. The location selected is more likely to cause significantly lower doses, and workers are likely to be accommodated off-site (thus reducing the time of exposure). Even if doses at the potential store location were similar to those quoted for the gravel road, gamma dose rates would be significantly less than 0.07 mSv per week. If this location were selected, a specific radiological risk assessment would be required to ensure the safety of construction workers.

Non-radiological hazards were also considered, including: subsidence of underground development; industrial waste; presence of unsound structures; possible asbestos etc. The field trip for this Interim Store study confirmed that there are significant hazards present at various locations around the site. The potential Interim Store site, however, is relatively free of these hazards and it would be possible to suitably restrict access to the old mine workings by use of signs and bunting.

The Stage 2 Report assessed the generic risks associated with the construction and operation of the store, and with the transport of waste to the store. Apart from the discussion above, the Radium Hill site does not present any risks that were not assessed in the Stage 2 Report.
3.1 Introduction

The Stage 1 Report pointed out that the disposal of radioactive waste attracts significantly higher standards of human health and environmental protection because, in disposal facilities, isolation of the waste from the biosphere relies primarily on site characteristics and secondarily on engineered features of the constructed facility. For an Interim Store, the final waste disposition will not occur and the waste will ultimately be moved for disposal.

It should be noted, however, that long-lived ILRW is within the scope of this study, and such material is not suitable for near-surface disposal (as it is excluded by the NHMRC 1992 Code). This material, while small in volume, represents a more significant risk in terms of storage safety and terrorism potential, and the existing arrangements are considered unacceptable for the long-term. This volume, based on the ILRW sealed source volumes in the Stage 1 report, is estimated to be up to 5 m$^3$ at present, and up to 24 m$^3$ in 2050 (URS 2005a).

An improved form of safe, secure and easy to manage (consolidated) storage is required until a permanent solution is available. Therefore a small Interim Store is an inherent component of any LLRW and short-lived ILRW disposal options discussed below.

Note also that the Interim Store will be designed for a life of up to 50 years, during which time a permanent solution will be developed and the waste moved. Under a disposal option, the NHMRC 1992 Code required a minimum institutional control period of 100 years. Thus the disposal aspects of any proposal will need to demonstrate that the controls will be in place for at least 100 years.

3.2 Site Selection Criteria

The site selection criteria for a near surface repository are set out in the Code of practice for the near-surface disposal of radioactive waste in Australia (NHMRC 1992), and are summarised in Table 3.1.

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Required Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The facility site should be located in an area of low rainfall, should be free from flooding and have good surface drainage features, and generally be stable with respect to its geomorphology.</td>
<td>Low rainfall.</td>
</tr>
<tr>
<td></td>
<td>Free from flooding.</td>
</tr>
<tr>
<td></td>
<td>Good surface drainage.</td>
</tr>
<tr>
<td></td>
<td>Stable geomorphology.</td>
</tr>
<tr>
<td>2. The water table in the area should be at a sufficient depth below the planned disposal structures to ensure that groundwater is unlikely to rise to within five m of the waste, and the hydrogeological setting should be such that large fluctuations in water table are unlikely.</td>
<td>Water table at sufficient depth.</td>
</tr>
<tr>
<td></td>
<td>Large fluctuations should be unlikely.</td>
</tr>
</tbody>
</table>
### Criterion Required Attributes

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Required Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. The geological structure and hydrogeological conditions should permit modelling of groundwater gradients and movement, and enable prediction of radionuclide migration.</td>
<td>Modelling of groundwater gradients and movement and thus radionuclide migration should have a high degree of certainty and reliability.</td>
</tr>
<tr>
<td>4. The repository should be located away from any known or anticipated seismic, tectonic or volcanic activity which could compromise the stability of the disposal structures and the integrity of the waste.</td>
<td>Away from seismic, tectonic or volcanic activity.</td>
</tr>
<tr>
<td>5. The site should be in an area of low population density and in which the projected population growth or prospects for future development are also very low.</td>
<td>Low population density, growth, and future development.</td>
</tr>
<tr>
<td>6. The groundwater in the region of the site which may be affected by the presence of a facility ideally should not be suitable for human consumption, pastoral or agricultural use.</td>
<td>Groundwater ideally not suitable for human consumption, pastoral or agricultural use.</td>
</tr>
<tr>
<td>7. The site should have suitable geochemical and geotechnical properties to inhibit migration of radionuclides and to facilitate repository operations.</td>
<td>Geochemical and geotechnical properties to inhibit migration of radionuclides, and to facilitate repository operations.</td>
</tr>
<tr>
<td>8. The site for the facility should be located in a region which has no known significant natural resources, including potentially valuable mineral deposits, and which has little or no potential for agriculture or outdoor recreational use.</td>
<td>No known significant natural resources. Potential for agriculture or outdoor recreational use.</td>
</tr>
<tr>
<td>9. The site should have reasonable access for the transport of materials and equipment during construction and operation, and for the transport of waste to the site.</td>
<td>Existing major roads and railways should provide reasonable access.</td>
</tr>
<tr>
<td>10. The site should not be in an area which has special environmental attraction or appeal, which is of notable ecological significance, or which is the known habitat of rare fauna or flora.</td>
<td>Special environmental attraction, notable ecological significance, known habitat of rare fauna or flora.</td>
</tr>
<tr>
<td>11. The site should not be located in an area of special cultural or historical significance.</td>
<td>Cultural or historical significance. Or proposed listing.</td>
</tr>
<tr>
<td>12. The site should not be located in reserves containing regional services such as electricity, gas, oil or water mains.</td>
<td>Regional services.</td>
</tr>
<tr>
<td>13. The site should not be located in an area where land ownership rights or control could compromise retention of long-term control over the facility.</td>
<td>Land ownership and retention of control.</td>
</tr>
</tbody>
</table>

Facility design requirements as required by the NHMRC 1992 Code are discussed in Section 3.3. Both the OD and Radium Hill sites are assessed against the Code criteria (Table 3.1) in Section 3.4.
3.3 Facility Design Requirements

Near-surface disposal would take place in accordance with the NHMRC 1992 Code. The two principal options available are trenches and boreholes, as described in the National Repository project Draft EIS (PPK 2002). A trench would require a relatively large excavation, with sides battered to prevent collapse, and a ramp for access by construction machinery, and is more suitable for relatively large quantities of waste material.

Boreholes are more suitable for small quantities of waste material, and cause much less surface disturbance. For the small quantities to be disposed of in SA, it is envisaged that the preferred disposal option would be by use of boreholes.

It is envisaged that the boreholes would be of order 9 m to 12 m deep and 2 m across. The proposed configuration is shown in Figure 3.1, and comprises seven standard 210 L drums (dimensions approximately 572x880 mm) per layer. Based on an average net storage of approximately 0.16 m$^3$ per drum, and assuming a cover of 100 mm of soil or clay between each layer, the configuration could accommodate approximately 1.1 m$^3$ of waste material for each 1 m depth of the borehole.

Thus, allowing for a 2 m cap, a 12 m deep borehole could accommodate up to approximately 11 m$^3$ of waste material in 210 L drums. It is expected that two boreholes of about 10 m depth each should be sufficient to accommodate the existing LLRW and short-lived RW (approximately 17 m$^3$ of the total of approximately 22 m$^3$). It is noted, however, that not all of the material may be accommodated in 210 L drums, and if so some other containers may be required, which may reduce the overall borehole capacity.

The facility design considerations are compared against the NHMRC Code requirements in Table 3.2. The feasibility of an underground repository is discussed in Section 3.4.3. It is noted that although the 1992 Code is for near-surface disposal, the general principles set out in this Code would apply for underground disposal.
# Table 3.2 NHMRC 1992 Code Design Requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Design Consideration</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Waste shall be disposed of in a manner which ensures the integrity of the package. Void spaces between packages should be minimised and such spaces filled to prevent subsidence or settlement.</td>
<td>Waste will be conditioned to satisfy this requirement prior to being transported to site. Spaces between waste packages (probably 210 L drums) will be filled with soil or clay.</td>
</tr>
<tr>
<td>b. The base of a disposal structure shall be constructed in accordance with best engineering practice, and shall be capable of bearing the weight of the whole system.</td>
<td>The base of each borehole would be compacted to ensure that it has sufficient strength to hold the weight of the waste and covering materials.</td>
</tr>
<tr>
<td>c. Suitable engineered barriers of natural or manufactured materials shall be incorporated in the design of the facility. Their purpose is to guarantee the integrity of the waste under all foreseeable circumstances, to minimise the possibility of water infiltrating the disposal structure, and to delay or prevent radionuclide migration, both during operations and after closure of the facility. In addition, the engineered barriers should be designed to provide protection in the event of inadvertent intrusion into the disposal structure. For Category B and C waste the design life of the barriers shall be not less than 300 years with a structural life of 1000 years. For Category B waste the conditioned waste package may provide one such barrier.</td>
<td>A multi-barrier approach would be adopted similar to that described in the National Repository EIS. The scale, however, would be much smaller (approx 17 m$^3$ of waste material initially, compared with 3700 m$^3$ nationally). The boreholes (9 m to 12 m deep) would probably be dug using compressed air tools or use of diamond drilling and expansions grouts if rock is encountered. It is expected that two boreholes would be sufficient to accommodate the existing LLRW and short-lived ILRW.</td>
</tr>
</tbody>
</table>
| d. The design shall include a suitably engineered cover for the disposal structure following a consideration of site specific parameters. The cover may require several layers of material to be incorporated into the design, each layer having a specific function to stabilise the structure, prevent ingress of water, discourage entry of animals and people, and inhibit erosion. The minimum cover requirements for each category of waste shall be: for Category A, 2 m between the top of the waste and the top surface of cover; for Category B, 5 m between the top of the waste and the top surface of cover; for Category C, 5 m between the top of the waste and the top surface of cover. | Category B waste would be stored in the bottom 4 m to 7 m of each borehole – for borehole depths of 9 m to 12 m respectively. The 2 m thick cover would be multi-layered including (starting from the top of the waste):  
- compacted soil;  
- an impermeable layer to prevent water infiltration, and domed to aid drainage;  
- a sand layer to allow water to drain away and protect the impermeable layer from the layers above;  
- a rock layer to discourage intrusion by digging animals;  
- a topsoil layer to encourage vegetation; and  
- erosion control layer (rocks and coarse gravel). |
### Requirement Design Consideration

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Design Consideration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>e.</strong> Backfill material shall be used to prevent subsidence and to minimise settlement within the disposal structure.</td>
<td>All voids would be filled and compacted as the waste is placed, in layers. Each layer could accommodate seven 210 L drums (Figure 3.1). Each layer of the cap up to the topsoil would be compacted, and the surface domed to minimise the impact of minor subsidence (see requirement (d) above).</td>
</tr>
<tr>
<td><strong>f.</strong> Each disposal structure shall be accurately located and surveyed. Appropriate permanent surface and below-ground markers shall be put in place to define the boundaries and locations of disposal structures.</td>
<td>Modern survey techniques will be used to mark the boreholes on a plan. Permanent above and below ground markers will be fixed to each borehole.</td>
</tr>
<tr>
<td><strong>g.</strong> A surface water management system shall be incorporated to control water erosion of the cover and to divert water away from any partially Filled disposal structure, but shall not allow water to drain off-site.</td>
<td>A temporary bund would be installed during construction to prevent water inflow into the borehole. A large tarpaulin could be used to prevent rainfall from entering the borehole, if required. The final layers of the cap will be domed to divert surface water away.</td>
</tr>
<tr>
<td><strong>h.</strong> Drainage shall be provided so that any water, which might enter the disposal structure during operations or following the closure of the site, does not accumulate within the structure.</td>
<td>Appropriate drainage will be installed.</td>
</tr>
<tr>
<td><strong>i.</strong> Category A waste shall not be placed in the same structure as Category B or C waste, except if Category A waste is conditioned or packaged to meet the same criteria as Category B or C. Suitable Category A waste may be considered to form part of the cover requirements for Category B or C as in d above.</td>
<td>It is proposed to condition all wastes in 210 L steel drums, and that Category A waste containers would be placed above Category B waste containers and thus form part of the cover (see requirement (d) above).</td>
</tr>
<tr>
<td><strong>j.</strong> A buffer zone shall be maintained between buried waste and the boundary of the repository. This zone shall be of sufficient area surrounding the facility operations to allow environmental monitoring to be carried out, to allow contingency measures to be carried out in an emergency, and to ensure that during site operations there is an adequate distance between the facility and any area used by, or accessible to, members of the public.</td>
<td>An adequate buffer zone will be defined and fenced.</td>
</tr>
<tr>
<td><strong>k.</strong> Consideration should be given to the inclusion of a zone of restricted occupancy outside the site perimeter as a region in which there is public access, but in which permanent occupancy is prohibited for the institutional control period.</td>
<td>This issue will be considered in the detailed plans.</td>
</tr>
</tbody>
</table>
3.4 Olympic Dam

3.4.1 Feasibility of Disposing of Waste in an Existing Repository

WMC indicated that it would prefer to manage its OD wastes separately, and would not wish to accept responsibility for the wastes of others. The OD Indenture makes no provision for activities that are not ancillary to mining or minerals processing (Section 6.6). Thus it is not recommended that the existing repository at OD used by BHP Billiton be used for the disposal of additional waste within the scope of this study.

3.4.2 Feasibility of Disposing of Waste in a New Surface Repository

The surface site selected for the Interim Store described in Section 2.3.2, would also be suitable for a repository for LLRW and short-lived ILRW, using boreholes. As noted in Section 3.1, a small Interim Store would be necessary for long-lived ILRW, pending a suitable long-term disposal option becoming available.

NHMRC Site Selection Criteria

The site selected at OD has the characteristics outlined in Table 3.3.

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Olympic Dam Suitability</th>
</tr>
</thead>
<tbody>
<tr>
<td>The facility site should be located in an area of low rainfall, should be free from flooding and have good surface drainage features, and generally be stable with respect to its geomorphology.</td>
<td>The long-term annual average rainfall is estimated from Bureau of Meteorology information to be 160 mm (Kinhill Engineers 1997). Kinhill Engineers estimated the 1 in 100 year storm event intensity to be 204 mm/hr (5-minute), 10.1 mm/hr (12-hour) and 2.16 mm/hr (72-hour). The site selected has good surface drainage and is elevated above the inter-dunal swale and thus will be free from flooding. The dune and swale system at OD is geomorphologically stable.</td>
</tr>
<tr>
<td>The water table in the area should be at a sufficient depth below the planned disposal structures to ensure that groundwater is unlikely to rise to within five metres of the waste, and the hydrogeological setting should be such that large fluctuations in water table are unlikely.</td>
<td>As described in Section 2.2.2, the hydrogeological regime at OD is very well known. The OD regional aquifer system that occurs in the sedimentary rocks of the Stuart Shelf, which extend to depths of 40-60 m. The static water levels are generally less than 50 m bgl. The OD area is dominated by a groundwater cone of depression caused by the mine underground development. Boreholes of up to 12 m depth would be well above the local groundwater. Fluctuations in groundwater level will be influenced by rainfall and mining activities. The low rainfall expected will have only a slight influence. The groundwater cone of depression caused by either the underground development or possible open pit (and the associated dewatering required), is likely to ensure that the groundwater level is depressed substantially further than the levels discussed above.</td>
</tr>
</tbody>
</table>
### Disposal Options

**SECTION 3**

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Olympic Dam Suitability</th>
</tr>
</thead>
<tbody>
<tr>
<td>The geological structure and hydrogeological conditions should permit modelling of groundwater gradients and movement, and enable prediction of radionuclide migration.</td>
<td>The geological structure and hydrogeological regime at OD are very well known. Thus modelling of groundwater gradients and radionuclide migration should have a high degree of certainty.</td>
</tr>
<tr>
<td>The repository should be located away from any known or anticipated seismic, tectonic or volcanic activity which could compromise the stability of the disposal structures and the integrity of the waste.</td>
<td>Olympic Dam is located in the in the medium seismic risk area of SA, i.e. in the area which has a predicted gravity acceleration coefficient of 5 to 10% over a 50 year period (Section 2.2.3). The design of the repository would take into account the likelihood and consequences of a severe earthquake, so that it would be of minor concern given the nature of the waste, and its conditioning and containment.</td>
</tr>
<tr>
<td>The site should be in an area of low population density and in which the projected population growth or prospects for future development are also very low.</td>
<td>In 2001 there were 3,814 people in the Roxby Downs region, an increase of 1,144 people (42.8%) since the 1996 Census, continuing the trend from the 1991 Census. The potential repository is 16 km north of the Roxby Downs town centre. Olympic Dam Village (ODV) is adjacent to the airport, but the accommodation is short-term and ODV is not a permanent settlement. Even with significant population growth in Roxby Downs over the next 50 years, it will not be necessary for anyone to live permanently near the potential repository.</td>
</tr>
<tr>
<td>The groundwater in the region of the site which may be affected by the presence of a facility ideally should not be suitable for human consumption, pastoral or agricultural use.</td>
<td>Groundwater has salinities in excess of 20,000 mg/L, and detectable levels of naturally occurring uranium and radium, making it unsuitable for either stock or human consumption.</td>
</tr>
<tr>
<td>The site should have suitable geochemical and geotechnical properties to inhibit migration of radionuclides and to facilitate repository operations.</td>
<td>Soil geochemical and geotechnical properties would need to be specifically studied to determine their ability to inhibit migration of radionuclides and to facilitate repository operations.</td>
</tr>
<tr>
<td>The site for the facility should be located in a region which has no known significant natural resources, including potentially valuable mineral deposits, and which has little or no potential for agriculture or outdoor recreational use.</td>
<td>The potential site is near the OD deposit, however the location is well away from the existing mine and metallurgical plant areas, and also away from the potential open pit and metallurgical plant footprint that is presently being studied by BHP Billiton. The area is within the existing OD Special Mining Lease, and so has little potential for agriculture or outdoor recreational use. A repository would reduce the available area by a trivial amount.</td>
</tr>
<tr>
<td>The site should have reasonable access for the transport of materials and equipment during</td>
<td>Olympic Dam is accessible by road and the distance from Adelaide is about 580km. The route from OD to Adelaide is currently used regularly</td>
</tr>
</tbody>
</table>
### Disposal Options

#### SECTION 3

<table>
<thead>
<tr>
<th><strong>Criterion</strong></th>
<th><strong>Olympic Dam Suitability</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>construction and operation, and for the transport of waste to the site.</td>
<td>to transport uranium oxide concentrate product for export. The potential repository site would require some minor road works to upgrade the existing track to the wide vehicle access road, a distance of about 250 m. This roadwork would be minor because it would need to be functional for a relatively short period during construction and initial operations, and then every 5 years or so during transfer campaigns.</td>
</tr>
<tr>
<td>The site should not be in an area which has special environmental attraction or appeal, which is of notable ecological significance, or which is the known habitat of rare fauna or flora.</td>
<td>As per the discussion above for the Interim Store, the potential impact of a repository on flora and fauna, in the context of the existing development at the OD site, is expected to be negligible.</td>
</tr>
<tr>
<td>The site should not be located in an area of special cultural or historical significance.</td>
<td>As per the discussion above for the Interim Store, the potential impact of a repository on culturally or historically significant sites, in the context of the existing development at the OD site, is expected to be negligible.</td>
</tr>
<tr>
<td>The site should not be located in reserves containing regional services such as electricity, gas, oil or water mains.</td>
<td>The site is not located in reserves containing regional services.</td>
</tr>
<tr>
<td>The site should not be located in an area where land ownership rights or control could compromise retention of long-term control over the facility.</td>
<td>The Roxby Downs (Indenture Ratification) Act 1982 as updated in 1996, sets out the relationship between the SA government and BHP Billiton. The OD operation is located on freehold land wholly owned by BHP Billiton, within a Special Mining Lease established under Section 19 of the Indenture. By negotiation with BHP Billiton for suitable lease or other arrangements for the Interim Store site, it is expected that the SA government would have the ability to exert long-term control over the facility.</td>
</tr>
</tbody>
</table>

The discussion above shows that the site selected at OD appears to meet all of the criteria for near-surface radioactive waste disposal, however further assessment would be required of the soil geochemical and geotechnical properties to inhibit the migration of radionuclides, and also for design purposes. Further studies would be required to resolve this issue, although it should be noted that this uncertainty is mitigated somewhat by the unsuitability of the local groundwater for either stock or human consumption.

### 3.4.3 Feasibility of Disposing of Waste Underground

The option described in Section 2.2.2 for storage underground at OD would be suitable for disposal of LLRW and short-lived ILRW. Long-lived ILRW could be held in managed storage underground in the same area, pending a suitable long-term disposal option becoming available. The underground option has benefits in relation to security, monitoring requirements and cost. Any arrangements would be subject to discussion with and agreement by BHP Billiton.
It is noted that it is assumed that the stainless steel containers described in Section 2.2.2 would continue to be used for the underground disposal option for LLRW and short-lived ILRW. Thus, if at some future time it were decided that the material should be re-located to another repository, this could be readily undertaken.

Options for long-lived ILRW are discussed further in Section 4.

3.4.4 The Quantity of Radioactive Waste

As discussed in Section 3.4.1, WMC indicated that it would prefer to manage its OD wastes separately, and does not wish to accept responsibility for the wastes of others.

The quantity of waste would thus remain unchanged from that discussed in the Stage 1 Report, because OD wastes will be managed separately.

3.4.5 Potential Risks to People and the Environment

The risk assessments presented in the Stage 2 Report and above in Section 2.2.5 also apply to a large extent to a surface disposal operation. The key differences are:

- groundwater – an Interim Store could employ active techniques to demonstrate its integrity and its isolation from the groundwater below for a period of 50 years. Near-surface disposal designs are aimed at ensuring this integrity and isolation via passive means, for some hundreds of years; and

- security – an Interim Store would be relatively visible and require continual security services for the 50 year period. A near-surface repository would require less sophisticated security services, for the period of institutional control (>100 years).

There are however some identified changes in the risk profile in relation to the underground option.

Generally, for the underground option the potential environmental risks are reduced, as the store and repository would be further isolated from the environment, being at considerable depth (some 740 m bgl) and within or immediately adjacent to an existing radioactive ore body. However, it is likely that the location would be in an area for which ventilation may no longer be in place. Thus personnel accessing the area may require breathing apparatus. Any personnel accessing the area would be subject to a radiation protection program.

In the future, when mining of the OD deposit is proposed to cease, any long-lived ILRW that may be held in storage underground would need to be removed. When mining operations have ceased, the minewater pumping system would no longer be in operation, and the mine (whether underground or open cut) would be expected to eventually flood to a level of approximately that of the pre-existing Arcoona quartzite water table level of 50 m bgl.

It would thus be necessary to undertake an assessment of the potential radionuclide pathways of the residual LLRW and short-lived ILRW (noting that the latter will have decayed significantly) into the biosphere, and to model these pathways to ensure that the public and environment would not be adversely affected.
The quality of the water in the flooded workings and the radionuclide content of the surrounding rock will be heavily influenced by the fact that the repository is within or adjacent to what was a very large uranium orebody. Thus the modeling will need to be able to show the incremental impact of the residual waste on the public and environment should this water return to the biosphere. This assessment would need to be undertaken during the environmental assessment stage of the project.

### 3.5 Radium Hill

#### 3.5.1 Feasibility of Disposing of Waste in an Existing Repository

During informal discussions with PIRSA personnel, it was apparent that PIRSA would probably not allow the existing waste repository to be modified in any way unless full responsibility for the site was to be transferred to a new owner. Furthermore, the existing site may not meet some of the NH&MRC near-surface disposal criteria, namely:

- **Stable geomorphology** – the existing repository is on top of the old tailings dam and thus is in a man-made, elevated structure whose erosion resistance may not be satisfactory; and
- **Groundwater modelling** - radionuclide migration modelling would have a low degree of certainty and reliability because of the influence of existing waste and the poor level of information about the construction of the existing structure.

Thus it is recommended that the existing repository not be used for the disposal of the additional waste within the scope of this study.

#### 3.5.2 Feasibility of Disposing of Waste in a New Surface Repository

The site identified in Section 2.3 for the Interim Store may also be suitable for near surface disposal. A slight disadvantage to permanent management is the fact that only about 2 m of surface soils exist at the Radium Hill site, making construction of near-surface boreholes difficult. This limitation could be overcome through standard engineering techniques at modest additional cost.

### NHMRC Site Selection Criteria

There is much overlap between the recommended site selection criteria for an Interim Store and the NHMRC selection criteria for a near-surface disposal operation. Thus much of the discussion in the sections above will be applicable to both storage and disposal of radioactive waste. Table 3.4 provides a summary of information provided above, and additional details on the other criteria.
### Table 3.4 Near Surface Repository Site Selection Criteria – Radium Hill

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Radium Hill Suitability</th>
</tr>
</thead>
<tbody>
<tr>
<td>The facility site should be located in an area of low rainfall, should be free from flooding and have good surface drainage features, and generally be stable with respect to its geomorphology.</td>
<td>The mean annual rainfall over the 11-year period commencing January 1951 was 233mm. The peak daily rainfall was typically about 40 mm with one peak of about 85mm. Annual evaporation was 2580 mm. Nearby the highest 24-hour rainfall event in over 100 years of records was 139.4 mm at Broken Hill and 112.3 mm at Yunta. Mean annual rainfall for all records at Broken Hill and Yunta is 255 mm and 236 mm, respectively. The potential location chosen for the repository is elevated above nearby drainage lines and some 2 km from Olary Creek. The data shows that high rainfall events are relatively rare and low in magnitude. This indicates that flooding would be relatively rare and probably confined to the vicinity of the main drainage lines and creeks. The flat terrain and the low rainfall indicate that erosion in the vicinity of a repository would be relatively easy to control.</td>
</tr>
<tr>
<td>The water table in the area should be at a sufficient depth below the planned disposal structures to ensure that groundwater is unlikely to rise to within five metres of the waste, and the hydrogeological setting should be such that large fluctuations in water table are unlikely.</td>
<td>The standing water level in the region is reported to vary from 6 to 50 m below surface, and is approximately 15 m at the mine site. A specific study would be required but it is likely that the water table is at sufficient depth and that large fluctuations are unlikely.</td>
</tr>
<tr>
<td>The geological structure and hydrogeological conditions should permit modelling of groundwater gradients and movement, and enable prediction of radionuclide migration.</td>
<td>There is some existing geological / hydrogeological information, and there is every reason to expect that modelling of groundwater gradients and movement and thus radionuclide migration could be done with a high degree of certainty and reliability.</td>
</tr>
<tr>
<td>The repository should be located away from any known or anticipated seismic, tectonic or volcanic activity which could compromise the stability of the disposal structures and the integrity of the waste.</td>
<td>Radium Hill is located in the in the medium seismic risk area of SA, i.e. in the area which has a predicted gravity acceleration coefficient of 5 to 10% over a 50 year period. The design of the repository would take into account the likelihood and consequences of a severe earthquake, so that it would be of minor concern given the nature of the waste, and its conditioning and containment.</td>
</tr>
<tr>
<td>The site should be in an area of low population density and in which the</td>
<td>The area is characterised by a sparse population (approximately one person for every 110 km²) and the</td>
</tr>
<tr>
<td>Criterion</td>
<td>Radium Hill Suitability</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>projected population growth or prospects for future development are also very low.</td>
<td>closest residence to the Radium Hill site is 20 km away. The current population trend is downwards.</td>
</tr>
<tr>
<td>The groundwater in the region of the site which may be affected by the presence of a facility ideally should not be suitable for human consumption, pastoral or agricultural use.</td>
<td>Groundwater at the site has been used for human consumption and pastoral or agricultural use. By today’s drinking water standards, some treatment would be required to allow human consumption in the future. It should be noted, however, that the presence of the existing tailings dam and LLRW repository would make insignificant any additional contributions from a new Interim Store facility designed to today’s standards.</td>
</tr>
<tr>
<td>The site should have suitable geochemical and geotechnical properties to inhibit migration of radionuclides and to facilitate repository operations.</td>
<td>Geochemical and geotechnical properties of the site have not been studied specifically, but the presence of the nearby tailings dam and LLRW repository, and the remaining uranium and radium ores, and the underground development would reduce the significance of this criterion.</td>
</tr>
<tr>
<td>The site for the facility should be located in a region which has no known significant natural resources, including potentially valuable mineral deposits, and which has little or no potential for agriculture or outdoor recreational use.</td>
<td>There may be minerals resources nearby, but the best available information suggests that the location selected minimises any potential impact. The chosen location is away from the line of lode of the Radium Hill deposit. There is minor potential for outdoor recreational use (annual Radium Hill Historical Association visit). There is also minor potential for agriculture. The development of a radioactive waste disposal operation would have negligible impact on such uses of the area.</td>
</tr>
<tr>
<td>The site should have reasonable access for the transport of materials and equipment during construction and operation, and for the transport of waste to the site.</td>
<td>Existing major roads should provide acceptable access. Maintenance may be required on the unsealed road from the Barrier Highway to the site before construction and before disposal campaigns.</td>
</tr>
<tr>
<td>The site should not be in an area which has special environmental attraction or appeal, which is of notable ecological significance, or which is the known habitat of rare fauna or flora.</td>
<td>There are no proclaimed National Parks and Wildlife Reserves within the Radium Hill district. The area has been used for grazing for over 150 years. The condition of the native vegetation is generally poor, suffering from the harsh climate (and the current drought) and stock trampling and grazing. The site selected (Figure 2.8) has very limited flora and habitat potential.</td>
</tr>
<tr>
<td>The site should not be located in an area of special cultural or historical significance.</td>
<td>There are no known sites of cultural or historical significance that would be impacted upon by a repository (Section 2.3).</td>
</tr>
<tr>
<td>The site should not be located in reserves</td>
<td>The site is not located in reserves containing regional</td>
</tr>
</tbody>
</table>
### Disposal Options

#### Criterion Radium Hill Suitability

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Radium Hill Suitability</th>
</tr>
</thead>
<tbody>
<tr>
<td>containing regional services such as electricity, gas, oil or water mains.</td>
<td>services.</td>
</tr>
<tr>
<td>The site should not be located in an area where land ownership rights or control could compromise retention of long-term control over the facility.</td>
<td>The site is located on SA Crown Land.</td>
</tr>
</tbody>
</table>

The above discussion shows that the Radium Hill site appears to meet all the selection criteria for a LLRW and short-lived ILRW repository. The potential issues of concern are the cost of drilling boreholes, the water table depth and the cost and reliability of security services. The water table issue might be accommodated by using a greater number of shallower boreholes but this would increase cost.

It is noted also that the groundwater has been used for human consumption and has potential for future agricultural use. There is also insufficient information available to make definitive conclusions about the geochemical and geotechnical properties of the site and the modelling of groundwater and radionuclide movements.

Long-lived ILRW would need to be held in managed storage, pending a suitable long-term disposal option becoming available. This managed storage could be a small surface store in the vicinity of the boreholes, in the general location described in Section 2.3.2. The options for long-lived ILRW are described further in Section 4.

#### 3.5.3 The Quantity of Radioactive Waste

As discussed in Section 2.3.5, the quantity of radioactive waste material would not change if Radium Hill were to be selected as a repository site.

#### 3.5.4 Potential Risks to People and the Environment

The risk assessments presented in the Stage 2 Report and above in Section 2.3.5 also apply to a large extent to a disposal operation. The key differences are:

- **groundwater** – an Interim Store could employ active techniques to demonstrate its integrity and its isolation from the groundwater below for a period of 50 years. Near-surface disposal designs are aimed at ensuring this integrity and isolation via passive means, for some hundreds of years; and

- **security** – an Interim Store would be relatively visible and require continual security services for the 50 year period. A near-surface repository would require less sophisticated security services, for the period of institutional control (>100 years).

In the case of Radium Hill, a comprehensive assessment would be required to quantify these risks. Nevertheless because of the location, history and nature of Radium Hill, it is expected that measures could be devised that would ensure that the residual risk is acceptable.
3.6 Conclusions

The discussion above shows that a near-surface radioactive waste repository for SA’s LLRW and short-lived ILRW could be developed at either OD or Radium Hill, which would meet the NHMRC criteria. A small Interim Store, which could be built adjacent to the repository, would be necessary for managed storage long-lived ILRW, pending a suitable long-term disposal option becoming available.

In addition, an underground repository for LLRW and short-lived ILRW could be developed at OD in either an existing or new development drive in the northern extent of the mine. Long-lived ILRW could be held in managed storage underground in the same area, pending a suitable long-term disposal option becoming available.

If either Olympic Dam or Radium Hill were determined to be unsuitable for any reason, other potential locations may be suitable, as discussed in the Stage 2 report (URS 2005b).

Olympic Dam

The surface site selected at OD appears to easily meet all of the NHMRC criteria, however the potential surface site soil geochemical and geotechnical properties would need to be further assessed, in relation to inhibition of migration of radionuclides, and also for design purposes. It should be noted, however, that any uncertainty in relation to radionuclide migration is mitigated by the local groundwater cone of depression and the unsuitability of the local groundwater for either stock or human consumption.

The underground option is also considered suitable and has benefits in relation to security, monitoring requirements and cost.

Radium Hill

There is much information available about previous operations at the Radium Hill mine to indicate that it would be a suitable site for a near-surface repository for LLRW and short-lived ILRW. The location appears to meet all the NHMRC criteria other than for groundwater, which may be relatively shallow, has been used for human consumption, and has potential for future agricultural use. However, it is noted that the area includes a radioactive ore body, and the groundwater regime in the area has been compromised by the previous mine development.

The potential surface site soil geochemical and geotechnical properties would need to be further assessed, in relation to inhibition of migration of radionuclides, and also for design purposes. The history of the site and the presence of the nearby tailings dam and LLRW repository, and the remaining uranium and radium ores, and the underground development would potentially place significance restrictions on future land uses of the site and its surrounds.

The development of a near-surface repository would not create the need for significant additional restrictions. Thus it is reasonable to conclude that the Radium Hill site would, subject to additional detailed studies, be a suitable site for a near-surface repository.
4.1 Introduction

The discussion above focuses on the interim storage of long-lived ILRW and the final disposal of LLRW and short-lived ILRW. The long-term management of long-lived ILRW is not able to be determined at this point in time. The following section reviews developments in this area.

4.2 Commonwealth

In 2001, the Australian government announced that it would establish a purpose-built facility on Commonwealth land for the storage of long-lived ILRW produced by Australian government agencies. In 2004, following abandonment of the national radioactive waste repository project, the Commonwealth announced that it would co-locate its repository facility for LLRW from Commonwealth agencies with the national store for long-lived ILRW, and that the States would need to make their own arrangements for their radioactive waste management.

A short-list of sites for the Commonwealth facilities was announced on 15 July 2005 (Commonwealth Minister for Education, Science and Training media announcement). Three potential sites have been identified: all are Defence properties in the Northern Territory. One is at Fishers Ridge, near Katherine, and the other two are at Mt Everard and Harts Range, near Alice Springs. Studies into the suitability of each of the sites are expected to commence later in 2005.

4.3 South Australia

In the long-term, because of the long half-lives of the ILRW involved, some form of permanent disposal will be required to safely manage SA’s long-lived ILRW.

In January 2005, the IAEA released a Draft Safety Guide titled “Borehole Facilities for the Disposal of Radioactive Waste” (DS 335), which is focused on ILRW. When this guide has been published as a final version, the information may be used by ARPANSA to develop a Code of Practice. When published, such a Code could be used to develop options for disposal of SA’s long-lived ILRW.

This option would be relatively expensive because of the small volumes involved, and thus it would be preferable to improve safety and economies of scale by combining efforts with other jurisdictions.

Pending the development of the above Code, and availability of other options, the long-lived ILRW could be held in managed storage at OD or Radium Hill, as described in Sections 3.4.3 and 3.5.3.

4.4 Other State Facilities

4.4.1 Queensland

The Queensland Radioactive Waste Store in Esk currently stores LLRW and short-lived ILRW that has become waste within that state. The store, however, was built to very high standards and may be suitable for temporary storage of long-lived ILRW.
Options for Long-Lived ILRW

Like most States and Territories, Queensland has a policy of not accepting radioactive waste from other jurisdictions. While there are obvious political advantages from such a policy, there is no technical reason why a small volume of SA long-lived ILRW could not be stored along side Queensland waste. Thus one option might be to liaise with the Queensland government and negotiate a cooperative agreement under which a fee is paid to Queensland for the indefinite storage of SA’s long-lived ILRW. Such an arrangement would probably require that ownership of the waste remain with SA. 

4.4.2 Other State or Territory

As all States and Territories are required to manage their own long-lived ILRW, it is possible that one of these jurisdictions might recognise the benefits of accepting (for a fee), a small quantity of waste from other jurisdictions in order to reduce unit costs. Furthermore, cooperation in the form of capital cost sharing in the early stages of such a project (for design, approval and construction), could result in substantial savings to all parties. Thus one option might be to liaise with other jurisdictions and negotiate a cooperative agreement under which capital is provided and/or a fee is paid for the indefinite storage of SA’s long-lived ILRW.

4.5 International

While many countries have laws preventing the import of radioactive waste, many do not. Furthermore, the Waigani Convention seeks to stop the import of hazardous and radioactive waste into the South Pacific region, and to stop waste traders from using the South Pacific as a highway for hazardous waste. Nevertheless there are appropriate legal means of transporting radioactive waste to properly licensed and regulated waste facilities in other countries.

In the USA, for instance, regulations of the U.S. Nuclear Regulatory Commission (NRC) allow radioactive waste from sources outside the U.S. to be imported through general licenses and through issuance of specific licenses (Code of Federal Regulations, Title 10, Part 110, “Export and Import of Nuclear Equipment and Material” – 10 CFR 110).

The process for granting a specific license to import radioactive waste requires the submittal of a license application and fees (about $13,000 or US$10,100). Nothing in current U.S. policy or NRC practice would prohibit importation of radioactive waste for disposal at a U.S. facility licensed for radioactive waste disposal. Indicative costs can be estimated from the charges for disposal at the Barnwell facility, which are set by the South Carolina Energy Office. Currently, disposal rates range from US$12,000 to US$14,000 per cubic metre for most radioactive waste. Disposal of sealed sources is charged at the rate of US$66,000 per cubic metre.

An exhaustive search for other options was outside the scope of this study so it is not known how many are available, and the requirements that would need to be met. Given the worldwide climate of fear and suspicion regarding all aspects of nuclear materials, it is expected that the options would be very limited, and the requirements would be comprehensive and expensive.
5.1 Commonwealth Approval Process

The Stage 1 Report outlined the Commonwealth approval process under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC), and noted that an Interim Store proposal may not trigger the Act, as the quantity of radioactive waste may be below the threshold regarded as “excessive”, as defined in the Act.

In addition, if the SA Government were to commit that the Store would be managed such that the threshold is not reached in the future, it would appear that the long-term use of the Store would also be outside the EPBC definition. It is recommended that the EPA should seek legal advice as to whether the Store will be a nuclear action, and thus whether a referral is required.

Under EPBC, it is possible to use an “accredited assessment process” where it is agreed that a State or Territory will manage the assessment. This assessment approach allows case-by-case accreditation of State or Territory assessment processes in situations where bilateral agreements and declarations do not apply.

At the present time there is no bilateral agreement in place between SA and the Commonwealth, however the SA assessment process could be used if it were accredited by the Commonwealth for this project. If the legal advice was that the EPBC Act is triggered, an “accredited assessment process” could be sought. In this arrangement the SA government would manage the assessment provided the Commonwealth Environment Minister is satisfied that the relevant impacts of the action will be fully addressed and that he or she will receive an adequate report on those impacts.

5.2 South Australian Approval Process

5.2.1 Development Approvals

Approval Requirement

Developments within SA are governed by the provisions of the Development Act, 1993, and a proposal to develop an Interim Store or repository would fall within the definition of “development”.

Pursuant to Section 32 of the Development Act, no development may be undertaken in SA without approval from the Relevant Authority after having been assessed against:

- the provisions of the appropriate Development Plan; and
- the provisions of the Building Rules.

Relevant Authority

The Relevant Authority is a body prescribed by Section 34 of the Development Act, and can be:

- the Local Council; or
• the Development Assessment Commission (DAC) where the Regulations prescribe, based on the class of development, or if required by the Minister, or if not within a Council area; or

• the Minister for Planning subject to the significance of the development proposed.

The Relevant Authority can only be defined for the project once the full details of the project and the location of the site are established, as both these aspects may affect the outcome of the determination. It is however suggested that the nature of activity is such that we would expect that the Relevant Authority would be either the DAC (pursuant to Schedule 10 of the Regulations, the development of land for the purpose of the reception, storage, treatment or disposal of waste), or the Minister for Planning.

Schedule 21 and 22 of the Development Act Regulations indicate activities that are considered to be activities of environmental significance, and can trigger differing processes for development approval determination.

5.2.2 Process for Approvals

The process for seeking Development Approvals can be achieved using either:

• a Section 39 standard Application for Development Approval process, or

• a Section 49 Crown Development process, or

• a Section 46 Major Developments Declaration process; or

• Creative Processing including use of Section 24 to Amend the Development Plan.

There are varying pros and cons for each option and these will vary depending on the exact site selected, the nature of possible issues, and the ultimate form of the development and it is premature to make such a recommendation at this stage. Nevertheless, it is useful to discuss the validity of each of these to the project generally.

Section 39 Process

As a Section 39 process, an application is lodged by the proponent to the Relevant Authority (and in this case likely to be the DAC) in a prescribed form and with any information reasonably required by the relevant authority and accompanied by such plans, drawings, specifications or other documents as may be prescribed; and a lodgement fee.

On receipt of an application, a relevant authority:

• May request an applicant to provide additional documents or information (including calculations and technical details) as the relevant authority may “reasonably require” to assess the application; seek the remedy of any defect or deficiency in any application or accompanying document or information required; consult with an authority or body prescribed by the regulations; request the preparation of a Statement of Effect in accordance with the regulations in relation to a development of a kind that is expressed to be a non-complying development under the relevant Development Plan.
Categorise the nature of the development and the category of development against which it will assess the application. This will essentially be to categorise the development and use against statutory terms, then to categorise such as Complying, Merit, or Non-Complying within the zone of the land, and to categorise the application as either Category 1, 2 or 3, which refers to the extent of public notification that is required prior to the Relevant Authority making its decision.

Will seek “Referrals and Concurrences” with public authorities and the level of importance that these referrals have are prescribed under the Regulations (and include Transport SA, Coast Protection Board, EPA, Minister for Heritage, Primary Industries and Resources South Australia (PIRSA), Department of Environment and Heritage, Native Vegetation Council, State Aboriginal Affairs, and Planning SA) as:

- **Regard** - the relevant authority cannot consent to or approve the development without having regard to the response of the prescribed body;

- **Concurrence** - the relevant authority cannot consent or approve the development without the concurrence of the prescribed body (which concurrence may be given by the prescribed body on such conditions as it thinks fit);

- **Direction** - the prescribed body may direct the relevant authority to refuse the relevant application; or if the relevant authority decides to consent to or approve the development (subject to any other Act) to impose such conditions as the prescribed body thinks fit (and that the relevant authority must comply with any such direction).

May require public notification if necessary (Category 2 and Category 3).

Will issue a Notice of Determination.

It is possible that the nature of this project is such that the zoning of sites where such a facility might be located will be such that this development could be categorised as either of Merit or Non-complying, as there are only a small number of zones in SA in which such an activity would be listed as Complying. A categorisation of Non-complying essentially removes any right of appeal by the proponent.

**Section 49 Process**

Crown Development Applications are decided by the Minister for Planning but are lodged with the DAC for assessment “advice”, with notification required to be issued to the local Council.

DAC is required to consider the application and the comments of the local Council and report to the Minister of Planning who can then approve or reject the application. The report will determine whether or not the project will be “seriously at variance” with relevant Development Plans, and any code or standard prescribed by Regulations. DAC may require the Development Application to be publicly notified.
Section 46 Process

The Minister of Planning may, if of the opinion that a declaration under Section 46 is appropriate or necessary for the proper assessment of development or a project of major environmental, social or economic importance, by notice in the Gazette, declare that this section applies and consider the application.

In such a case, a Major Developments Panel (panel of experts) is appointed by the Minister of Planning to consider the matter, and this could require the proponent to prepare either:

- an EIS;
- a PER; or
- a Development Report (DR).

Each of the above has differing (reducing) degrees of assessment rigour. The Panel will formulate guidelines for the preparation of the report. A public meeting is required during the public exhibition period for an EIS or PER but not for a DR.

5.3 Environmental Authorisations

Activities which are likely to be of environmental significance are also governed by the Environment Protection Act, 1993 (EP Act). Clause 36 requires that a person must not undertake a prescribed activity of environmental significance except as authorised by an environmental authorisation in the form of a licence.

Part A of Schedule 1 of the EP Act lists the activities that are considered to be prescribed activities of environmental significance. Item 3 is Waste or Recycling Depots, which is defined as the conduct of a depot for the reception, storage, treatment or disposal of waste. In addition, a waste transport business (category B) is included on the list and is defined as the collection or transport for fee or reward of .... solid waste from any commercial or industrial premises or from any teaching or research institution (other than building or demolition waste).

Accordingly, a licence will be required under the EP Act for both the operation of the Interim Store and the transport of waste to the store. This can only be granted after the Development Approval is issued, but prior to works and operations commencing.

Notwithstanding the above approvals, there are general environmental duties under the EP Act (Section 25) that require that a person may not undertake an activity that pollutes or might pollute the environment unless the person has taken all reasonable and practicable measures to prevent or minimise any resulting environmental harm.

Environmental harm is defined by Section 5 of the EP Act and a series of Environmental Protection Policies under the Act. This while not an approval per se, is a very powerful statutory tool that needs to be considered in defining the project. Measures to comply with the provisions of Section 25 will depend on:

- The nature of pollution or potential pollution and the sensitivity of the receiving environment
The financial implications of the various measures that might be taken as those implications relate to the class of persons undertaking activities of the same kind or similar kind.

The current state of technological knowledge and likelihood of successful applications of various measures that might be taken.

### 5.4 Radiation Protection Authorisations

**Licence to use or handle radioactive substances**

Clause 28 of the Radiation Protection and Control Act 1982 (RPC Act) requires that “A natural person shall not use or handle a radioactive substance unless that use or handling is authorised by a licence or temporary licence under this section.”

Thus a licence will be required for each person involved in the handling of radioactive waste, i.e., conditioning operations, transfers within the storage facility etc. Such people will need to demonstrate that they are fit and proper people to hold a licence, and that they have appropriate knowledge of the principles and practices of radiation protection to carry on the activities required.

**Registration of premises in which unsealed radioactive substances are handled or kept**

Clause 29 of RPC Act requires that “Any premises in which an unsealed radioactive substance is kept or handled must be registered under this section in the name of the occupier of the premises”. Note that it is not intended that unsealed sources in liquid form will be accepted for storage in the Interim Store.

Thus the Interim Store will need to be registered in the name of the occupier of the premises.

**Registration of sealed radioactive source**

Clause 30 of the RPC Act requires that a sealed radioactive source must be registered in the name of the owner of the source. Registration is achieved by application in the prescribed form and the payment of a fee.

Arrangements will need to be made to clarify the ownership of the sealed sources once physically transferred to the store. Transfers of ownership are also controlled under the regulations under the Act. Registration requirements will also need to be clarified.

**Regulations under the Radiation Protection and Control Act 1982**

Division 3 of the Regulations, Accounting for and Storage and Labelling of Radioactive Substances, places many requirements on the registered occupier of premises in which radioactive substances are kept or handled, including:

- maintain a detailed register of unsealed radioactive substances; and
• maintain a detailed register of sealed radioactive sources (whether or not registered under Section 30 of the Act);

As long-term interim storage was probably not foreseen by the writers of the regulations, arrangements will need to be made to ensure that these administrative requirements are sufficiently comprehensive without being unnecessarily complex, to achieve the aims of the Act.

### 5.5 Emergency Response Plan

A suitable Emergency Response Plan should be in place for potential incidents that could occur during conditioning, transport, interim storage, construction and disposal. These procedures should include events such as accidents, protest, terrorism and sabotage.

### 5.6 Other State Approvals

Dependant on the site selected, there could be other State approvals required including but not limited to:

- Permits under the Native Vegetation Act for vegetation clearance; and
- Approvals under the Heritage and Aboriginal Heritage Acts.

### 5.7 Issues Specific to Olympic Dam

The Indenture under which OD operates provides for mining and exploration activities, and activities and infrastructure ancillary to mining and the processing of minerals. Ministerial consent is required for the lessee to use the Special Mining Lease for other activities. A legal view would need to be obtained to confirm that the Indenture would permit the establishment of an Interim Store or repository within the Special Mining Lease, and to determine any processes for this to occur.

One of the options noted in Section 2.2.3 is excision of the site from the Special Mining Lease. This option may be able to overcome any issues associated with the OD Indenture, however the SA government would need to discuss this option with BHP Billiton.

### 5.8 Issues Specific to Radium Hill

As stated in Section 2.3.3, the Radium Hill site is on SA Crown Land, and is vested with PIRSA. The 247 ha rectangular area is exempt from operation under the provisions of the Mining Act, and has been gazetted as ‘Reserved for Purposes of a Repository for Low Level Radioactive Wastes’. Legal advice may be required to determine if an Interim Store or new repository would be allowed under the current terms of the Reserve, or if modifications need to be gazetted.

### 5.9 Public Consultation

The generic requirements for public consultation under both Commonwealth and SA planning laws were outlined in the Stage 1 Report. Given that an Interim Store or repository project is likely to be seen as a
sensitive issue, however, it would be prudent to plan for a more extensive public consultation process than is required by the various planning laws.

Public consultation should be conducted at each stage of the process, and the type of consultation should be appropriate to allow public education and acceptance. Table 5.1 outlines a generic consultation process that would be suitable for an Interim Store or repository project.

### Table 5.1 Public Consultation

<table>
<thead>
<tr>
<th>Stage</th>
<th>Type of Public Consultation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feasibility and site selection</td>
<td>Web site containing all relevant information.</td>
</tr>
<tr>
<td></td>
<td>Half-day workshop of invited community, industry and government representatives.</td>
</tr>
<tr>
<td></td>
<td>Final presentations to the general public followed by questions and answers.</td>
</tr>
<tr>
<td>Planning approvals</td>
<td>Invite public comments on environmental assessment guidelines.</td>
</tr>
<tr>
<td></td>
<td>Presentations of the draft environmental assessment report to the general public followed by questions and answers.</td>
</tr>
<tr>
<td></td>
<td>Invite written comments on the draft environmental assessment report.</td>
</tr>
<tr>
<td></td>
<td>Updated web site.</td>
</tr>
<tr>
<td>Construction and operation</td>
<td>Pre-construction consultation with local community - presentations followed by questions and answers.</td>
</tr>
<tr>
<td></td>
<td>Annual or biannual community consultation during the operational phase.</td>
</tr>
<tr>
<td></td>
<td>Updated web site.</td>
</tr>
</tbody>
</table>

Most of the consultation described in Table 5.1 would be conducted after suitable advertising, allowing sufficient time for the public to plan and respond. The advertising should reference previous advertising to highlight the efforts to be transparent and consultative.

Should the OD site be chosen, the local stakeholders that would be affected are relatively familiar with issues associated with the transport and management of uranium product from the mine. Many stakeholders en route would be familiar with the regular truck movements transferring uranium oxide concentrate to Adelaide for export. Thus the level of consultation would be targeted accordingly.

In the Radium Hill case, however, many stakeholders (particularly further from but en route to the site) may not be aware of the uranium mining history or the more recent transfer of radioactive waste to the site (which ceased in 1998). Thus more comprehensive education and consultation would be required.

### 5.10 Timing

There are minimum periods for public consultation specified in both Commonwealth and SA planning laws. There is also discretion allowed for the period for public comment on the draft report to be extended. In
addition, the length of time needed to conduct the environmental assessment depends on the level of assessment determined by the relevant Commonwealth / SA Ministers.

Thus there are inherent uncertainties as to the length of time needed to conduct an environmental assessment process, and it is very difficult to plan a timeline for the approval process. Table 5.2 sets out the steps required and an estimate of the deadline for each step, following submission of this report. Note the time periods indicated are approximate, and are generally sequential unless otherwise indicated. Where opportunities arise to run steps in parallel, these should be undertaken.
## Table 5.2 Timetable for the Approval Process

<table>
<thead>
<tr>
<th>Stage</th>
<th>Step milestone / event</th>
<th>Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 3 Report submitted to EPA</td>
<td>EPA to then review and determine final site selection process and the nature of the project (store/repository)</td>
<td>August 2005</td>
</tr>
<tr>
<td>Final site selection</td>
<td>Half-day workshop of invited community, industry and government representatives. Final Feasibility Report presentations to the general public followed by questions and answers. Web site containing all relevant information.</td>
<td>1 to 2 months</td>
</tr>
<tr>
<td>Planning and other approvals</td>
<td>Agreement with Commonwealth on level of assessment and cooperative arrangements</td>
<td>1 month</td>
</tr>
<tr>
<td></td>
<td>Prepare and issue draft guidelines</td>
<td>1 month</td>
</tr>
<tr>
<td></td>
<td>Invite public comments on environmental assessment guidelines.</td>
<td>1 month</td>
</tr>
<tr>
<td></td>
<td>Issue final guidelines</td>
<td>1 month</td>
</tr>
<tr>
<td></td>
<td>Conduct environmental assessment and prepare preliminary draft (NB – time depends on level of assessment)</td>
<td>6 to 12 months</td>
</tr>
<tr>
<td></td>
<td>Finalise preliminary draft and submit and release the draft environmental assessment report</td>
<td>1 month</td>
</tr>
<tr>
<td></td>
<td>Public comment on the draft report</td>
<td>1 to 1.5 months</td>
</tr>
<tr>
<td></td>
<td>Response to comments (NB – time depends on level of assessment)</td>
<td>1 to 2 months</td>
</tr>
<tr>
<td></td>
<td>Planning authority releases environmental assessment report</td>
<td>2 months</td>
</tr>
<tr>
<td></td>
<td>Ministerial approval</td>
<td>1 month</td>
</tr>
<tr>
<td></td>
<td>Finalise environmental and radiation licences / approvals</td>
<td>1 month</td>
</tr>
<tr>
<td>Construction</td>
<td>Specific design for the facility</td>
<td>2 months</td>
</tr>
<tr>
<td></td>
<td>Approval of plans</td>
<td>1 month</td>
</tr>
<tr>
<td></td>
<td>Construction</td>
<td>3 months</td>
</tr>
<tr>
<td></td>
<td>Inspection and approval of building works</td>
<td>1 month</td>
</tr>
<tr>
<td>Operation</td>
<td>Management system, including Management Plans for environment, radiation, quality, health and safety, emergency response (in parallel with facility design)</td>
<td>2 months</td>
</tr>
<tr>
<td></td>
<td>Training (in parallel with approval of plans)</td>
<td>1 month</td>
</tr>
<tr>
<td></td>
<td>Waste collection and conditioning pilot (commence following approval of plans)</td>
<td>1 month</td>
</tr>
<tr>
<td></td>
<td>Waste collection and conditioning</td>
<td>1 month</td>
</tr>
<tr>
<td></td>
<td>Transport</td>
<td>1 month</td>
</tr>
<tr>
<td></td>
<td>Storage/disposal</td>
<td>1 month</td>
</tr>
<tr>
<td>Audit</td>
<td>Initial audit, and submit report</td>
<td>1 month</td>
</tr>
</tbody>
</table>
6.1 Auditing

6.1.1 Standards

In order to ensure that the operation of the facility is safe and sustainable, some form of management system will need to be implemented, which addresses the issues of quality, risk, environmental, and occupational health and safety. While there are many effective systems available, the following standards appear to have the greatest public recognition in Australia and are relatively common in business and government:

- the International Organization for Standardization (ISO) 9000 family - generic management system standards applying to quality;
- ISO 14001 - generic management system standard applying to environmental performance;
- AS/NZS 4801 – an occupational health and safety standard that follows the same principles and structure as the ISO standards above; and
- AS 4360 – a risk management standard that could be used to address the risk management issues that are part of the above environmental and occupational health and safety standards.

Whatever standards are used to develop the management system for the facility, it is recommended that ISO 19011, Guidelines for Quality and Environmental Management Systems Auditing, should be used to develop the auditing program.

6.1.2 Audit Team

In order to ensure that the management system discussed above is comprehensive and is achieving the safety and public comfort outcomes desired, a publicly credible audit team will need to be formed. An independent audit team leader, who is independent of both the operator and the regulator, would provide an additional level of technical expertise and public comfort that both the operator and regulator could call upon to demonstrate the level of compliance and performance. This auditor should be an accredited lead auditor (recognised by the Quality Society of Australasia, or other international qualification).

The other members of the audit team should include:

- the regulator; and
- a representative from either of the SA government departments responsible for the health or environment areas.

At least one of the audit team should have expertise in radiation protection and the management of radioactive materials.

6.1.3 Audit Timing

It is envisaged that the facility will be constructed and operated briefly initially, and then operated in campaigns that could be as much as 5 years apart. For the remainder of the time the facility will be largely unoccupied and inactive, and visited periodically by security and environmental monitoring personnel.
For this type of operation, an initial audit would need to coincide with the availability of operational personnel, perhaps towards the end of the first scheduled storage/disposal campaign. Thereafter, audits should be scheduled to coincide with subsequent storage/disposal campaigns.

Depending on the outcomes of these audits, and any need to action Corrective Action Requests (CARs), periodic audits could be scheduled, perhaps initially every 2 years. These audits would need to be hosted by a representative of the operator but it would not be expected that the full complement of operational personnel would need to be available.

### 6.1.4 Audit Scope

Because of the infrequent nature of the audits, each campaign audit would need to be fairly comprehensive, covering all of the management system and in particular, the issues identified in Section 6.2.

The periodic audits would focus on security and environmental issues, as well as action on CARs raised by previous audits.

### 6.2 Verification

The following verification information has been developed as a guide for audits and inspections. The information relates mainly to a storage situation rather than disposal, because once disposed of, there is a limited range of appropriate verification techniques available at the individual waste package level. The information on CAR verification and check monitoring, however, applies equally to storage and disposal.

#### 6.2.1 Records Checks

The first aspect of an operation that needs to be verified is its records. It would be difficult to ensure safety without records that are comprehensive, compliant and easy to locate. Examples of checks include:

- completeness – is the full range of documentation filed as required;
- weight - recorded weight of the package compared with the allowable limits for each type of container;
- activity limits - recorded activity levels need to be checked against both package limits and limits for the store/repository;
- radiation - recorded radiation information compared with acceptable levels for safe handling; and
- surface contamination - recorded surface contamination information compared with acceptable levels.

#### 6.2.2 Visual Checks

In addition to checking the records, visual inspection of waste packages can provide increased confidence in the competence and safety of operations. Visual examination may include:

1. external package condition - examination of the external condition of the waste package to identify:
   - package damage (dents, punctures, cracks, swelling, etc.);
Auditing and Verification Systems

SECTION 6

\begin{itemize}
  \item corrosion, evidence of leakage from the package (discoloration, streaking); and
  \item damaged or missing waste package closure mechanisms (bolts, screws, welds).
\end{itemize}

2. tamper seals – check to ensure that seals are not missing or broken;

3. package labeling – labels and markings should be checked to ensure that they are comprehensive (meet the requirements), fixed to the container, and in good condition. Package labels also need to be checked against the records.

6.2.3 Direct Measurement

Having checked that the records conform to the requirements and the labels conform to the records, direct measurements are required to verify that the packages conform to the information on their labels. Examples of direct measurements include:

1. radiation survey - portable radiation monitors can be used to verify conformance with radiation limits of individual waste packages in some cases (depending on the geometry of the situation). The survey may be able to detect mislabeled packages and high activity packages that have been incorrectly placed.

2. surface contamination – a survey of waste packages can verify compliance with acceptance criteria and transportation limits, and can serve as an indication of loss of waste package integrity.

3. torque testing – containers with a bolted closure mechanism can be checked to ensure that bolts have the correct torque (using a calibrated torque wrench).

6.2.4 Radiological and Environmental Check-Monitoring

It is assumed that the operators of the store/repository will be required to conduct radiological and environmental monitoring and to report the data (and an interpretation of data trends) to the regulator. In order to verify these data and analyses, the regulator may wish to obtain its own independent data via a check-monitoring program.

Check monitoring programs can take many forms, depending on the severity of the risks, the costs, and public opinion. Some of the options are for the regulator to:

\begin{itemize}
  \item conduct its own sampling and measuring surveys (concurrently with the operator or at other times); and
  \item require the operator to take duplicate environmental samples so that independent analyses can be conducted;
\end{itemize}

In this case the site is likely to be remote, the costs relatively high, and the site selection criteria and the regulatory requirements are designed to keep the risks down to very acceptable levels. It is therefore recommended that a combination of the above check-monitoring options be used. For example, duplicate environmental samples could be required (for a subset of samples) from the operator as a routine part of the monitoring program, and independent sampling radiation surveys could be conducted when the regulators are visiting the site for audits or inspections.
### 7.1 Introduction

The Stage 2 Report provided recommendations relating to how the various management issues might best be addressed in the SA context. Table 7.1 provides a summary of these recommendations.

**Table 7.1 Recommended Management Model**

<table>
<thead>
<tr>
<th>Issues</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Land ownership and Tenure</strong></td>
<td></td>
</tr>
<tr>
<td>Land owned by?</td>
<td>SA government</td>
</tr>
<tr>
<td>Length of lease?</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Other relevant land issues</td>
<td></td>
</tr>
<tr>
<td><strong>Operational management</strong></td>
<td></td>
</tr>
<tr>
<td>Who is responsible for the management and coordination of:</td>
<td></td>
</tr>
<tr>
<td>• Initial contact with waste owners</td>
<td>Facility Operator – private sector contractor to the responsible Department (independent of EPA)</td>
</tr>
<tr>
<td>• Conditioning of waste</td>
<td>Waste Generator / Owner</td>
</tr>
<tr>
<td>• Transportation to store facility or central loading point</td>
<td>Waste Generator / Owner</td>
</tr>
<tr>
<td>• Unloading,</td>
<td>Facility Operator</td>
</tr>
<tr>
<td>• Storage</td>
<td>Facility Operator</td>
</tr>
<tr>
<td>• Waste ownership</td>
<td>SA government</td>
</tr>
<tr>
<td>• Emergency procedures, contingency plans</td>
<td>Facility Operator</td>
</tr>
<tr>
<td>• Security</td>
<td>Facility Operator</td>
</tr>
<tr>
<td>• Environmental monitoring</td>
<td>Facility Operator</td>
</tr>
<tr>
<td>• Liaison with local communities.</td>
<td>SA government / Operator</td>
</tr>
<tr>
<td><strong>Supervision/Reporting structure</strong></td>
<td></td>
</tr>
<tr>
<td>Who do on-site operators report to?</td>
<td>SA government Department responsible for the site (independent of EPA).</td>
</tr>
<tr>
<td>Who are the auditors?</td>
<td>Internal audits by Operator.</td>
</tr>
<tr>
<td></td>
<td>External audit program and audit team selection by EPA (independent team leader, and team members from EPA and Industry or Health Department)</td>
</tr>
<tr>
<td></td>
<td>External audit reports should be available to the public</td>
</tr>
<tr>
<td><strong>Regulation</strong></td>
<td></td>
</tr>
<tr>
<td>Who is the ultimate regulator?</td>
<td>EPA</td>
</tr>
</tbody>
</table>
### Issues

<table>
<thead>
<tr>
<th>Description</th>
<th>Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>As independent as possible</td>
<td>What is the relationship with operator/manager?</td>
</tr>
<tr>
<td>Yes, during storage operations.</td>
<td>Are inspections conducted?</td>
</tr>
<tr>
<td>SA government and waste owners as per “user pays” principle</td>
<td>Who funds the operator?</td>
</tr>
<tr>
<td>SA government</td>
<td>Who funds the Regulator?</td>
</tr>
</tbody>
</table>
| Partial for existing material  
Full cost recovery for future radioactive material | User pays? |

The key issues from Table 7.1 are assessed below with respect to the two site options.

#### 7.2 Public Safety

Government or semi-government agencies operate the majority of radioactive waste storage or repositories reviewed in the Stage 2 Report, including the 2 existing facilities in Australia. It was therefore recommended that an SA government Department independent of the EPA be given the responsibility to operate (directly or by use of contractors) the Interim Store.

From a public safety point of view, this recommendation would apply irrespective of whether OD or Radium Hill was chosen. The recommendation would also apply to a repository.

#### 7.3 Waste Ownership

The operating facilities discussed in the Stage 2 Report all assume SA government ownership and responsibility for the waste. No examples could be found where ownership was retained by the waste generator. This greatly simplifies the apportioning of responsibility should things go wrong, and would be a clear advantage over the current situation in SA (numerous owners in numerous locations). It also simplifies the administrative procedures by not requiring ongoing paperwork from the waste owners.

Hence at some point in the waste acceptance procedure, ownership should be transferred to the SA government (the Department with operational responsibility for the facility).

#### 7.4 Regulation

As discussed in the Stage 2 Report, the key issue for the public is regulatory independence. Such independence is very clear in the case of a company operating a facility and a government department being responsible for its regulation. Independence can also be achieved to varying degrees when the operator is a government agency, although as can be seen in the Mount Walton case, the regulatory agency needs to be sufficiently separate for there to be public confidence in its independence.
An important part of the regulatory system is auditing. An independent auditor, as described in Section 6.1, who is independent of both the operator and the regulator, would provide an additional level of independence.

### 7.5 Facility Operator

#### 7.5.1 Olympic Dam

The three main options for operating an Interim Store or repository at OD are:

1. OD be engaged as contractor to operate the facility for a fee on behalf of the SA government;

   This is the simplest option in that it would require minimal change of land status, would require little additional resources at OD (OD already have people with the necessary background and the necessary equipment), and provide clear paths of responsibility. It would also be seen as allowing for regulatory independence.

2. A separate contractor operate the facility for a fee on behalf of the SA government, and pay a fee to OD for the use of the land (assuming that the land is not excised from the lease and acquired by the SA government);

   This has similar advantages to the above option but there are potential security complications (contractors accessing the Special Mining Lease area), and lower potential for economical resource use (people and equipment would need to be brought in).

3. A government agency independent of the EPA operates the facility (directly or by use of contractors) and pays a fee to OD for the use of the land.

   This option has similar advantages and disadvantages to option 2.

All of the above options could be made to work effectively, but Options 2 and 3 would be more expensive and require more organisational skills.

#### 7.5.2 Radium Hill

As there is nobody present at Radium Hill, there are two main options for operating an Interim Store or repository at that site, namely:

1. A contractor to operate the facility for a fee on behalf of the SA government;

   This option has the advantage of regulatory independence.

2. A government agency independent of the EPA operates the facility.

Both of the above options could be made to work effectively but given the absence of local infrastructure and services, and the frequency of activities on site, Option 2 may be more reliable.
### 7.6 Costs

#### 7.6.1 Interim Store

The costs derived in the Stage 2 Report for establishing and running an Interim Store have been applied to the OD and Radium Hill sites in Table 7.2. Note that as per the Stage 2 Report, these costs are order of magnitude estimates only.

The figures given for the underground option assumes an existing unused drive can be used, and a security gate/fence would be the only construction needed. It also assumes that reduced environmental and security monitoring would be required. If a new drive needs to be developed specifically for the interim store, an additional construction cost of approximately $150,000 would apply, for an assumed 50 m drive (Section 2.2.2).

<table>
<thead>
<tr>
<th>Table 7.2 Cost Comparison for Interim Store Locations (not including GST)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stage</strong></td>
</tr>
<tr>
<td>Fixed and First Year Costs</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Pilot test</td>
</tr>
<tr>
<td>Initial transfer of existing waste</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Security</td>
</tr>
<tr>
<td>Environmental and security monitoring Auditing Reporting</td>
</tr>
<tr>
<td>Total Cost (first year)</td>
</tr>
<tr>
<td>Annual Ongoing Costs</td>
</tr>
</tbody>
</table>
### Management Options and Costs

#### SECTION 7

<table>
<thead>
<tr>
<th>Stage</th>
<th>Item</th>
<th>Olympic Dam Surface</th>
<th>Olympic Dam Underground</th>
<th>Radium Hill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facility maintenance</td>
<td>Fire break maintenance, minor repairs and maintenance</td>
<td>$2000</td>
<td>$500</td>
<td>$5000</td>
</tr>
<tr>
<td>Subsequent transfers of waste to the store</td>
<td>Assuming ~8 m$^3$ transferred ($40k) every 5 years</td>
<td>$7,000</td>
<td>$10,200$(^1)</td>
<td>$8,000</td>
</tr>
<tr>
<td><strong>Total Annual Ongoing Costs</strong></td>
<td></td>
<td><strong>$21,000</strong></td>
<td><strong>$15,700</strong></td>
<td><strong>$28,000</strong></td>
</tr>
</tbody>
</table>

Note 1 - Includes cost of fabrication of stainless steel containers described in Section 2.2.2, and packing of drums into the containers, of approx $2000 each.

Note 2 - Assumes a suitable existing development drive is available. Need to add $150,000 if a 50 m development drive needs to be constructed.

Thus the OD underground option is the lowest cost option both for establishment and ongoing costs.

The fixed first year costs for the Radium Hill option will be slightly higher, and annual ongoing costs will be 25 to 30 % higher, than for the OD surface option. Because of the absence of local infrastructure, the estimates for Radium Hill may be optimistic, and it should be noted that response times would be significantly greater than for OD. In order to have directly comparable standards of security for OD and Radium Hill, the costs at the latter would be significantly higher.

#### 7.6.2 Interim Store and Repository

Using the same assumptions as above, costs have been estimated in Table 7.3 for the development of an Interim Store and a nearby repository for LLRW and short-lived ILRW at each site. The Interim Store would be used for temporary storage of LLRW and short-lived ILRW prior to disposal, and for managed storage of long-lived ILRW.

In the case of the surface facilities options at OD and Radium Hill, the long-lived ILRW Interim Store would be a purpose built structure in the vicinity of the boreholes. In the case of the underground OD option, it is envisaged that the long-lived ILRW Interim Store would be located underground in the same area as the LLRW and short-lived ILRW repository.

In all options the long-lived ILRW would need to be held in managed storage, pending a suitable long-term disposal option becoming available.
### Table 7.3 Cost Comparison for Interim Store and Disposal (not including GST)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Item</th>
<th>Olympic Dam Surface</th>
<th>Olympic Dam Underground</th>
<th>Radium Hill</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed and First Year Costs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upfront</td>
<td>Permitting &amp; approvals</td>
<td>$360,000</td>
<td>$360,000</td>
<td>$360,000</td>
</tr>
<tr>
<td></td>
<td>Construction - store</td>
<td>$180,000</td>
<td>$54,000$^{2,3}</td>
<td>$200,000</td>
</tr>
<tr>
<td></td>
<td>Construction - boreholes &amp; caps</td>
<td>$25,000</td>
<td>$0</td>
<td>$50,000</td>
</tr>
<tr>
<td>Pilot test</td>
<td>Conditioning handling, and transport</td>
<td>$60,000</td>
<td>$60,000</td>
<td>$60,000</td>
</tr>
<tr>
<td>Initial transfer of existing waste</td>
<td>Waste conditioning</td>
<td>$50,000</td>
<td>$50,000</td>
<td>$50,000</td>
</tr>
<tr>
<td></td>
<td>Collect material (metro)</td>
<td>$12,000</td>
<td>$12,000</td>
<td>$12,000</td>
</tr>
<tr>
<td></td>
<td>Collect material (rural)</td>
<td>$17,500</td>
<td>$17,500</td>
<td>$17,500</td>
</tr>
<tr>
<td></td>
<td>Pack Material</td>
<td>$30,000</td>
<td>$30,000</td>
<td>$30,000</td>
</tr>
<tr>
<td></td>
<td>Transport to Interim Store</td>
<td>$2,500</td>
<td>$2,500</td>
<td>$2,500</td>
</tr>
<tr>
<td></td>
<td>Unload and store waste</td>
<td>$5,000</td>
<td>$5,000</td>
<td>$7,000</td>
</tr>
<tr>
<td></td>
<td>Place waste in boreholes and backfill</td>
<td>$5,000</td>
<td>$0</td>
<td>$7,000</td>
</tr>
<tr>
<td>Security</td>
<td>Set up telemetric security system</td>
<td>$40,000</td>
<td>$0</td>
<td>$50,000</td>
</tr>
<tr>
<td>Environmental and security monitoring</td>
<td>Validation of treatment and storage process</td>
<td>$15,000</td>
<td>$5,000</td>
<td>$20,000</td>
</tr>
<tr>
<td>Auditing</td>
<td>Reporting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Cost (first year)</strong></td>
<td></td>
<td>$802,000</td>
<td>$596,000</td>
<td>$866,000</td>
</tr>
<tr>
<td>Annual Ongoing Costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental and security monitoring, Auditing and Reporting</td>
<td></td>
<td>$15,000</td>
<td>$5,000</td>
<td>$20,000</td>
</tr>
<tr>
<td>Facility maintenance</td>
<td>Fire break maintenance, minor repairs and maintenance</td>
<td>$2,000</td>
<td>$500</td>
<td>$5,000</td>
</tr>
<tr>
<td>Subsequent transfers of waste to the store (Note: costs are annualised)</td>
<td>Assuming ~8 m$^3$ transferred ($40k) every 5 years</td>
<td>$7,000</td>
<td>$10,200$^{2}</td>
<td>$8,000</td>
</tr>
</tbody>
</table>
### Management Options and Costs

#### SECTION 7

<table>
<thead>
<tr>
<th>Stage</th>
<th>Item</th>
<th>Olympic Dam Surface</th>
<th>Olympic Dam Underground *See note 1</th>
<th>Radium Hill</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Construction - boreholes (1 per 5 years)</td>
<td>$5,000</td>
<td>$0</td>
<td>$10,000</td>
</tr>
<tr>
<td></td>
<td>Place waste in boreholes and backfill (1 per 5 years)</td>
<td>$1,000</td>
<td>$0</td>
<td>$1,400</td>
</tr>
<tr>
<td></td>
<td><strong>Total Annual Ongoing Costs</strong></td>
<td><strong>$30,000</strong></td>
<td><strong>$15,700</strong></td>
<td><strong>$44,400</strong></td>
</tr>
</tbody>
</table>

Note 1 - OD underground option assumes that the long-lived ILRW is held in managed storage underground in the same area as used for disposal of LLRW and short-lived ILRW, until a suitable long-term disposal option is available.

Note 2 - Includes cost of fabrication of stainless steel containers described in Section 2.2.2, and packing of drums into the containers, of approx $2000 each.

Note 3 - Assumes a suitable existing development drive is available. Need to add $150,000 if a 50 m development drive needs to be constructed.

Again, the underground option at OD (including managed storage of long-lived ILRW underground) is the lowest cost option. The fixed first year costs for the surface option at OD will be marginally lower, and annual ongoing costs will be 25 to 30% lower than those for Radium Hill. As per the discussion above, the costs for comparable security standards at Radium Hill would be significantly higher than for OD.

#### 7.6.3 Cost Recovery

As discussed in the Stage 2 report, the issue of fairness is different for existing and future radioactive waste. Future owners of radioactive substances can be fully informed on the options for return or recycle of their material, and of the costs of storage or disposal if required. They can thus make informed decisions on the cost and benefit of the purchase and use of such radioactive material.

Existing owners radioactive material (some of which is already regarded as waste) could not have been provided with such information. In this situation it would not be unusual for governments to accept some responsibility and cost of future management of this material.

It is therefore recommended that cost recovery be based on fair principles, and that the SA government covers all of the costs of existing wastes and of existing sources that will become waste over the next ten or so years. At that point, all waste should be managed on a full cost recovery basis.

#### 7.7 Conclusions and Recommendations

The recommendations made in the Stage 2 report were assessed against the possibility of siting a facility at OD or Radium Hill. Most of the recommendations remain unchanged, however, the following refinements are recommended:

- if the OD site is selected, it is recommended that the facility be operated by OD for a fee that covers land use and management costs; and
if the Radium Hill site is selected, it is recommended that the facility be operated by a government agency.

Note that the perception of regulatory independence would be greater if the operations were managed by a non-government agency such as OD.

Costs were also assessed, both for an Interim Store and a combination Interim Store and surface repository, located at either OD or Radium Hill. The assessment indicated that costs would be higher for the Radium Hill location for both scenarios, and that security standards would be lower for this location. Thus on a security and cost basis, the OD surface site would be preferred.

Costs were also assessed, both for an Interim Store and a combination Interim Store and underground repository, located at OD. The underground option at OD (including managed storage of long-lived ILRW underground) has the best security and is the lowest cost option, and is the overall preferred option.
8.1 Summary

The focus of Stage 1 of this study included:

- a review the quantities and types of radioactive waste under SA legislative control that are likely to require interim storage now and into the future;

- site selection criteria for an Interim Store, consistent with international best practice for safety and protection of people and the environment;

- design and structural criteria for the Interim Store, consistent with international best practice; and

- the processes and procedures that would need to be addressed.

This stage of the study concluded that an Interim Store should be designed to cater for about 100 m$^3$ of waste, should be located according to criteria that recognise the key differences between storage and disposal but were nevertheless based on the near surface disposal Code (NHMRC 1992). The study also proposed a design for the store and concluded that the approval process was not insurmountable.

Stage 2 of the study used the Stage 1 findings to:

- develop feasible options for locating an Interim Store, including a single purpose-built store, and the use of a number of stores;

- identify options for management of an Interim Store, including government agency and public/private company;

- identify potential risks and benefits for people and the environment of using a purpose-built Interim Store compared with the current storage arrangements, including transport of wastes to and from stores, and operations at the stores; and

- determine the costs associated with establishing and running an Interim Store, and compare with those associated with the current storage arrangements.

It was concluded that a single Interim Store is a feasible option for safely managing existing and future LLRW and ILRW in SA. From this assessment the following sites met the criteria and were recommended for further investigation:

- Beverley;

- Olympic Dam;

- Radium Hill; and

- Other sites identified by regional communities.

The EPA decided to extend the feasibility study to include further investigation into the Olympic Dam and Radium Hill sites.
8.2 Conclusions

The purpose of this final stage of the study was to investigate the feasibility of developing an Interim Store or disposal at Olympic Dam or at Radium Hill.

8.2.1 Interim Store

Potentially suitable locations have been identified at both OD and Radium Hill for developing an Interim Store. In both cases, the quantity of waste to be managed remains the same because the landowners would prefer to keep the existing waste and arrangements separate from the activities currently being undertaken at the sites.

Between these sites, OD holds the following advantages for hosting an Interim Store:

- availability of trained operational and security workforce;
- familiarity of affected community with radiation hazards and radiation safety practices (and potentially, greater willingness to accept the facility);
- existing supporting infrastructure;
- lower cost;
- better security; and
- better timeliness of response to threats or intrusions.

**Olympic Dam**

Two potential sites were identified at OD that meet all the criteria, one on the surface near the southern boundary of the Special Mining Lease north of the current airport runway, and one deep underground in an unused (or purpose built) development drive. Both sites have very low risks, but the underground option would have significant advantages over all other options considered, in particular in relation to security, monitoring requirements and cost.

**Radium Hill**

The potential site at Radium Hill is near the northern corner of the Reserve boundary. It meets all the relevant selection criteria for an Interim Store, although there may be some security issues that would need special attention. It was also noted that the current population levels and its downward trend indicate that the sustained availability of nearby infrastructure and service providers may not be reliable.

The Radium Hill site presents risks similar to those that were assessed in the Stage 2 Report, as well as a radiological risk to construction workers. This additional risk is well understood and can easily be mitigated by appropriate off-site accommodation and well-designed work procedures.
8.2.2 Disposal

Long-lived ILRW is not suitable for near-surface disposal, and thus the assessment of disposal options is only relevant to the LLRW and short-lived ILRW. The existing arrangements for this material are considered unacceptable for the long-term, and an improved form of safe, secure and easy to manage (consolidated) storage is required until a permanent solution is available. Therefore a small Interim Store is an inherent component of any LLRW and short-lived ILRW disposal option for SA.

Disposal of LLRW and short-lived ILRW material would take place in accordance with the NHMRC 1992 Code, probably in boreholes. The option of disposing of waste in an existing repository was considered at both locations and found to be inappropriate.

An analysis of the NHMRC criteria shows that a near-surface radioactive waste repository could be developed at either OD or Radium Hill that would meet the criteria.

Olympic Dam

The surface site selected at OD appears to easily meet all of the criteria, however soil geochemical and geotechnical properties would need to be assessed. It should be noted that any uncertainty is mitigated by the groundwater cone of depression for the mine, and unsuitability of the local groundwater for either stock or human consumption. Long-lived ILRW would be held in managed storage in an Interim Store pending a suitable long-term option becoming available.

Disposal underground at OD was also considered, within the OD underground development. A potential suitable general area of the underground development was identified, at the north-west extremity of the deposit. It was considered that this would be a suitable option for disposal of LLRW and short-lived ILRW. Long-lived ILRW would need to be kept in managed storage, which could be in the same area, until a suitable long-term disposal option becomes available.

Radium Hill

Radium Hill has a history of radium and uranium mining, and a legacy of incomplete rehabilitation and some surface contamination from uranium tailings. There is much information available about previous operations at the mine to indicate that it would be a suitable site for a near-surface repository for LLRW and short-lived ILRW.

The location selected for a potential site appears to meet all the NHMRC criteria, however soil geochemical and geotechnical properties would need to be assessed. The history of the site and the presence of the nearby tailings dam and LLRW repository, and the remaining uranium and radium ores, and the underground development would potentially place significance restrictions on future land uses of the site and its surrounds.

The development of a near-surface repository would not create the need for significant additional restrictions. Thus it is reasonable to conclude that the Radium Hill site would, subject to additional
studies, would be suitable for a near-surface repository. Long-lived ILRW would be held in managed storage in an Interim Store pending a suitable long-term option becoming available.

### 8.2.3 Options for Long-Lived ILRW

The focus of this study was on the interim storage of LILRW and the final disposal of LLRW. As long-lived ILRW is unsuitable for near surface disposal, other options need to be considered for its long-term management.

In January 2005, the IAEA released a Draft Safety Guide titled “Borehole Facilities for the Disposal of Radioactive Waste” (DS 335), which is focused on ILRW. When this guide has been published as a final version, the information may be used by ARPANSA to develop a Code of Practice. When published, such a Code could be used to develop options for disposal of SA's long-lived ILRW.

This option would be relatively expensive because of the small volumes involved, and thus it would be preferable to improve safety and economies of scale by combining efforts with other jurisdictions.

Pending the development of the above Code, and availability of other options, the long-lived ILRW could be held in managed storage at OD or Radium Hill.

### 8.2.4 Regulatory Processes and Timeframes

As noted in the Stage 1 Report, an Interim Store proposal may not trigger the EPBC Act. However, if the legal advice was that the EPBC Act is triggered, an “accredited assessment process” could be sought, in which the SA government would manage the assessment as long as the Commonwealth is satisfied that standards will be met.

There are some specific approval issues relating to the two sites:

**OD:**

The Indenture under which OD operates provides for mining and exploration activities, and activities and infrastructure ancillary to mining and the processing of minerals. A legal view would need to be obtained to confirm whether the Indenture would permit the establishment of an Interim Store or repository,

Excision of the site from the Special Mining Lease may be able to overcome any issues associated with the OD Indenture, however the SA government would need to discuss these issues with BHP Billiton.

**Radium Hill:**

The site is on SA Crown Land, and is vested with PIRSA. The area is exempt from operation under the provisions of the Mining Act, and has been gazetted as ‘Reserved for Purposes of a Repository for Low Level Radioactive Wastes’. Legal advice may be required to determine if an Interim Store or new repository would be allowed under the current terms of the Reserve, or if modifications need to be gazetted.

The generic requirements for public consultation under both Commonwealth and SA planning laws were outlined in the Stage 1 Report. Given that an Interim Store or repository project is likely to be seen as a sensitive issue, it would be prudent to plan for a more extensive public consultation process than may be
normally required. The public consultation program would need to be focused on the needs of the stakeholders associated with the selected site.

There are minimum periods for public consultation specified in both Commonwealth and SA planning laws. There is also discretion allowed for the period for public comment on the draft report to be extended. In addition, the length of time needed to conduct the environmental assessment depends on the level of assessment determined by the Commonwealth/SA planning Ministers. It is therefore very difficult to plan a timetable for the approval process. A conservative timetable was developed that indicates that it could take up to 2 years to complete the approval process, construction of the facility, and transfer of waste.

### 8.2.5 Auditing and Verification Systems

In order to ensure that the operation of the facility is safe and sustainable, it was recommended that the following standards be implemented for the facility:

- ISO 9001 for quality;
- ISO 14001 for environmental performance;
- AS/NZS 4801 – for occupational health and safety; and
- AS 4360 – for risk management.

It was further recommended that ISO 19011, Guidelines for Quality and Environmental Management Systems Auditing, be used to develop the auditing program. This standard specifically addresses quality and environmental issues, and the auditing program would need to be extended to cover occupational health and safety.

It was recommended that the audit team should consist of:

- an independent audit team leader, who is an accredited lead auditor (recognised by the Quality Society of Australasia or other international qualification) and have qualifications and experience in radiation issues;
- the regulator; and
- a representative from either of the SA government departments responsible for the health or environment areas.

Audit timing would be dependent on the operation of the facility. It is envisaged that the facility will be constructed and operated briefly initially, and then operated in campaigns that could be as much as 5 years apart. For this type of operation, an initial audit would need to coincide with the availability of operational personnel, perhaps towards the end of the first scheduled storage/disposal campaign. Thereafter, audits should be scheduled to coincide with subsequent storage/disposal campaigns. Depending on the outcomes of these audits and any need to action Corrective Action Requests, periodic audits could be scheduled, perhaps initially every 2 years.
Techniques for verification were discussed including records checks, visual checks, and direct measurements. Radiological and environmental check-monitoring was also discussed and it is recommended that the check-monitoring program includes a combination of independent samples and operator-supplied duplicate samples.

### 8.2.6 Management Options and Costs

The recommendations relating to management options made in the Stage 2 report were assessed against the possibility of siting a facility at OD or Radium Hill. Most of the recommendations remain unchanged, however, the following refinements are recommended:

- if the OD site is selected, it is recommended that the facility be operated by OD for a fee that covers land use and management costs; and
- if the Radium Hill site is selected, it is recommended that the facility be operated by a government agency.

Note that the perception of regulatory independence would be greater if the operations were managed by a non-government agency such as OD.

Costs were also assessed, both for an Interim Store and a combination Interim Store and surface repository, located at either OD or Radium Hill. The assessment indicated that costs would be higher for the Radium Hill location for both scenarios, and that security standards would be lower for this location. Thus on a security and cost basis, the OD surface site would be preferred.

Costs were also assessed, both for an Interim Store and a combination Interim Store and underground repository, located at OD. The underground option at OD (including managed storage of long-lived ILRW underground) has the best security and is the lowest cost option, and is the overall preferred option.
Limitations

URS Australia Pty Ltd has prepared this report for the use of the EPA in accordance with the usual care and thoroughness of the consulting profession. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated 13 October 2004.

The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between April and August 2005, and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

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