Australian Government

Department of Industry, Science, Energy and Resources

Site Assessment

National Radioactive Waste Management Facility

March 2020

industry.gov.au

Contents

Preface ii
About iii
A snapshot of key events and activities iv
About the approved sites x
Lyndhurst x
Napandee xii
Wallerberdina xiv
Selecting a site 1
The process for selecting a site for a facility, under the NRWM Act 2
How the NRWM Act informs the site suitability assessment 3
The site suitability criteria 4
Site suitability criterion 1 5
Site suitability criterion 2 6
Site suitability criterion 3 7
Site suitability criterion 4 7
Executive summary of findings 8
Matrices 9
Site assessments 13
Site suitability criterion 1 13
Site suitability criterion 2 47
Site suitability criterion 3 52
Additional resources I
Glossary II
Abbreviations XIII
Summaries of independent reports XV
Site physical characteristics XVI
Enabling infrastructure XL
Aboriginal cultural heritage LI
Socio-economic impact LV
Attachments LXIV

Preface

About

This report was prepared by the Department of Industry, Science, Energy and Resources (the department, formerly the Department of Industry, Innovation and Science) to provide detail of the factors considered by the former Minister for Resources and Northern Australia, Senator the Hon Matthew Canavan (the former Minister), when identifying Napandee in Kimba, South Australia, as the site for the National Radioactive Waste Management Facility (the facility).

While the identification of the site was undertaken in-line with the *National Radioactive Waste Management Act 2012* (Cth) (the NRWM Act), the Australian Government has subsequently introduced legislative amendments to specify the Napandee site. Specification of the site in legislation provides clarity to the local community, broader Australian public, and nuclear industry on the Government's commitment to appropriately manage Australia's radioactive waste; and gives Parliament a say in the decision to site this important national infrastructure.

This report contains information about three sites – Lyndhurst, Napandee, and Wallerberdina – which were shortlisted following the nomination and approval processes specified in the NRWM Act. The sites are referenced in alphabetical order throughout this report.

The department has taken an evidenced-based approach to gathering and analysing the available information about each of the three sites. Each site was assessed against the site suitability criteria, designed by the department to consider the various aspects of site suitability and identify key risks.

The report structure enabled the former Minister to work logically and methodically through the required considerations under the NRWM Act. Detailed results of all assessments are presented both in written form and visually in matrices, which are similar to traffic light reports.

The information presented in this report is based on independent specialist reports commissioned by the Australian Government (the Government). Summaries of these reports have been author reviewed for accuracy and included at the end of the report.

The data from the independent reports (and where applicable, preliminary facility design information) has informed assessments against the site suitability criteria by technical specialists and the department. The assessment methodology and ratings definition is explained at the beginning of each site suitability assessment.

This report does not include additional information that is subject to legal privilege, Cabinet-in-Confidence, private or commercial-in-confidence, which was also considered by the former Minister.

A snapshot of key events and activities

Pre 2012

Before the enactment of the current legislation, the Government led a number of processes to establish national facilities for Low Level Waste (LLW) disposal and Intermediate Level Waste (ILW) storage arising from medical, industrial and scientific use of radioactive materials in Australia.

- In 1978, the Government agreed to co-ordinate a national approach to the management of Australia's produced radioactive waste. However, it was not until 1985 that state and territory Governments were asked to identify potential sites for a facility. The Northern Territory initially suggested a site but then withdrew this site in 1991.
- Between 1992 and 2004, the Government undertook an Australia-wide survey to site the construction of a near-surface repository for disposal of Australia's low level and short-lived intermediate level radioactive waste.
- Between 2000 and 2002, the Woomera Protected Area (WPA) was investigated as a possible site for the facility (culminating in a 2002 Environmental Impact Statement). There were three sites identified as being suitable in that report: one within the WPA and two outside the WPA.
    - In May 2003, a site was chosen site for the facility by the then Minister for Science, the Hon Peter McGauran MP.
    - The South Australian Government passed the *Nuclear Waste Storage Facility (Prohibition) Act 2000* (Prohibition Act), as well as moving to declare the proposed site a park in 2003. Before the South Australian Government could formally declare the site a park, the Commonwealth compulsorily acquired the land in 2003.
    - Following a Federal Court case in 2004, it was determined that the process by which the land was acquired by the Commonwealth for the facility was illegal and the project was abandoned.
- In 2005, the *Commonwealth Radioactive Waste Management Act 2005* (Cth) was passed by Federal Parliament to facilitate the construction of co-located facilities on Commonwealth land for the management of low and intermediate level radioactive waste produced by Australian Government agencies. This legislation was repealed and replaced in April 2012 by the NRWM Act.

2012

The NRWM Act provides the legislative framework for the selection of a site and the establishment and operation of a radioactive waste management facility. The NRWM Act is built on the principle of voluntarism, where anyone who has suitable interest in the land can voluntarily nominate the land to be considered as a site for the facility. The relevant Minister must accord procedural fairness to each nominator of the land (for approving nominations or declaring a site) in accordance with the requirements of the NRWM Act.

While the provisions in the NRWM Act allow the Minister to approve nominations of a site and declare a site for the facility with 'absolute discretion', successive Ministers have committed that the facility will not be imposed on an unwilling community.

2015

March

The former Minister for Industry and Science, The Hon Ian Macfarlane MP, called for voluntary site nominations from landholders under section 6 of the NRWM Act. The department received 28 site nominations under section 7 of the NRWM Act, including the Wallerberdina nomination. A desktop multi-criteria assessment was conducted on the high level technical merits of the sites.

November

Former Minister for Resources, Energy and Northern Australia, The Hon Josh Frydenberg MP identified six sites within five communities:

Sallys Flat—Hill End, New South Wales
Hale—Northern Territory
Cortlinye—Kimba, South Australia
Pinkawillinie—Kimba, South Australia
Wallerberdina—Hawker, South Australia
Oman Ama—Gore, Queensland.

The Minister announced a 120-day community consultation period and an independent survey was conducted by ORIMA Research to indicate the level of community support to progress to the next stage of the site selection process. The level of community support for five of the six sites progressing was 51 per cent or lower and these nominated sites were not approved under section 9 of the NRWM Act. Community support for Wallerberdina progressing to the next phase of the process was measured at 65 per cent by ORIMA Research.

2016

April

Part of the nominated Wallerberdina site was approved under section 9 of the NRWM Act. The department commenced site selection activities (referred to as 'phase two' activities) including Aboriginal cultural heritage assessments, preliminary site assessment, continuing community consultation, and the delivery of a $2 million per annum Community Benefits Programme (CBP) grants package in 2017 and 2018.

2017

January

Two additional sites (Lyndhurst and Napandee) near Kimba were nominated under section 7 of the NRWM Act.

March to June

The then Minister for Resources and Northern Australia, Senator the Hon Matthew Canavan, announced a 90-day community consultation period at Kimba. At the request of the District Council of Kimba, the Australian Electoral Commission conducted a community ballot to measure community support for progressing to the next stage of the process. The ballot result showed 57.4 per cent community support for moving forward in the process.

The Lyndhurst and Napandee nominations were approved under section 9 of the NRWM Act. Phase two activities commenced, including Aboriginal cultural heritage assessments, preliminary site assessments, continuing community consultation and the delivery of a $2 million CBP grant package in 2018.

PHASE TWO: KEY ACTIVITIES

Phase two of the site selection process has involved the collection of relevant information about each of the three sites, first to inform a generic concept design and costs, and secondly to inform the Minister's site selection decision.

Information collection is ongoing and the preliminary assessments undertaken cover:

- physical characterisation of nominated sites
- requirements for enabling infrastructure
- Aboriginal cultural heritage
- socio-economic impact.

Site-specific technical work to progress facility design and approvals will be undertaken post-site selection.

►

2018

February to November

The Senate referred an inquiry into the selection process for a facility in South Australia to the Senate Economics References Committee for report on 6 February 2018. Submissions to the Committee focussed on the appropriateness and thoroughness of the site selection process for a radioactive waste management facility. On 14 August 2018, the Committee released its report which found no fault with the site selection process but made five recommendations, including enhancing consultation with key stakeholders, undertaking independent valuations of the land to be acquired, and exploring how the land acquired for the facility could be used to support research and development activities for the local community. The Government agreed to the Committee's recommendations (in full or in principle) in a response dated 20 November 2018 and committed to continuing engagement with involved parties to progress site selection and facility establishment. There were two dissenting statements with recommendations from the Australian Greens and the Centre Alliance, which the Government did not support.

Report: www.aph.gov.au/Parliamentary_Business/Committees/Senate/Economics/Wastemanagementfacility/Report

Government Response: www.aph.gov.au/Parliamentary_Business/Committees/Senate/Economics/Wastemanagementfacility/Government_Response

PHASE TWO: KEY ACTIVITIES

During phase two, significant engagement activities occurred to inform the communities about the potential facility.

The department engaged locally employed community liaison officers in each community, and facilitated community engagement through the communities' Consultative Committees and Economic Working Groups.

Information about various aspects of the facility proposal was provided using a variety of methods including specialist visits, social media, workshops, information sessions, newsletters, fact sheets and independent reports.

Public education community visits to ANSTO were arranged for community members to learn about nuclear waste management.

April

The Government released the Australian Radioactive Waste Management Framework (the framework). The framework sets out principles and long-term goals for radioactive waste management in Australia.

The framework:

- ensures consistency of how waste is managed across Australian government agencies (as the largest waste holders and generators in Australia)
- identifies appropriate accountability for Australia's radioactive waste management practices
- provides explicit and mutually agreed principles and long-term goals to form the basis of Australia's national approach to radioactive waste policy-making
- provides greater certainty to Commonwealth, state and territory regulators in facility licencing decisions
- ensures that Australia's domestic arrangements align with its international obligations.

The establishment of a facility to dispose of Low Level Waste (LLW) and temporarily store Intermediate Level Waste (ILW) is a centrepiece of the framework.

Australian Radioactive Waste Management Framework: www.industry.gov.au/data-and-publications/australian-radioactive-waste-management-framework

August

The Kimba District Council and the Flinders Ranges Council planned to hold community ballots to be undertaken by the Australian Electoral Commission. However, the community ballots were suspended pending the outcome of a Federal Court hearing of the *Barngarla Determination Aboriginal Corporation (BDAC) v. Kimba Council* case.

PHASE TWO: KEY ACTIVITIES

To understand community sentiment and expectations, the department continues to undertake a variety of activities, including direct consultation with neighbours, businesses and Aboriginal groups.

A public submission process has remained open, for those both within and outside of the communities to express their views.

The District Council of Kimba and the Flinders Ranges Council have also commissioned the Australian Electoral Commission to conduct community ballots to inform a determination on community sentiment.

2019

January

The Federal Court heard the *BDAC v. Kimba Council* matter on 30 January and reserved judgement.

July

On 12 July, the Federal Court handed down its decision to dismiss BDAC's application, on the grounds that BDAC had not established any contravention of the *Racial Discrimination Act 1975* (Cth). Following this decision, the District Council of Kimba and the Flinders Ranges Council resolved to conduct community ballots before the end of 2019.

September

BDAC lodged an appeal to the Full Bench of the Federal Court in *BDAC v. Kimba Council*. While BDAC sought a further injunction to stop the ballots, the injunction application was dismissed. The appeal was subsequently heard in the South Australian Registry of the Federal Court of Australia, which handed down its decision to dismiss the appeal on 13 March 2020.

About the approved sites

Lyndhurst

Figure 1: Landscape of the approved site at Lyndhurst

Nomination

Section 38, Hundred of Moseley, Certificate of Title Volume 5925 Folio 858 (Lyndhurst) was nominated under section 7 of the NRWM Act in January 2017, by Brett Anthony Hutchinson Rayner and Michelle Angela Rayner.

The Lyndhurst nomination was approved by the Minister under section 9 of the NRWM Act in June 2017, after a community consultation period which included a community ballot.

Proposed acquisition parcel

Preliminary site characterisation works at Lyndhurst and other volunteered sites have determined approximately 160 hectares in total would need to be acquired to accommodate a buffer zone, community uses and supporting infrastructure.

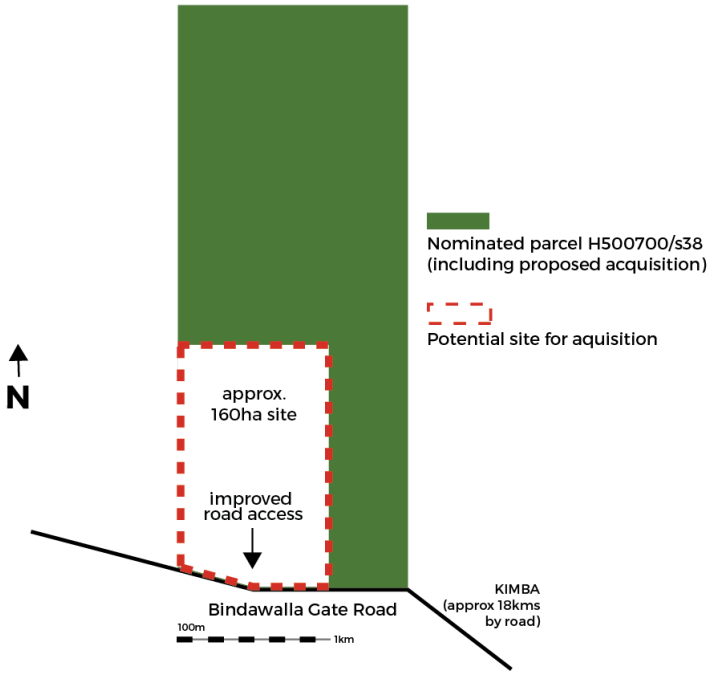


Figure 2: Map of proposed acquisition parcel within the approved site at Lyndhurst

Nearby interests (Figure 3)

Located 15-20 kilometres north-east of Kimba on the Eyre Peninsula and approximately 10 kilometres north of the Eyre Highway.

The site sits within the District Council of Kimba.

While there is no Native Title on the approved site, the Barngarla People and Gawler Ranges People[1] hold Native Title in the surrounding area (see images showing Native Title at attachment H, p. 7).

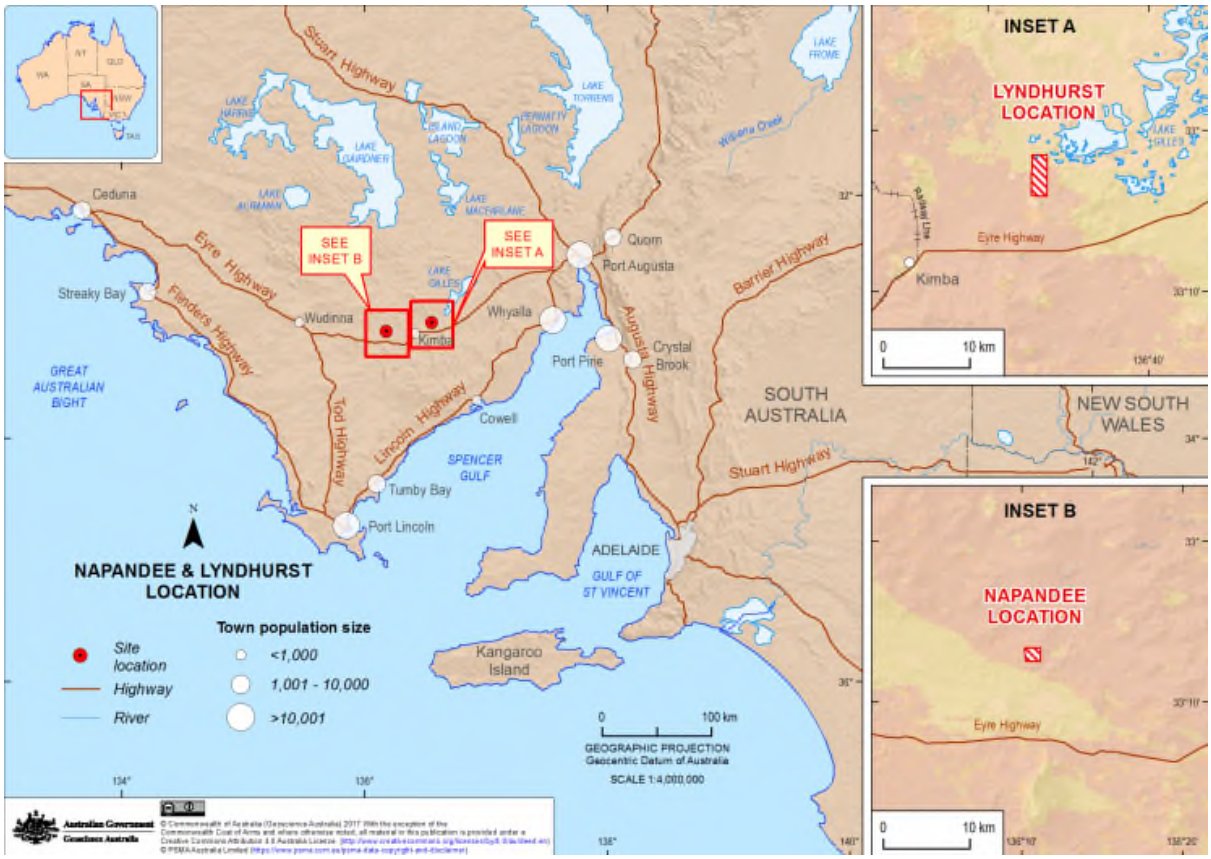


Figure 3: Map of the approved site at Lyndhurst, in relation to Napandee and the broader region

[1] The registered Native Title body corporate (RNTBC) for the Gawler Ranges People, the Gawler Ranges Aboriginal Corporation (GRAC), has written to the department indicating that it does not wish to be further involved in site selection activities, deferring to BDAC which is the RNTBC for the Barngarla People, as Traditional Owners of lands in the vicinity of the Lyndhurst and Napandee sites.

Napandee

Figure 4: Landscape of the approved site at Napandee

Nomination

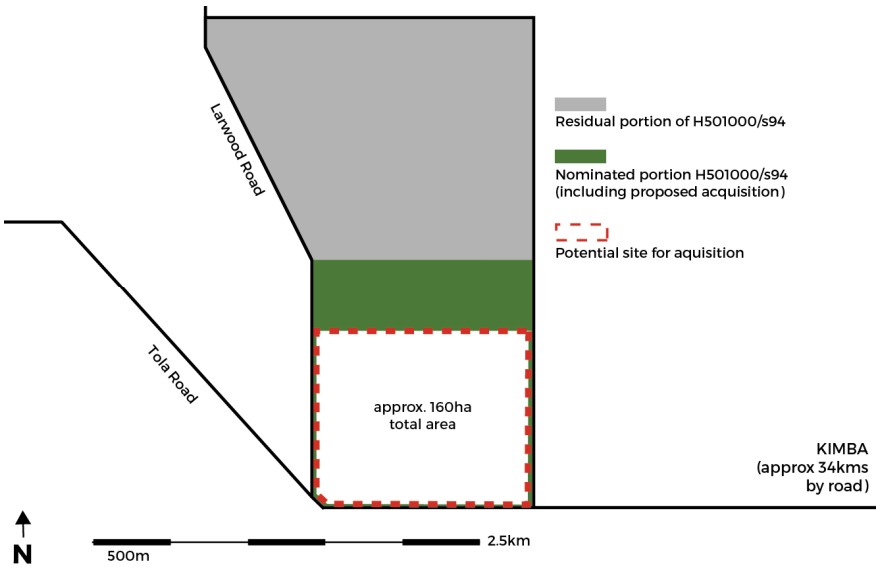
Part of section 94, Hundred of Pinkawillinie, Certificate of Title Volume 5937 Folio 542 (Napandee) was nominated under section 7 of the NRWM Act in January 2017, by Jeffrey Frank Baldock and Jennifer Anne Baldock.

The Napandee nomination was approved by the Minister under section 9 of the NRWM Act in June 2017, after a community consultation period which included a community ballot.

Propose acquisition parcel

Preliminary site characterisation works at Napandee and other volunteered sites have determined approximately 160 hectares in total would need to be acquired to accommodate a buffer zone, community uses and supporting infrastructure.

Figure 5: Map of proposed acquisition parcel within the approved site at Napandee



Nearby interests (Figure 6)

Located 25 kilometres west of Kimba on the Eyre Peninsula and approximately 10 kilometres north of the Eyre Highway.

The site sits within the District Council of Kimba.

While there is no Native Title on the approved site, the Barngarla People hold Native Title in the surrounding area (see images showing Native Title at attachment H, p. 7).

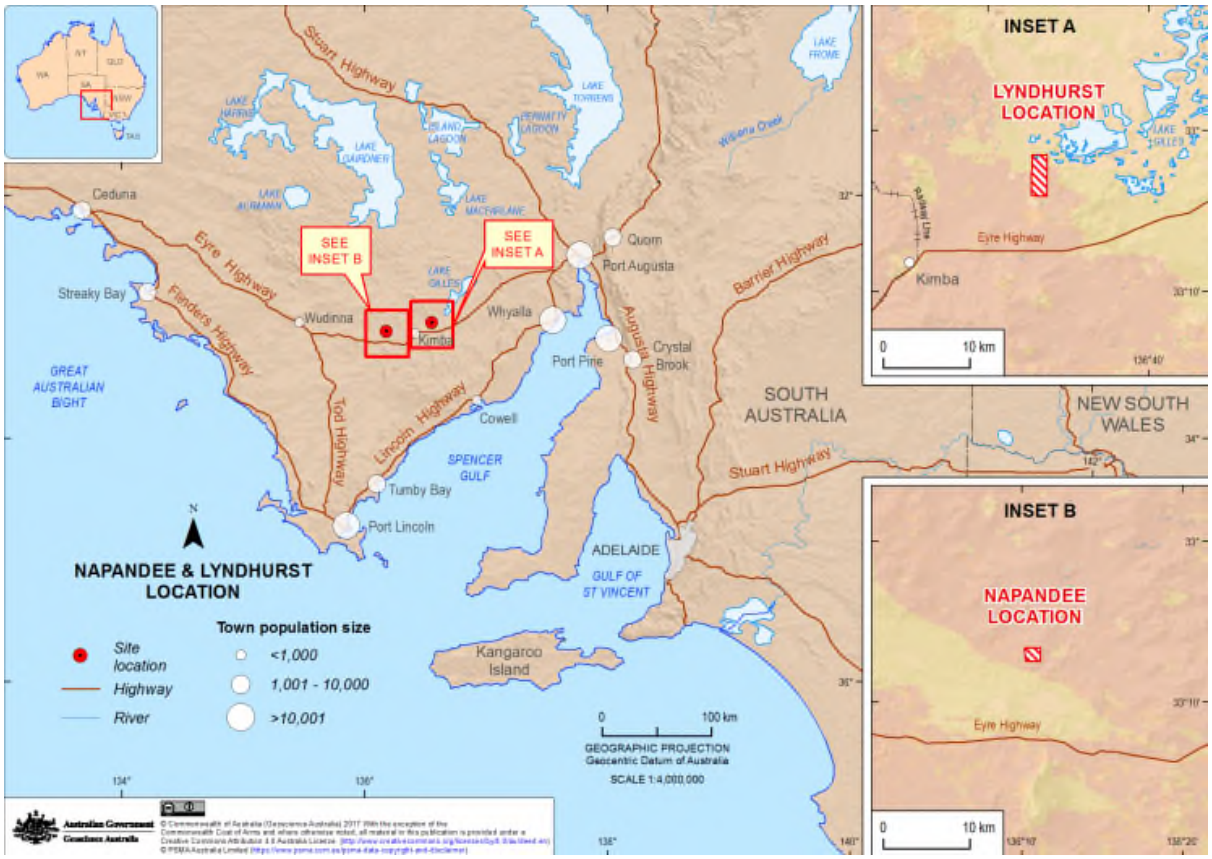


Figure 6: Map of the approved site at Napandee, in relation to Lyndhurst and the broader region

Wallerberdina

Figure 7: Landscape of the approved site at Wallerberdina

Nomination

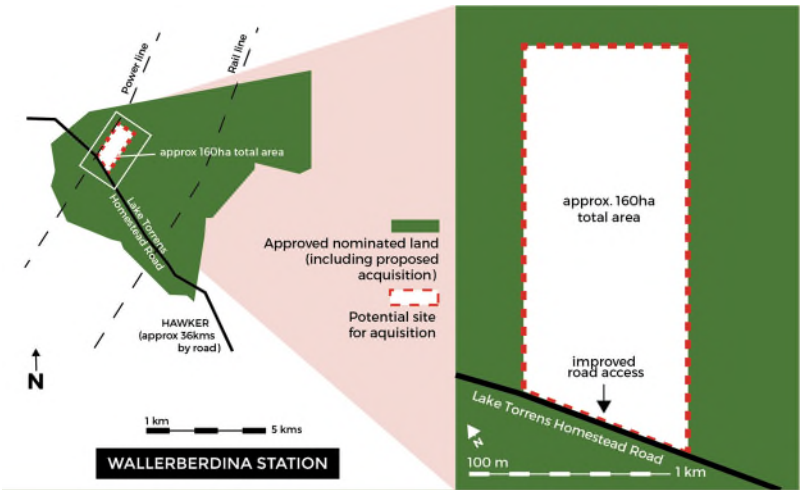
Perpetual Crown Lease Register Book Volume 1215 Folio 28 (now Crown Lease Volume 6200 Folio 237) and Crown Lease Register Book Volume 1280 Folio 1 (Wallerberdina) was nominated under section 7 of the NRWM Act, in March 2015 by Wallerberdina Pty Ltd, as trustee for the Wallerberdina Pastoral Trust. Philip Alan Speakman and Hedley Grant Pearson Chapman are the directors of Wallerberdina Pty Ltd.

Crown Lease Register Book Volume 1215 Folio 28 (now Crown Lease Volume 6200 Folio 237) was approved by the Minister under section 9 of the NRWM Act in April 2016 after a community consultation period, which included a community survey.

Proposed acquisition parcel

Preliminary site characterisation works at Wallerberdina and other volunteered sites have determined approximately 160 hectares in total would need to be acquired to accommodate a buffer zone, community uses and supporting infrastructure.

Figure 8: Map of proposed acquisition parcel within the approved site at Wallerberdina



Nearby interests (Figure 9)

The Wallerberdina locality is also known as Barndioota.

The site is located 30 kilometres north-west of Hawker, 90 kilometres north-east of Quorn and 130 kilometres north-east of Port Augusta, and approximately 10 kilometres west of The Outback Highway.

The site straddles the Flinders Ranges Council (FRC) area and the Outback Communities Authority (OCA).

While there is no Native Title on the approved site, the Adnyamathanha People hold Native Title in the surrounding area (see images showing Native Title at attachment I, p. 7).

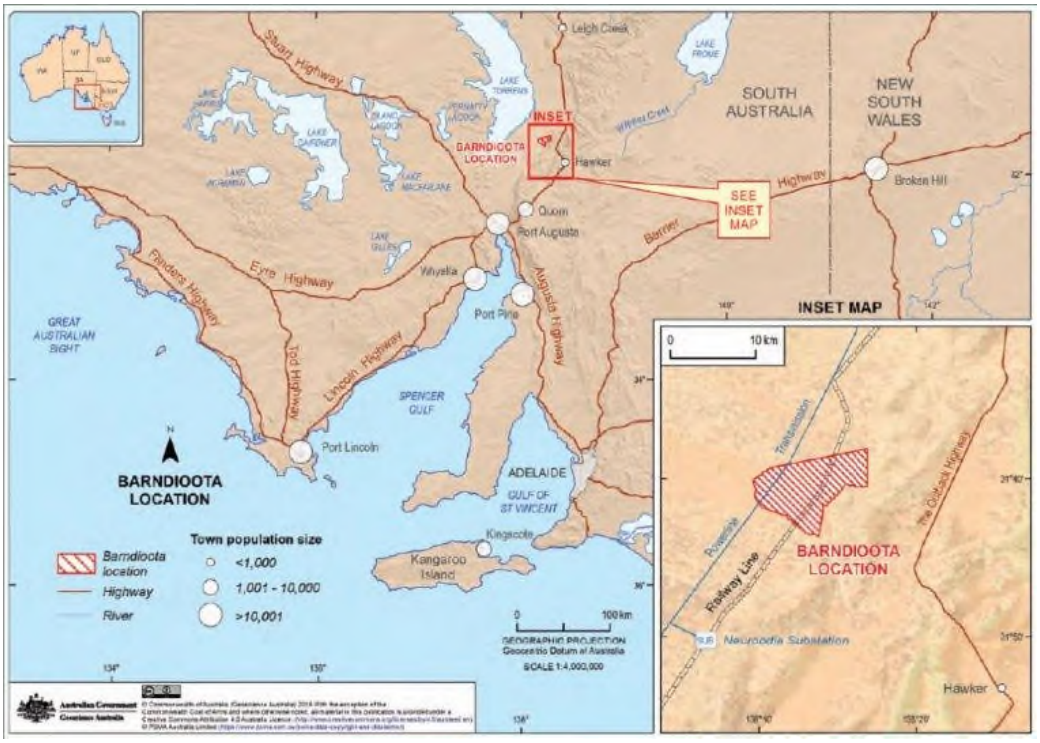


Figure 9: Map of the approved site at Wallerberdina in relation to the broader region

Selecting a site

The process for selecting a site for a facility, under the NRWM Act

The NRWM Act prescribes the process for selecting and acquiring, by declaration, a site for a facility which has been nominated and approved under the NRWM Act, for the purpose of ensuring the safe and secure management of radioactive waste.

The sites considered in this report were nominated under section 7 of the NRWM Act, in response to a call for voluntary nominations made under section 6. The nominated sites (or at Wallerberdina, a portion of the nominated site) were declared by the Minister as approved sites under section 9 of the NRWM Act.

Section 14(2) of the NRWM Act provides that the Minister may, in their 'absolute discretion', declare that an approved site or part of an approved site is selected as the site for a facility. Only one site may be declared and the Minister has the option not to select any of the approved sites.

The passage of the National Radioactive Waste Management Amendment (Site Specification, Community Fund and Other Measures) Bill 2020 (the Bill) would affect the processes for the acquisition of land and other matters relevant to the establishment of the facility.

While the former Minister identified a preferred site for the facility, in-line with the existing legislation, the parts of the NRWM Act relating to nomination and approval of sites would be made redundant as the Bill will specify the site for the facility. For example, section 14 relating to declaration of a site by the Minister, and section 18, which relates to the issuing of public notices that the Minister proposes to declare a site, would become redundant with the passage of the legislation. Instead, the Bill will give the Parliament a say in the decision, as well as clarity to the community and nuclear industry on the Government's commitment to appropriately manage Australia's low level and intermediate level radioactive waste.

How the NRWM Act informs the site suitability assessment

The Minister's 'absolute discretion' to declare that a particular site has been selected as the site for the facility under section 14 of the NRWM Act is limited by the subject matter, purpose and scope of the NRWM Act. Section 3 of the NRWM Act states:

> The object of this Act is to provide for:
>
> a) the selection of a site for a radioactive waste management facility on voluntarily nominated land in Australia; and
> b) the establishment and operation of such a facility on the selected site;
>
> to ensure that radioactive waste generated, possessed or controlled by the Commonwealth or a Commonwealth entity is safely and securely managed.

This means that in making a decision to declare a site as the site for a facility, the Minister should have regard to the extent to which the site is suitable in relation to subsections 3(a) and 3(b) of the NRWM Act, to ensure that radioactive waste generated, possessed or controlled by the Commonwealth or a Commonwealth entity is safely and securely managed.

When passed, the Bill will amend the object of the NRWM Act to reflect that the site for the facility is specified in the Act, and make clear that the safe and secure management of controlled material gives effect to Australia's obligations as a party to the *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management*. The object of the NRWM Act as described in the Bill states:

> (1) The object of this Act is to ensure that controlled material is safely and securely managed by providing for:
> (a) the specification of a site for a radioactive waste management facility; and
> (b) the establishment and operation of such a facility on the site specified.
> (2) By ensuring that controlled material is safely and securely managed, this Act, among other things, gives effect to certain obligations that Australia has as a party to the Joint Convention, in particular, Australia's obligations under Chapters 3 and 4 of the Joint Convention.

The site suitability criteria

The following site suitability criteria were developed to enable a suitability assessment to support a decision about site selection:

1. The extent to which it is reasonably likely that, at the site, radioactive waste can be safely and securely managed by the establishment and operation of the NRWM facility that meets the necessary regulatory or other approvals, licences and permits.
2. The costs to acquire the site and realise the NRWM facility at the site.
3. Other matters relevant to the suitability of the site for the establishment and operation of the NRWM facility.
4. The extent to which there is broad community support for the NRWM facility to be hosted at the site.

Site suitability criterion 1

The extent to which it is reasonably likely that, at the site, radioactive waste can be safely and securely managed by the establishment and operation of the NRWM facility that meets the necessary regulatory or other approvals, licences and permits.

Safe and secure management of radioactive waste controlled by the Commonwealth is the primary objective of the NRWM Act. To assess the potential capacity of each site to meet this objective, the assessment methodology used for criterion 1 is based on the likely requirements of future regulators for whom the safe and secure management of radioactive waste is also a priority.

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)[2], the Australian Safeguards and Non-Proliferation Office (ASNO)[3], and the Department of Agriculture, Water and the Environment (DAWE)[4] will require extensive evidence that radioactive waste will be safely and securely managed at the facility, before issuing the licences and approvals necessary for the establishment and operation of the facility.

Robust guidance on siting nuclear facilities, including radioactive waste management facilities and incorporating international best practice, already exist. The first criterion 1 assessment (see attachment A) draws on ARPANSA documentation (including licence applications, regulatory assessment principles, regulatory guides and codes), ASNO guidance (including security and safeguards guidance and specific requirements), and International Atomic Energy Agency (IAEA) siting criteria and guidance documents. While IAEA is not a regulator for this facility, it produces international nuclear safety, security and safeguards standards which provide guidance and success criteria to consider in the siting of radioactive waste management facilities. The IAEA and ASNO will conduct inspections of the facility to verify compliance with Australia's comprehensive safeguards agreement and additional protocol with the IAEA.

A comparative technical assessment of the suitability of the sites for the facility in terms of the likelihood of meeting regulatory requirements and IAEA guidance has been prepared by

[2] ARPANSA's purpose is to protect the Australian people and the environment from the harmful effects of radiation through understanding risks and best practice regulation, including to ensure the safety and security of radioactive material (including the safety of nuclear material). ARPANSA draws on international best practice and guidance, including from the IAEA and the International Committee on Radiation Protection (ICRP) to understand risks and best practice regulation and is the Australian Government's primary authority on radiation protection and nuclear safety.

[3] ASNO will regulate the security arrangements for storage of some waste at the facility which is subject to international security treaties, as part of its wider role enhancing Australian and international security through activities that contribute to effective regimes against the proliferation of weapons of mass destruction.

[4] The DAWE regulates the EPBC Act (Cth), ensuring the protection of flora, fauna and the environment.

specialists and the department. This considers desk top information and site characterisation investigations carried out to date. This includes a rating of the technical risk for each site using the Australian Nuclear Science and Technology Organisation (ANSTO) risk assessment methodology (recognised by the regulators).

The assessment is framed in terms of the likelihood of a regulator being concerned about a particular site characteristic associated with a future licence application, rather than the likelihood of meeting regulatory requirements as such (which would require presumption of the regulator's actual responses to applications). The approach provides an appropriate proxy assessment of the safety and security risk of the sites using the information that is currently available.

A second assessment has been prepared to identify potential site differentiators of interest to regulators in terms of a future *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) approval (see attachment C). This assessment followed a similar approach to the technical ARPANSA/ASNO/IAEA site suitability assessment.

The respective regulators reviewed the methodologies for each of the assessments and were comfortable with the approaches taken. This ensured that an appropriate methodology was utilised for both assessments, but without compromising the future independence of the regulators when making their regulatory licence determinations. Additionally, the technical assessment was peer reviewed by CSIRO, who had not been included in the assessment panel and so provided an independent view to the department.

A range of future regulatory and other considerations, apart from those considered in criterion 1, have also been identified and considered for completeness. For example the *Public Works Committee Act 1969* (Cth) requires that the facility be referred to the Parliamentary Standing Committee on Public Works for consideration. No risk rating has been applied to these considerations, as the available information is currently too preliminary to conduct comparative assessments.

Site suitability criterion 2

The costs to acquire the site and realise the NRWM facility at the site.

This criterion relates to the financial costs associated with establishing the facility at each site. There are two distinct costs associated with the facility: the cost of the facility itself, and the compensation costs associated with acquiring land or property needed to support the facility. The cost of operating the facility has not been examined. The department has assessed the risk that proposed expenditure would not result in a fit-for-purpose facility. This was based on facility (and enabling works) cost estimates for each site prepared by specialists. The cost estimates take into account the estimates for additional works to

address risks associated with each site. An assessment of the possible compensation costs associated with each of the sites has been prepared by the department.

Site suitability criterion 3

Other matters relevant to the suitability of the site for the establishment and operation of the facility.

The facility will have a presence within the environment and community over hundreds of years across the pre-operational, operational and post operational phases. Criterion 3 considers matters that could potentially impact the suitability of the site for facility establishment, operation and decommissioning, beyond the consideration of regulatory approvals, costs and community sentiment as examined in criterion 1, 2 and 4. This includes the consideration of the possible practical, legal and stakeholder risks associated with the discrete tasks necessary to achieve the object of the NRWM Act across the lifecycle of the facility.

The department identified and grouped the factors relevant to assessing this criterion, then each group of factors was evaluated using the approach described in the department's risk management framework (see pp. 52-54).

Site suitability criterion 4

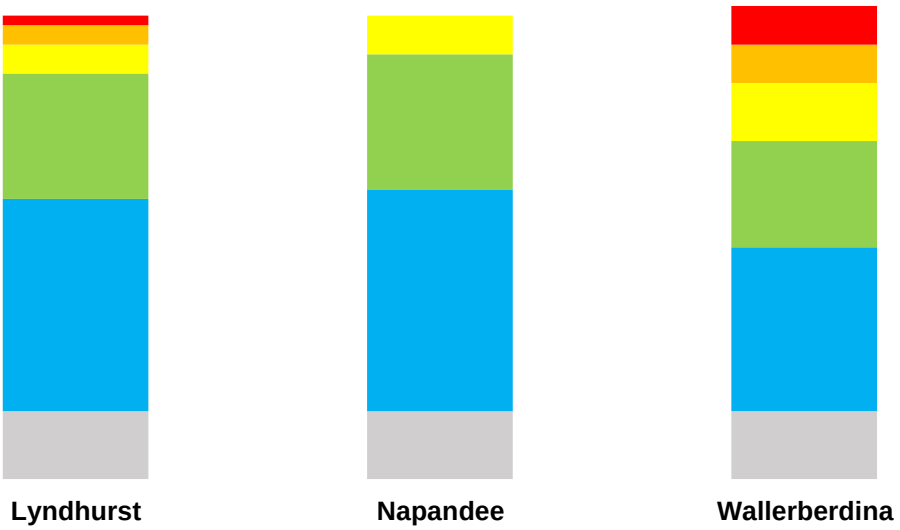
The extent to which there is broad community support for the facility to be hosted at the site.

Successive ministers have made a commitment that the facility will be established in a community where there is broad community support. To assist the Minister's consideration of this criterion, a report of key community sentiment indicators was provided to supplement the site assessment report, after the community ballots were conducted. Indicators included: the results of the community ballots, business surveys and neighbour surveys, analysis of public submissions and Ministerial correspondence, and views of Traditional Owner groups.

Executive summary of findings

The following pages of this executive summary include written summaries of the findings of this report, including detailed matrices for criterion 1, technical assessment (ARPANSA, ASNO and IAEA).

The below graphic is a visual representation of the level of risk for each site.



The Lyndhurst site has **3 high/very high risk ratings**, including potential regulator concern about flooding (pages 22 and 36). There are 3 medium risk ratings and 35 low/very low risk ratings.

The Napandee site has **no high/very high risk ratings**, 4 medium risk ratings and 37 low/very low risk ratings.

The Wallerberdina site has **7 high/very high risk ratings**, including potential regulator concern about flooding (pages 22 and 36), seismicity (page 20), implementation of the emergency plan (page 28) and ground water access (pages 25 and 38). There are 6 medium risk ratings and 28 low/very low risk ratings.

While all identified risks can be managed with appropriate mitigations, the complexity and cost to achieve this varies significantly between the sites.

Matrices

The matrices present the outcomes of the site suitability assessments in a visual format, grouped by the site suitability criterion. Each matrix corresponds to a site suitability assessment and draws on that assessments methodology to define the ‘traffic-light’ ratings. The rating definitions are summarised at the top of each matrix and described full in the relevant section of the report. Elements of the site suitability assessments which were not assessed are represented by grey circles in all matrices.

Site suitability criterion 1

Technical assessment (ARPANSA, ASNO and IAEA)

This is an assessment of the likelihood of ARPANSA/ASNO being concerned about particular site characteristics associated with a future licence application, not pre-empting any outcome from an assessment by the regulator. The assessment was carried out by specialists and the department using available information and ARPANSA, ASNO and IAEA guidance and regulations. The assessment used the ANSTO risk assessment methodology and matrix to derive risk ratings for the site characteristics which are shown here. The regulator reviewed the methodology for the assessment and was comfortable with the approach. A full summary can be found from p. 13, also see attachment A (technical assessment). A matrix presents the outcomes of the site suitability assessments for this criterion in a visual format. It draws on the assessment’s methodology to define the ‘traffic-light’ ratings.

The rating definitions are summarised below. Elements of the site suitability assessments which were not assessed are represented by grey circles. For all three sites all identified risks can be mitigated but with varying degrees of complexity and cost involved.

Table 1: Technical assessment (ARPANSA, ASNO and IAEA) ratings definitions

	N/A	Very low	Low	Medium	High	Very high
Traffic light						

Table 2: The department’s assessment of the risk that the regulator would have concerns about a particular site characteristic, technical factor or measurement, based on the currently available information

	Lyndhurst	Napandee	Wallerberdina
Long-term closure safety (p. 19)			
Volcanism (p. 19)			
Geology—earthquake and active Faulting (p. 20)			
Meteorology (p. 21)			
Hydrology/transfer processes—flooding and RN dispersion in surface water (p. 22)			
Geology—geotechnical considerations (p. 24)			
Geology/transfer processes—groundwater risk (p. 25)			
Radionuclide dispersion in atmosphere (p. 26)			
Human induced events (p. 26)			
Demographics—populations (p. 27)			
Demographics—nearby human activities and land use (p. 27)			
Ambient radioactivity (p. 27)			
Specific events—bush fire risks (p. 28)			

Implementation of emergency plan (p. 28)			
Ecology and non-radiological environmental impacts (p. 29)	*Refer to the EPBC Act assessment*		
Services and enabling works (p. 29)			
ASNO permits and IAEA requirements (p. 30)			

EPBC Act assessment

This is an assessment of the likelihood of the Department of the Environment and Energy being concerned about particular site characteristics associated with a future licence application, not pre-empting any outcome from an assessment by the regulator. The assessment was carried out by specialists and the department using available information and EPBC guidance and regulations. The assessment used the ANSTO risk assessment methodology and matrix to derive risk rating for the site characteristics which are shown here. The regulator reviewed the approach taken and was comfortable with the approach. The full summary can be found from p. 31 and also see attachment C (EPBC Act assessment). For all three sites all identified risks can be mitigated but with varying degrees of complexity and cost involved.

Table 3: EPBC assessment ratings definitions

Risk rating	N/A	Very low	Low	Medium	High	Very high
Traffic light						

Table 4: The department's assessment of the risk that the regulator would have concerns about a particular site characteristic, technical factor or measurement, based on the currently available information. Asterisks indicate differentiators where mitigations are found in the separate ARPANSA/ASNO/IAEA assessment

	Lyndhurst	Napandee	Wallerberdina
Water supply, storage, monitoring, sewage and treatment (p. 35)			
Surface water quality and hydrology* (p. 36)			
Groundwater* (p. 38)			
Seismic risk* (p. 39)			
Flora and fauna (p. 40)			
Landscape and visual amenity (p. 41)			
Traffic and transport (p. 42)			
Aboriginal cultural heritage (p. 43)			
Land use planning (p. 44)			
Agriculture (p. 45)			

Future regulatory and other considerations matrix

The department has considered the likelihood that requirements can be met with respect to future regulatory processes, outside of the other ARPANSA, ASNO and EPBC Act requirements considered in criterion 1 (p. 46). The site-specific information available for such additional requirements is currently too preliminary to conduct comparative assessments.

Site suitability criterion 2

The costs to acquire the site and realise the facility at the site.

In this section consideration is given to two distinct financial costs associated with the facility: the cost of the facility itself and the compensation costs (initial and future) associated with acquiring land or property needed to support the facility. The cost of operating the facility has not been examined.

The department has assessed the risk that proposed expenditure would not be sufficient to ensure a fit-for-purpose facility at the site. A traffic light rating indicates if this risk is low, medium or high. For all three sites all identified risks can be mitigated but with varying degrees of complexity and cost involved.

Table 5: The department's colour code for rating the risk that proposed expenditure would not result in a fit-for-purpose facility.

Rating	Low	Medium	High
Traffic light			

Facility cost estimates

On assessment, across the three sites did not impact the risk ratings. The cost differentials reflect the complexity of mitigating risks to safety and security, as identified at site suitability criterion 1.

The department has assessed that there is a **low risk** for Lyndhurst and Napandee and **medium risk** for Wallerberdina that proposed expenditure for facility capital costs would not result in a fit-for-purpose facility at the site.

Table 6: The department's assessment of the facility capital cost differentials between the sites

	Lyndhurst	Napandee	Wallerberdina
Capital cost Differentials	+$22.5m	$0 (baseline)	+$150.9m
Total capital cost (estimated)			

Compensation

The department has assessed that there is a **low risk** for Lyndhurst, Napandee and Wallerberdina that proposed expenditure for compensation would not result in a fit-for-purpose facility at the site.

	Lyndhurst	Napandee	Wallerberdina
Compensation costs (estimated)			

Site suitability criterion 3

Other matters relevant to the suitability of the site for the establishment and operation of the facility.

Beyond the consideration of regulatory approvals, costs and community sentiment as examined in criterion 1, 2 and 4, criterion 3 considers other matters that could impact the suitability of each site across the lifecycle of the facility. This includes the consideration of the possible practical, legal and stakeholder risks associated with the discrete tasks necessary to achieve the object of the NRWM Act. The assessment of this criterion was undertaken by a panel of experienced Commonwealth policy and legal officers. Initially, the factors relevant to assessing this criterion were identified and grouped. Each group of factors was evaluated using the approach described in the department's risk management framework, with the resulting ratings shown here for nine of the 11 group of factors (refer to pp. 52-55 for further details). For all three sites all identified risks can be mitigated, but with varying degrees of complexity and cost involved.

Table 7: The following colour code from the department's risk management framework represents risk ratings assigned to factors.

Risk rating	Low	Minor	Medium	High	Very high
Traffic light					

Table 8: The department's assessment of the risk that a particular factor would impact the suitability of the site for the establishment and operation of the facility.

	Lyndhurst	Napandee	Wallerberdina
Aboriginal cultural heritage			
Transport and road use			
Noise, dust, visual and other disturbance			
Security			
Utilities supply			
Future land use and activities			
Additional land or property acquisitions			
Environment			
Socio-economic			
Community relationships			
Legislative override provisions of the NRWM Act			

Site assessments

Site suitability criterion 1

The extent to which it is reasonably likely that, at the site, radioactive waste can be safely and securely managed by the establishment and operation of the NRWM facility that meets the necessary regulatory or other approvals, licences and permits.

Technical assessment (ARPANSA, ASNO and IAEA)

The purpose of the ARPANSA/ASNO/IAEA site suitability assessment of site-specific characteristics is to inform the Minister of: the potential risks of each site, areas where a regulator is likely to require more information than is currently known and areas where the information to date suggests that further design work and mitigations may be required to build the facility on a particular site to safely and securely manage radioactive waste. This purpose does not include a risk assessment of the concept design against risk events or a comparison of the current concept design basis against possible events.

Based on the preliminary site characterisation studies conducted to date and relevant publicly available information, this section provides a technical basis for differentiating between approved sites. It assesses the suitability for safe and secure management of radioactive waste by evaluating the likelihood of a regulator being concerned about a particular site characteristic associated with a future licence application. This section provides a technical basis for site comparison and selection in the context of risk and likelihood of gaining regulatory approval, without pre-empting any outcome from an assessment by the regulator. This is not a risk assessment of whether the concept design will address specific risk events.

The assessment results on the following pages have been compiled from information extracted from the technical assessment performed using ARPANSA, ASNO and IAEA guidance or regulations (see attachment A).

The assessment draws on the preliminary site characterisation studies conducted to date and relevant publicly available information. It is a comparative technical risk assessment of the suitability of the approved sites in the context of ARPANSA, ASNO and IAEA guidance and regulations. Potential risk mitigations are highlighted in the assessment. Costs associated with these mitigations are captured in site suitability criterion 2.

ARPANSA documents (including licence applications, regulatory assessment principles, regulatory guides and codes); ASNO guidance (including security and safeguards guidance and specific requirements), and International Atomic Energy Agency (IAEA) criteria were used to inform the likely areas of interest for future regulatory approvals. Assessment against ARPANSA, ASNO and IAEA criteria will ensure consistency with international best practice, and consistency with the factors likely to be important in the regulatory siting licence determinations for the facility.

ARPANSA officials provided feedback on the methodology used, codes and standards applied in the ARPANSA/ASNO/IAEA site suitability assessment and indicated they were comfortable with the approach, while retaining ARPANSA's right to make a different assessment when considering future completed regulatory applications.

The ARPANSA/ASNO/IAEA site suitability assessment process comprised the following:

1. Identification of the IAEA, ARPANSA, and ASNO criteria for use in the assessment (site exclusion and discretionary/site comparators).
2. Comparison of the available information with IAEA exclusionary criteria to identify whether the sites offered a feasible option for the facility.
3. A more detailed assessment, comparing the available site information with IAEA discretionary criteria to assess and differentiate between the sites on the likely level of regulatory concern (which is also indicative of the practicability).
4. Identification of the types of mitigation measures that may be required and estimation of the mitigation costs at an order of magnitude level.

The assessment included four IAEA exclusionary criteria and further 13 non-exclusionary criteria as described in table 10. For exclusionary criteria (site volcanism, earthquake/active faulting, major geotechnical hazards, emergency plan implementation) if the site risk level was too great or not mitigatable, this could be used as a reason for excluding/ rejecting the site. Non-exclusionary criteria were used in addition to the exclusionary criteria to create a well-based assessment of risk of regulatory concern.

In the tables set out from pages 19 to 30 below, the department has provided its rating of the risk that a regulator will be concerned about particular characteristics of a site (the 'risk rating'). The department has used ANSTO's risk methodology determinations matrix to produce those risk ratings, having regard to the likelihood and regulatory consequence associated with each characteristic (see table 9).

In this matrix, 'likelihood' is the department's assessment of the probability that the regulator will have concern that the particular site characteristic will affect approval. This is not the likelihood of a significant or catastrophic event resulting from one of the assessment factors and is not an assessment of the design risks against reference events.

The consequence assigned per characteristic, indicates the department's assessment of the level of potential regulator concern. This is the overall consequence for achieving facility approval, for example, 'catastrophic impact' means the worst case scenario for meeting

ARPANSA requirements, that regulatory approval may not be attainable. ‘Severe impact’ indicates significant regulatory impact, and additional mitigation work and/or studies may be required to satisfy the regulator. This is not the consequence of an issue concerning a certain characteristic, for example, not the consequence of a seismic event. The level of consequence can additionally indicate need for the mitigations to be addressed and integrated in facility siting or design.

The department then used the ANSTO risk assessment methodology risk determination matrix to combine likelihood and consequence to determine a final risk rating. Specialist organisations also contributed to the assessment, including ANSTO and AECOM. The regulator reviewed the methodology for the assessment and was comfortable with the approach taken. This ensured that an appropriate methodology was utilised, but without compromising the future independence of the regulator when making their regulatory licence determinations. Additionally, the technical assessment was peer reviewed by CSIRO, who had not been included in the assessment panel and so provided an independent view to the Department.

Table 9: Risk determination matrix, combining likelihood and consequence levels to determine a final risk rating (adapted from the ANSTO risk assessment methodology)

Medium	High	High	Very High	Very High	Very High	Very High	6	Catastrophic	**Consequence**
Low	Medium	Medium	High	High	Very High	Very High	5	Severe	
Low	Low	Medium	Medium	High	High	Very High	4	Major	
Very Low	Very Low	Low	Low	Medium	Medium	High	3	Moderate	
Very Low	Very Low	Very Low	Very Low	Low	Low	Medium	2	Minor	
Very Low	Very Low	Very Low	Very Low	Very Low	Low	Low	1	Negligible	
A	B	C	D	E	F	G			
Extremely Unlikely	Highly Unlikely	Very Unlikely	Unlikely	Likely	Very Likely	Almost Certain			
Likelihood									

Table 10: non-technical description of the criteria used in the ARPANSA/ASNO/IAEA site suitability assessment report (attachment A)

Criterion included in assessment	Criterion characteristics
Long term closure safety *(non-exclusionary criterion)*	The extent to which there is an adequate understanding and confidence in post closure safety. The operator should undertake an ongoing programme of assessment of safety of the disposal facility. The aim of the safety assessment should not be solely to evaluate the performance and radiological impact of the disposal system, but should also be to develop an understanding of how the disposal system (the facility and its surrounding environment) may behave and evolve.
Volcanism *(exclusionary criterion)*	Assessment of proximity to active volcanoes.
Geology–earthquake and active faulting *(exclusionary criterion)*	Assessment of potentially active, near surface and nearby faults and ridge crests, which would have the potential to affect the feasibility of design, construction and safe operation of the facility.
Meteorology *(non-exclusionary criterion)*	Assessment of existing climatic conditions to identify any potential hazards that could impact the facility or workers. This includes assessing extreme values, rare events and the risk of climate change impacts.
Hydrology/transfer processes–flooding and radionuclide dispersion risk in surface water *(non-exclusionary criterion)*	Assessment of surface processes (or the potential for them) that may affect the safety of the facility, such as flooding, landslides, erosion, drainage, ponding and water accumulation.
Geology–geotechnical considerations *(exclusionary criterion)*	Assessment of geotechnical hazards, including potential for slope instability, soil liquefaction, collapsing or expansive soils, subsidence due to ground features, long-term settlement, and soil scour and erodibility. Site geology is an important consideration in the long-term safety of the facility, as these can impact the required building foundations and also the potential movement of radionuclides.
Geology/transfer processes–groundwater risk *(non-exclusionary criterion)*	Assessment of the potential impact of the contamination of groundwater on the population, including assessment of water table depth, potential for migration of water, soil absorption capacity, limited or no current groundwater users, and poor quality groundwater to discourage future use.
Radionuclide dispersion in atmosphere *(non-exclusionary criterion)*	Assessment of pathways for airborne dispersion of radionuclides, including consideration of proximity of population/human receptors, radionuclide transfer risk and operational accidents (in particular on-site fire incidents).

Criterion included in assessment	Criterion characteristics
Human-induced events *(non-exclusionary criterion)*	Assessment of potential interactions with the site as a result of human activity – human induced events. This includes assessment of flight paths, proximity to chemicals and industrial gas depots, high voltage power lines, tourists and airstrips.
Demographics–populations *(non-exclusionary criterion)*	Assessment of potential risk of health effects (for local populations and critical groups) resulting from site operations or accidents.
Demographics–nearby human activities and land use *(non-exclusionary criterion)*	Assessment of the risk of human uses/land uses impacting on the establishment, operation and safety of the facility, which could impact regulatory approval. For example, existing residences or community facilities in close proximity, mining tenements, hazardous facilities and airfields.
Radiological baseline *(non-exclusionary criterion)*	Assessment of the current radiological characteristics of the site so to establish a baseline from which to progress environmental impacts, safety case and monitoring for the next stages. Determining baseline radiological levels is also important to ensure that the radiation levels at the sites are within normal ranges and that a facility could be operated within the ARPANSA requirements for worker safety.
Specific events–bushfire risks *(non-exclusionary criterion)*	Assessment of bushfire risk and potential for impacts on site operations (e.g. curtailment of operations or need to evacuate staff). Factors include climatic conditions, fuel loadings and topography, plus potential mitigations such as buffers and setbacks.
Implementation of emergency plan *(exclusionary criterion)*	Assessment of ability to meet regulatory requirements to enact an emergency plan to cover incidents such as, but not limited to fires, radiological emergency, severe weather, suspicious package, site utilities disruption, medical emergencies, terrorism and protests. The emergency plan needs to consider the design of facilities and site access.
Ecology and non-radiological environmental impact	ARPANSA will consider ecology and non-radiological impacts as part of the facility assessment. Factors include vegetation types and abundance, wildlife and threatened and endangered species. These are considered through the EPBC assessment.
Services and enabling works *(non-exclusionary criterion)*	Assessment of the availability and vulnerability of site services and the difficulty in providing enabling works for the facility (such as power, water, sewerage, transport, communications, and emergency services).
ASNO permits and IAEA requirements *(non-exclusionary criterion)*	Assessment of any site-specific differences that would impact the ability to meet ASNO and IAEA requirements for the safe and secure storage of nuclear safeguard material and the ability to inspect this material for verification and accounting purposes.

The tables below have been compiled with information extracted from section 5 ‘summary assessment—siting criteria and regulatory risk’ in the ARPANSA/ASNO/IAEA site suitability assessment report at attachment A. They show: the risk rating assigned to the criteria for each approved site, a description of each criterion and a summary of information, mitigation and residual risk. Where a criterion has not been rated, the reasons are listed in the tables.

Long term post closure safety

This summary is compiled from information extracted from the ARPANSA/ASNO/IAEA site suitability assessment (attachment A). The information summary for this element was authored by ANSTO.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**N/A**	**N/A**	**N/A**
Information summary	For the LLW disposal system, a conceptual stage model has been developed for assessing potential dose rates to humans in the post-closure period. The modelling has been developed in accordance with Radiation Safety Assessment guidance of IAEA SSR-5, IAEA SSG-23 and IAEA SSG-29. The conceptual stage dose modelling is currently based on the available generic siting information for the LLW disposal system. In the iterative approach, the base model does not yet differentiate between the three candidate sites, as it has incorporated data generally representative of the region as well as generic internationally-recognised data. The dose assessment modelling has been undertaken using the computer package called RESRAD OFFSITE which has been developed by, and is supported by nuclear regulatory agencies in the United States and has a record of international use. In accordance with the IAEA guidance, assumptions about the future conditions have been made that are conservative in that they tend to over-predict potential dose rates and therefore provide a level of safety assurance. The key assumptions for the conceptual model are: • Modelling starts at the end of the 100-year operational period (2127). • People may access the site at the end of the operational period. No credit is given to the institutional control measures. • At the end of the 100-year operational period, the model assumes the waste is mixed homogenously and spread over a portion of the facility site (assumed to be 500m x 500m). No credit is given to the engineered vault structure or waste conditioning processes. Assessment is performed using varying thickness of clean covers. • The bounding case is a farmer that: spends 100% time at the site, lives ‘outdoors’ and consumes garden and meat products grown at the site. A water well (groundwater) provides irrigation and drinking water. • A conservative waste source term (bounding estimate for LLW) is assumed (no radioactive decay is currently factored in till end of operational period). • The conceptual stage generic model assumes 1m depth to groundwater and varying clean cover thickness of 0m, 1m and 3m. The main outcome from the conceptual modelling indicates that potential dose rates to future receptors, even the conservative bounding cases, are well below the relevant regulatory criteria of 1 mSv/yr. However, the results also indicate that future exposures vary according to the protective capabilities of the cover over the wastes (e.g. assumed cover thickness, resistance to erosion). Potential dose rates decrease relative to increasing cover thickness when they were assessed for 0-3m clean cover depths. The scenarios that involve potential direct exposure to the wastes (assuming minimal cover effectiveness) are likely to result in greater dose rates than those associated with groundwater pathways according to modelling results on near-surface disposal configurations. The results so far are preliminary and indicate the need to incorporate site-specific data once that is available to refine the models and allow comparison between the candidate sites. Refined modelling is also needed to assess the potential dose rates that result from scenarios where receptors may penetrate any protective barriers and be exposed directly to the wastes at some time in the future. Also needed under the IAEA process, is a sensitivity/uncertainty analysis on the refined well-developed site-specific models. Not considered to be a differentiator at this point, with further future development of the model required to incorporate additional site characterisation information, plus the development of the inventory, design and safety case.		

Geology—Volcanism

This summary is extracted from the ARPANSA/ASNO/IAEA site suitability assessment (attachment A). The information summary for this element was authored by Geoscience Australia

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**N/A**	**N/A**	**N/A**
Information summary	Criterion not relevant to sites. The nearest active (but dormant) volcanoes are located in the Newer Volcanics Province (NVP) that that extend from approximately Melbourne in the east to Mount Gambier in the west. The western extent of this region is over 500km from the sites. The key point is that there are active (but dormant) volcanoes in Australia but these are located a long way from the Lyndhurst, Napandee and Wallerberdina sites, so the ‘not exclusionary’ criteria is still valid. The closest active but dormant volcanoes to the sites are located in the Newer Volcanics Province (NVP) that extends from approximately Melbourne in the east to Mount Gambier in the west. The western extent of this region is over 500km from the sites so the risk of impact on the sites from lava flow, pyroclastic flow and lahars (massive) is very low given these events would extend only a few tens of kilometres from an erupting volcano in the NVP. Cas et al (2017) suggest that given that heat flow and other geophysical anomalies indicate the presence of partial melts at depth under the Bendigo–Ballarat region, and that the most recent eruptions occurred approximately 5000 years ago in the Mt Gambier region, these are the two areas where future eruptions are most likely to occur.		

Geology - Earthquake and active faulting

This summary is compiled from information extracted from the ARPANSA/ASNO/IAEA site suitability assessment (attachment A). The department and AECOM have assessed this element taking into account specialist inputs from AECOM, ANSTO and Jacobs, and review from ARPANSA, ANSTO, AECOM and CSIRO.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**Low**	**Low**	**Very high**
Residual risk	No change	No change	There is residual risk associated with seismic events after the identified design mitigations have been applied, which may concern regulators. While the risks can be mitigated, additional assessments will be necessary, and subject to those assessments, additional mitigations may be necessary.
Criterion of differentiator	IAEA SSG9 para 8.8: Where reliable evidence shows that there may be a capable fault with the potential to affect the safety of a plant at a site, the feasibility of design, construction and safe operation of a plant at this site should be re-evaluated and, if necessary, an alternative site should be considered. For the facility this means: • absence of potentially active fault that could cause surface faulting through the facility. • absence of near surface faults that could cause folding or other deformation within the facility. • absence of nearby faults that could cause hanging wall or rupture directivity effects, which amplify ground motions. • absence of ridge crests, which amplify ground motions.		
Summary	Seismic hazards are not as high as identified at WBD due to the absence of potentially active faults in the foundation, near-surface faults beneath or near the foundation, and faults in the nearby area are not present (excluding the possibility of one-off faulting). However, additional seismic studies will be required to inform design and give confidence to the regulator that this has been considered.	Seismic hazards are not as high as identified at WBD due to the absence of potentially active faults in the foundation, near-surface faults beneath or near the foundation, and faults in the nearby area are not present (excluding the possibility of one-off faulting). However, additional seismic studies will be required to inform design and give confidence to the regulator that this has been considered.	Seismic hazards from ground shaking and deformation are higher at WBD (by 2.4 times) than the Lyndhurst and Napandee sites and will require additional structural mitigations to be incorporated into the facility design (typically applied in constructing buildings in earthquake prone regions in the world). The greater likelihood of an active fault at WBD compared to Lyndhurst and Napandee sites will drive regulatory focus.
Risk mitigation(s)	No additional engineering enhancement required	No additional engineering enhancement required	For WBD mitigation for fault activity/potential ground movement will need to be included in design. Mitigation by engineering enhancement (e.g. design enhancement to foundations, structural elements and key services to cater for increased accelerations above generic site) are similar to those required for earthquake mitigation. Further layers of containment such as concrete disposal containers may need to be considered if the regulator is not accepting of the safety assessment, but this is of low likelihood. Further seismic survey and analysis will need to be undertaken post-site selection to locate faults of the western range-front, to determine the likely impact of any seismic event on ground motion and to inform design parameters. Detailed fault mapping would be required on-site if a fault line is located to determine the age of the fault (i.e. active or not active). Site layout of items important to radiological safety and key operational elements will to consider any identified fault locations. The greater ground accelerations predicted at the WBD site will also result in enhanced specifications for service infrastructure.

Meteorological events (includes historic records)

This summary is compiled from information extracted from the ARPANSA/ASNO/IAEA site suitability assessment (attachment A). The department and CSIRO have assessed this element taking into account specialist inputs from CSIRO, and review from CSIRO.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**Very low**	**Very low**	**Very low**
Residual risk	N/A	N/A	N/A
Criterion of differentiator	Establish existing climatic conditions for the site based on historic average and identify likely changes to climate based on projections. From this, identify resultant key hazards that could impact on the future facility and workers. Establish the risk of extreme values and rare events to allow for design basis and beyond design basis considerations. Establish the effect of climate change on sites. Future (projected) climate conditions where the frequency and intensity of climatic events has minimal impact upon the site and facility, or where design intervention can reasonably mitigate risks.		
Summary	All sites are arid and have similar temperature range, wind speed and average rainfall profiles. Climate projections are the same for all sites and indicate hotter and drier conditions, and increased days above 40˚C. More intense rainfall events are predicted. The consequence of climate change on hydrology is addressed in the hydrology/flooding section.		
Risk mitigation(s)	Flooding mitigation at Lyndhurst is dealt with in the following section. Climate change review and risk assessment to be completed as part of design process, including adaptations	Climate change review and risk assessment to be completed as part of design process, including adaptations	Flooding mitigation at WBD is dealt with in the following section. Climate change review and risk assessment to be completed as part of design process, including adaptations

Hydrology/transfer processes—flooding and radionuclide dispersion risk in surface water

This summary is compiled from information extracted from the ARPANSA/ASNO/IAEA site suitability assessment (attachment A). The department has assessed this element taking into account specialist inputs from AECOM, ANSTO and Jacobs, and review from AECOM, ANSTO, ARPANSA and CSIRO.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**High**	**Medium**	**Very High**
Residual risk	The minimum length of time for which the mitigation must remain in place and functional is about 400 years (100 years of operations plus 300 years of institutional control). While these risks can be mitigated, and it is likely that identified mitigations will satisfy regulators' concerns, further investigations are required.	The minimum length of time for which the mitigation must remain in place and functional is about 400 years (100 years of operations plus 300 years of institutional control). While these risks can be mitigated, and it is likely that identified mitigations will satisfy regulators' concerns, further investigations are required.	The minimum length of time for which the mitigation must remain in place and functional is about 400 years (100 years of operations plus 300 years of institutional control). While these risks can be mitigated, further investigations are required to determine the full extent of mitigations necessary to satisfy the safety case. Flood mitigations identified to date may not fully satisy the regulators.
Criterion of differentiator	IAEA SSG-29 identifies that surface processes that may affect the safety of the facility need to be considered in the siting process, and recommends: • Verification that surface processes such as flooding of the disposal site, landslides or erosion do not occur with such frequency or intensity that they could affect the ability of the disposal system to meet safety requirements. • That the disposal site is generally well drained and free of areas subject to flooding or frequent ponding. • That accumulation of water in upstream drainage areas due to precipitation or snowmelt and the failure of water control structures, channel obstruction, or landslides is evaluated and minimised so as to decrease the amount of runoff that could erode or inundate the facility. • That preference is given to areas or sites with topographical and hydrological features that preclude the potential for flooding.		
Summary	Local catchment (21km^2) flooding risk with risk of significant inundation of the site. Climate change predictions include higher intensity of rainfall events that could increase flooding risk Low risk of regional scale flooding No creek lines Potential for on-site localised flash flooding. IAEA SSG-29 identifies that surface processes that may affect the safety of the facility need to be considered in the siting process and recommends include 'that the disposal site is generally well drained and free of areas subject to flooding or frequent ponding'.	Local catchment (5km^2) flooding risk with reduced risk of inundation of the site due to higher elevation. Climate change predictions include higher intensity of rainfall events that could increase flooding risk. No creek lines Low risk of regional scale flooding. Potential for on-site localised flash flooding.	Large 1700km^2 catchment area, water course adjacent to site Risk of regional flooding to the site. For example, for 1:2000 AEP–0.25-0.5m inundation, including breakout of Hookina Creek Potential for more frequent on-site localised flooding at lower recurrence intervals. Climate change predictions include higher intensity of rainfall events that could increase flooding risk at Wallerberdina. Risk of erosion of engineered barriers, principally engineered cap over the vaults, and pathway to Hookina Creek. Risk of loss of site access in flood events affecting the ability to mount an emergency response at this site. Potential connectivity to receptors during flooding events (likely more a community perception issue). Note: Direction of surface water flow is towards Lake Torrens and away from human receptors.
Risk mitigation(s)	Investigations – Further refined modelling; a detailed, quantitative assessment of the consequences of floods, using robust models for all possible radionuclide release mechanisms, dispersion patterns, and exposure pathways be developed. This will help to quantify the potential for and, if relevant, risks of flooding within the catchment, the site and the site access road. Design flood protection may include all or a combination of the following: • placing key structures that are important to safety, operations, and security on higher ground • localised land filling (depressions) • provision of flood levee structures to protect the facility (and the access route) against large episodic flood events • creation of local catch drains to intercept external catchments	Additional investigations should be carried out including on the consideration of the change of the magnitude of floods based on climate change scenarios, to collect the necessary information to support a robust comparative risk assessment; a detailed, quantitative assessment of the consequences of floods, using robust models for all possible radionuclide release mechanisms, dispersion patterns, and exposure pathways be developed. This will help to quantify the potential for and, if relevant, risks of flooding within the catchment, the site and the site access road. Design site drainage to protect against local catchment modelling flood predictions. Review of site access with consideration of flood modelling, considering a route that avoids flood risk or one that requires flooding upgrades to site access road. Design flood protection may include all or a combination of the following:	Investigations - Further work is required including on the consideration of the change of the magnitude of floods based on climate change scenarios, to collect the necessary information to support a robust comparative risk assessment; a detailed, quantitative assessment of the consequences of floods, using robust models for all possible radionuclide release mechanisms, dispersion patterns, and exposure pathways be developed. This will help to quantify the potential for and, if relevant, risks of flooding and also avulsion within the catchment, the site and the site access road. Design flood protection is likely to require all of the following: • placing key structures that are important to safety, operations, and security on higher ground • more extensive building and infrastructure raising (compared to LYN)

	Lyndhurst	Napandee	Wallerberdina
	• increasing the scale and capacity of site surface and subsurface drainage arrangements. • excavate 4m deep drainage channel through ridge line on adjacent local western area • water-proofing and or protection of buildings/key services. • adjustment of site location Flood levee/landraising of the site will need to be remodelled in the flood model once designed. Operational and maintenance if a flood occurs • repair of access road • repair to site flood protection • repair of engineered earth structures over LLW vaults. Mitigation for flooding/potential inundation of the facility will need to be included in design or could result in risk of: damage to structures, buildings and waste packages; damage to key services; or lead to the dispersion of radioactive material. It is recommended that all radioactive waste storage, characterisation, and conditioning facilities be located beyond the reach of a 1 in 2000 AEP flood event of the selected site; and LLW disposal vaults be located beyond the reach of PMF level on the selected site without relying on bunds and levees as a mitigation measure to ensure that disposal vaults continue to provide containment and isolation to radioactive waste beyond the operational phase. To site the vaults and other items that are important to safety at Lyndhurst may require selective placement to avoid the areas that are impacted by localised flooding. Develop an emergency access plan that can be enacted if road is flooded.	• placing key structures that are important to safety, operations, and security on higher ground • increasing the scale and capacity of site surface and subsurface drainage arrangements • water-proofing and or protection of buildings/key services. Any flood protection and site drainage will need to be remodelled in the flood model once designed. Operational and maintenance if a flood occurs • repair of access road • repair to site drainage • repair of engineered earth structures over LLW vaults. Mitigation for flooding/potential inundation of the facility will need to be included in design or could result in risk of: damage to structures, buildings and waste packages, damage to key services, or lead to the dispersion of radioactive material. It is recommended that all radioactive waste storage, characterisation, and conditioning facilities be located beyond the reach of a 1 in 2000 AEP flood event of the selected site; and LLW disposal vaults be located beyond the reach of PMF level on the selected site without relying on bunds and levees as a mitigation measure to ensure that disposal vaults continue to provide containment and isolation to radioactive waste beyond the operational phase. Develop an emergency access plan that can be enacted if road is flooded.	• provision of flood levee structures to protect the facility (and access route) against large episodic flood events • increasing the scale and capacity of site surface and subsurface drainage arrangements • water-proofing and or protection of buildings/key services. Flood levee/land raising of the site would need to be remodelled in the flood model once designed. Operational and maintenance if a flood occurs: • repair of access road • repair to site flood protection/levees. • management of stream banks to prevent/ recover from avulsion • repair of engineered earth structures over LLW vaults. Mitigation for flooding/potential inundation of the facility will need to be included in design or could result in risk of: damage to structures, buildings and waste packages; damage to key services; or lead to the dispersion of radioactive material. It is recommended that all radioactive waste storage, characterisation, and conditioning facilities be located beyond the reach of a 1 in 2000 AEP flood event of the selected site; and LLW disposal vaults be located beyond the reach of PMF level on the selected site without relying on bunds and levees as a mitigation measure to ensure that disposal vaults continue to provide containment and isolation to radioactive waste beyond the operational phase. Given the site-wide nature of the flooding at WBD, selective placement of items related to safety would be insufficient to address the risk posed by flooding. Proposed that road access is an unsealed road due to the flooding risk and increased O&M required to respond to flood events. Develop an emergency access plan that can be enacted if road is flooded.

Geology — Geotechnical considerations

This summary is compiled from information extracted from the ARPANSA/ASNO/IAEA site suitability assessment (attachment A). The department has assessed this element taking into account specialist inputs from AECOM, ANSTO and Jacobs, and review from AECOM, ANSTO, ARPANSA and CSIRO.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	Medium	Low	Low
Residual risk	N/A	N/A	N/A
Criterion of differentiator	Geotechnical: Absence of geotechnical hazards (potential for slope instability, soil liquefaction, collapsing or expansive soils, subsidence due to ground features, long-term settlement, soil scour and erodibility). Geotechnical: Site geology is the principal long-term safety barrier. Site geotechnical characteristics impact the selection of the type of building foundations. Deep pile foundations may impact the underground water table and provide an additional potential pathway for radionuclide contamination of groundwater. The ability for site to support both raft (shallow) and pile (deep) foundations has been assessed.		
Summary	No geotechnical hazards present. Shallower groundwater. Piled foundations are proposed in the generic design for all warehouse style waste storage buildings (excluding LLW), the visitor centre and the administration building. Piled foundation solutions at Lyndhurst were less favourable than the other sites, due to longer proposed pile lengths with the potential to intersect with the shallower water table. If used for the LLW vaults, this could result in interaction with the water table, providing a potential pathway between waste storage and the groundwater. Deep raft foundations combined with ground stabilisation in the form of Cement Injected Columns are currently proposed for the LLW vaults and are viable across all three sites. The choice between a pile and a raft foundation design for other items important to safety would be based on the requirement of the LLW safety case. It is noted that Cement Injected Columns are a structural form similar to piles and may have the same relationship with the water table as noted above, but would not be connected to the base structural slab of the LLW vaults.	No significant geotechnical hazards present. Deeper groundwater. Piled foundations are proposed in the generic design for all warehouse style waste storage buildings (excluding LLW), the visitor centre and the administration building. Piled foundation solution is more favourable at Napandee, as the proposed pile lengths are unlikely to directly interact with the water table at this site. Deep raft foundations combined with ground stabilisation in the form of Cement Injected Columns are currently proposed for the LLW vaults and are viable across all three sites. The choice between a pile and a raft foundation design for other items important to safety would be based on the requirement of the LLW safety case. It is noted that Cement Injected Columns are a structural form similar to piles and may have the same relationship with the water table as noted above, but would not be connected to the base structural slab of the LLW vaults.	No geotechnical hazards present. Deeper groundwater. Piled foundations are proposed in the generic design for all warehouse style waste storage buildings (excluding LLW), the visitor centre and the administration building. Piled foundation solution is more favourable at Wallerberdina, as the proposed pile lengths are unlikely to directly interact with the water table at this site. Deep raft foundations combined with ground stabilisation in the form of Cement Injected Columns are currently proposed for the LLW vaults and are viable across all three sites. The choice between a pile and a raft foundation design for other items important to safety would be based on the requirement of the LLW safety case. It is noted that Cement Injected Columns are a structural form similar to piles and may have the same relationship with the water table as noted above, but would not be connected to the base structural slab of the LLW vaults.
Risk mitigation	Detailed geotechnical investigations of the chosen site. Further geotechnical analysis of the ground conditions during construction phase. LLW foundations design specific to the sites to meet requirements of the safety case. Preliminary analysis suggests that a raft slab is structurally viable and be adopted as the generic base case for all 3 sites. The concept raft design currently includes the provision and detailing of a geomembrane below the LLW vault facility, subject to the requirements of the LLW safety case. The geomembrane would act as an additional safety barrier delaying infiltration to the underlying geology and ground water, but may impact structural loading.	Detailed geotechnical investigations of the chosen site. Further geotechnical analysis of the ground conditions during construction phase. LLW foundations design specific to the sites to meet requirements of the safety case. Preliminary analysis suggests that a raft slab is structurally viable and be adopted as the generic base case for all 3 sites. The concept raft design currently includes the provision and detailing of a geomembrane below the LLW vault facility, subject to the requirements of the LLW safety case. The geomembrane would act as an additional safety barrier delaying infiltration to the underlying geology and ground water, but may impact structural loading.	Detailed geotechnical investigations of the chosen site. Further geotechnical analysis of the ground conditions during construction phase. LLW foundations design specific to the sites to meet requirements of the safety case. Preliminary analysis suggests that a raft slab is structurally viable and be adopted as the generic base case for all 3 sites. The concept raft design currently includes the provision and detailing of a geomembrane below the LLW vault facility, subject to the requirements of the LLW safety case. The geomembrane would act as an additional safety barrier delaying infiltration to the underlying geology and ground water, but may impact structural loading.

Geology/Transfer processes —Groundwater risk

This summary is compiled from information extracted from the ARPANSA/ASNO/IAEA site suitability assessment (attachment A). The department has assessed this element taking into account specialist inputs from AECOM and ANSTO, and review from AECOM, ANSTO, ARPANSA and CSIRO.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**Very low**	**Very low**	**High**
Residual risk	N/A	N/A	While the risks can be mitigated, there will be residual risk associated with groundwater (that the current use of groundwater provides an ongoing exposure pathway) after the identified mitigations have been applied. Additional mitigations that have not been factored into this assessment may be necessary.
Criterion of differentiator	IAEA NSR-3: An assessment of the potential impact of the contamination of groundwater on the population shall be performed by using the data and information collected in a suitable model. Advantageous aspects include: Deep water table. Low potential for vertical or horizontal migration of water through underlying soil. Available sorption capacity to mitigate in case of RN releases. Limited or no current groundwater users, low incidence of exposure pathways. Poor quality groundwater to discourage future use.		
Summary	Shallower water table but of limited use based on saline groundwater quality and low yield, and no known groundwater users. The presence of clayey soil conditions above the groundwater will limit potential vertical migration to groundwater. Radionuclide dispersion mitigated to some extent by sorption/attenuation properties of the clayey soil layers in the vadose zone.	Deeper water table of limited use based on saline groundwater quality and low yield, and no known groundwater users. The presence of clayey soil conditions above the groundwater will limit potential vertical migration to groundwater. Radionuclide dispersion mitigated to some extent by sorption/attenuation properties of the clayey soil layers in the vadose zone.	Deeper water table providing separation from surface. Current groundwater use is limited to stock watering and irrigation. Potential further future beneficial use based on groundwater quality. Possible viable pathway for radionuclide transfer due to nearby groundwater use and also potential connectivity to Hookina Creek (probably perception issue only as groundwater flow is from Hookina Creek towards Lake Torrens). Risk of radionuclide transfer pathway for any future users of the resource. However, mitigated to some extent by sorption/attenuation properties of the clayey soil layers in the vadose zone. The presence of clayey soil conditions above the groundwater will limit potential vertical migration to groundwater, however it is noted the upper soil layers include clayey and gravelly silts that have a lower potential to limit vertical migration compared to the clays observed at the Lyndhurst and Napandee sites.
Risk mitigation	Investigations: Further drilling and testing will be required to further characterise the site to input into the design, safety case and environmental approvals. Conceptual modelling: A Conceptual Site Model (CSM) will need to be developed that will be used to assess the combined relationship and impact of sub-surface materials, groundwater, key facility elements (for example, vault foundation or capping) and safety scenarios where radionuclides are released to the environment. A suitable code, in this case ResRad will be used to quantify the risk. Planning controls: Restriction on future installation of water bores in close proximity to the site. Resource development: Location of water supply bores to be up gradient. Long term: Monitoring network set up prior to operations to allow comparative studies and early remediation.	Investigations: Further drilling and testing will be required to further characterise the site to input into the design, safety case and environmental approvals. Conceptual modelling: A Conceptual Site Model (CSM) will need to be developed that will be used to assess the combined relationship and impact of sub-surface materials, groundwater, key facility elements (for example, vault foundation or capping) and safety scenarios where radionuclides are released to the environment. A suitable code, in this case ResRad will be used to quantify the risk. Planning controls: Restriction on future installation of water bores in close proximity to the site. Resource development: Location of water supply bores to be up gradient. Long term: Monitoring network set up prior to operations to allow comparative studies and early remediation.	Investigations: Further drilling and testing will be required to further characterise the site to input into the design, safety case and environmental approvals. Conceptual modelling: A Conceptual Site Model (CSM) will need to be developed that will be used to assess the combined relationship and impact of sub-surface materials, groundwater, key facility elements (for example, vault foundation or capping) and safety scenarios where radionuclides are released to the environment. A suitable code, in this case ResRad will be used to quantify the risk. Planning controls: Restriction on future installation of water bores in the close proximity to the site. Resource development: Location of water supply bores to be up gradient. Long term: Monitoring network set up prior to operations to allow comparative studies and early remediation.

Transfer process — Atmospheric dispersion of radioactive materials

This summary is compiled from information extracted from the ARPANSA/ASNO/IAEA site suitability assessment (attachment A). The department has assessed this element taking into account specialist inputs from AECOM and ANSTO, and review from AECOM, ANSTO, ARPANSA and CSIRO.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**Very Low**	**Very Low**	**Very Low**
Residual risk	N/A	N/A	N/A
Criterion of differentiator	IAEA NSR-3: The atmospheric dispersion of radioactive material released shall be assessed with the use of appropriate models. These models shall include all significant site-specific and regional topographic features and characteristics of the installation that could affect atmospheric dispersion. Key factors include: • proximity of population/human receptors • radionuclide transfer risk • operational accident event for regulation will be a fire at the operating facility leading to offsite releases.		
Summary	All sites have similar pathways for airborne dispersion. All sites have the same inventories and inventory characteristics. Relevant safety studies are still to be undertaken for operations.		
Risk mitigation	For all sites includes site and vehicle inspections and maintenance. Limiting the fuel available for bush fire or other fires on-site. Fire suppression designs.		

Human induced event

This summary is compiled from information extracted from the ARPANSA/ASNO/IAEA site suitability assessment (attachment A). The department has assessed this element taking into account specialist inputs from AECOM and ANSTO, and review from AECOM, ANSTO, ARPANSA and CSIRO.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**Very Low**	**Very Low**	**Very Low**
Residual risk	N/A	N/A	N/A
Criterion of differentiator	Relatively low susceptibility to human induced events.		
Summary	Lyndhurst closer to airport flight path than other sites although site location was moved south, to avoid flight path All sites are in areas of low population density. Significant distance to the sites from nearest town. Airports used by small aircraft very infrequently. Significant effort required for human impact events.	All sites are in areas of low population density. Significant distance to the sites from nearest town. Airports used by small aircraft very infrequently. Significant effort required for human impact events.	All sites are in areas of low population density. Significant distance to the sites from nearest town. Airports used by small aircraft very infrequently. Significant effort required for human impact events.
Risk mitigation	None	None	None

Demographics—Populations

This summary is compiled from information extracted from the ARPANSA/ASNO/IAEA site suitability assessment (attachment A). The department has assessed this element taking into account specialist inputs from AECOM, and review from AECOM, ANSTO, ARPANSA and CSIRO.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**Very Low**	**Very Low**	**Very Low**
Residual risk	N/A	N/A	N/A
Criterion of differentiator	IAEA siting - knowledge of population to allow evaluation of potential impact of normal and accident releases, the dose to the critical group, demonstrate ALARP and demonstrate feasibility of emergency response.		
Summary	All sites have a low population density limiting the collective impact of normal operations and accidents. Main towns are located 15km or more from the sites.		
Risk mitigation	Not required	Not required	Not required

Demographics — nearby human activities and land use

This summary is compiled from information extracted from the ARPANSA/ASNO/IAEA site suitability assessment (attachment A). The department has assessed this element taking into account specialist inputs from AECOM, and review from AECOM, ANSTO, ARPANSA and CSIRO.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**Very Low**	**Very Low**	**Very Low**
Residual risk	N/A	N/A	N/A
Criterion of differentiator	Minimal sensitive land uses (e.g. residences, community facilities) on or proximal to the site, suitable buffer distances from nearest sensitive land uses. Minimal land uses (e.g. mining tenements, hazardous facilities, airfields) on the site which could adversely impact on the facility.		
Summary	Low intensity farming. No current or past mining activity.	Low intensity farming. No current or past mining activity.	Very low intensity farming, low land occupancy. No current or past mining activity
Risk mitigation	Acquisition of the site by the Commonwealth will extinguish the tenements over the site (note that other mining rights on surrounding land may would not be extinguished). Future planning controls to maintain buffers.		

Radiological baseline—ambient site baseline radioactivity

This summary is compiled from information extracted from the ARPANSA/ASNO/IAEA site suitability assessment (attachment A). The department has assessed this element taking into account specialist inputs from AECOM and ANSTO, and review from AECOM, ANSTO, ARPANSA and CSIRO.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**Very Low**	**Very Low**	**Very Low**
Residual risk	N/A	N/A	N/A
Criterion of differentiator	Background radiation levels within the ARPANSA Action Levels for workplaces. Background radiation levels are not sufficiently elevated to impact on the effectiveness of environmental monitoring.		
Summary	A radiological baseline would be used during operation of the facility to monitor performance of safety features, and in due course to set values for post operational phases. Background radiation level at all the sites is within normal range for this area of Australia, based on data collected to date via aerial survey. However soil and groundwater testing to be completed in future stages to provide confirmation.		
Risk mitigation	Not applicable	Not applicable	Not applicable

Specific events — Bushfire risks

This summary is compiled from information extracted from the ARPANSA/ASNO/IAEA site suitability assessment (attachment A). The department has assessed this element taking into account specialist inputs from AECOM, ANSTO and Jacobs, and review from AECOM, ANSTO, ARPANSA and CSIRO.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**Very Low**	**Very Low**	**Very Low**
Residual risk	N/A	N/A	N/A
Criterion of differentiator	IAEA NSG 3.1: Requires the assessment of local factors which might result in significant risk. For the Australian situation bush fire is identified as such a factor.		
Summary	Combination of climatic conditions, fuel loadings and topography makes bushfires an intermittent danger across all the sites. With appropriate mitigations, design and engagement with Country Fire Service/regulator, all of the sites are likely to meet the criteria. This includes ability to create buffers which minimises the risk and potential severity of bushfires and allows for sufficient setbacks/buffers to meet the Australian Standard for building in bushfire prone areas (see mitigations).		
Risk mitigation	Bushfire risk will also be mitigated through detailed bushfire risk assessments of the site and proposed infrastructure with setbacks being determined based on asset vulnerability to bushfire attack, building design measures and also the level of provision of firefighting infrastructure.	The nominated site is not unduly impacted by bushfire hazards if setbacks/areas of cleared vegetation are established around assets, commensurate with asset vulnerability to bushfire attack, building design measures and provision of firefighting infrastructure.	Bushfire risk could be readily mitigated by implementing appropriate setbacks and buffer areas from vegetation and through building design measures.

Implementation of emergency plan

This summary is compiled from information extracted from the ARPANSA/ASNO/IAEA site suitability assessment (attachment A). The department has assessed this element taking into account specialist inputs from AECOM and ANSTO, and review from AECOM, ANSTO, ARPANSA and CSIRO.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**Low**	**Low**	**High**
Residual risk	N/A	N/A	While the risks can be mitigated, there will be residual risk associated with implementation of emergency plan and potential flooding of the emergency access/egress road, after the identified design mitigations have been applied, and additional mitigations that have not been factored into this assessment may be necessary.
Criterion of differentiator	Location of site and site characteristics make implementation of emergency plans more, or less, practicable.		
Summary	Lyndhurst, Napandee and Wallerberdina sites are all located away from main populations.	Lyndhurst, Napandee and Wallerberdina sites are all located away from main populations.	Lyndhurst, Napandee and Wallerberdina sites are all located away from main populations. Wallerberdina more likely to be affected such that emergency plans will be difficult to implement (for emergencies associated with flood or seismic events)
Risk mitigation	On-site facilities designed and fully resourced to deal with all credible emergencies (assuming no access to local services such as firefighting and medical) e.g. staff evacuation, sustained emergency response, provisioning on site by air/helicopter access maintained.	On-site facilities designed and fully resourced to deal with all credible emergencies (assuming no access to local services such as firefighting and medical) e.g. staff evacuation, sustained emergency response, provisioning on-site by air, helicopter access maintained.	On-site facilities designed and fully resourced to deal with all credible emergencies (assuming no access to local services such as firefighting and medical) e.g. staff evacuation, sustained emergency response, provisioning on-site by air, helicopter access maintained. Design mitigations for flooding and seismic risk are key and contribute to risk mitigation by making the site more resilient - see previous sections. New emergency access built above flood levels. 48km emergency access road constructed downstream of the former rail line.

Ecology and non-radiological environmental impacts

This summary is compiled from information extracted from the ARPANSA/ASNO/IAEA site suitability assessment (attachment A). The department has authored the information for this element, and this was reviewed by ANSTO.

	Lyndhurst	Napandee	Wallerberdina
Information summary	Information for each site is presented in the EPBC assessment. Refer to this separate assessment for an evaluation of ecology and non-radiological environmental impacts (attachment C)		
Criterion of differentiator	Site-specific differences in ecology and potential environmental impacts may influence ARPANSA considerations. According to ARPANSA guidelines (appendix 1 in attachment C), these include information and details related to: • vegetation types and abundance • wildlife • threatened and endangered species. The IAEA guidelines include the presence of bio-sensitive areas adjacent to site and natural reserves, monuments or tourist spots, as examples of non-radiological environmental impacts.		

Services and enabling works

This summary is compiled from information extracted from the ARPANSA/ASNO/IAEA site suitability assessment (attachment A). The department has assessed this element taking into account specialist inputs from AECOM and ANSTO, and review from AECOM, ANSTO, ARPANSA and CSIRO.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**Very Low**	**Very Low**	**Medium**
Residual risk	Engagement with stakeholders, detailed studies for enabling works may highlight factors that have not yet been considered. Change in facility system requirements (as the design progresses).	Engagement with stakeholders, detailed studies for enabling works may highlight factors that have not yet been considered. Change in facility system requirements (as the design progresses).	While the risks can be mitigated, there will be residual risk associated with service and enabling works (due to risk of flooding of access roads) after the identified design mitigations have been applied, and additional mitigations that have not been factored into this assessment may be necessary.
Criterion of differentiator	The availability and vulnerability of services provision to the facility, including enabling works for the construction of the facility, may be considered in site assessment by ARPANSA. The main services required are electricity (and other power systems), water, sewerage, transport, communications, and emergency services. The 'implementation of emergency plan' criterion assesses access to emergency services.		
Summary	N/A	N/A	N/A
Risk mitigation	Power: Microgrid on site (note 11kV connection is unsuitable as requires network upgrades upstream and also due to the length of the 11kV line this option isn't reliable and multiple regulator stations may be required to support the voltage along the length. Water: Dedicated supply to the site via connection at the Kimba tanks with a 19km pipeline. Sewerage: On site sewerage system – included in facility design – excluded from costs below as treated on site. Additional classified information on transport and communications was also considered.	Power: Microgrid on site (note 11kV connection is unsuitable as requires network upgrades upstream and also due to the length of the 11kV line this option isn't reliable and multiple regulator stations may be required to support the voltage along the length. Water: Dedicated supply to the site via connection at the Kimba tanks with a 24km pipeline. Sewerage: On site sewerage system – included in facility design – excluded from costs below as treated on site. Additional classified information on transport and communications was also considered.	Power: 132kV connection with 132/11kv substation on site. Water: Local groundwater source with desalination for potable water only, not firefighting water. Communications: Sewerage: On site sewerage system – included in facility design – excluded from costs below as treated on site. Additional classified information on transport and communications was also considered.

ASNO permits and IAEA requirements

This summary is compiled from information extracted from the ARPANSA/ASNO/IAEA site suitability assessment (attachment A). The department has assessed this element taking into account specialist inputs from ANSTO, and review from AECOM, ANSTO, ARPANSA and CSIRO.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**Low**	**Low**	**Low**
Residual risk	No change	No change	No change
Criterion of differentiator	Site-specific differences that would impact the ability to meet ASNO and IAEA requirements for the safe and secure storage of nuclear safeguard material and the ability to inspect this material for verification and accounting purposes.		
Summary	The facility design will feature appropriate physical security and inspection measures to meet ASNO permit and IAEA inspection requirements. This is an inherent part of the facility design requirements irrespective of the selected site.		
Risk mitigation(s)	Facility design will incorporate security and inspection requirements. Facility location and design will ensure that the site is reasonably accessible for inspections at short notice (noting that inspectors travel from the nearest city) and ensure adequate security for nuclear material both on site and in transport to/from the site.	Facility design will incorporate security and inspection requirements. Facility location and design will ensure that the site is reasonably accessible for inspections at short notice (noting that inspectors travel from the nearest city) and ensure adequate security for nuclear material both on site and in transport to/from the site.	Facility design will incorporate security and inspection requirements. Facility location and design will ensure that the site is reasonably accessible for inspections at short notice (noting that inspectors travel from the nearest city) and ensure adequate security for nuclear material both on site and in transport to/from the site.

EPBC Act assessment

Establishment of the facility is classified as a nuclear action under the EPBC Act. Therefore, a referral to the Australian Government Department of Agriculture, Water and the Environment (DAWE) will be required for a decision by the Minister for the Environment on what assessment and approval is required under the EPBC Act.

The EPBC Act site suitability assessment is a preliminary, comparative assessment of potential risks and risk mitigations for the approved sites, in the context of the likelihood of meeting EPBC Act regulatory approval requirements for facility establishment (construction and operation) and decommissioning. The assessment provides a technical basis for site comparison and selection without pre-empting any outcome from an assessment by the regulator in future. The assessment is based on currently available information as technical characterisation of the sites is only at a preliminary stage. Officials from the then Department of Environment and Energy (DoEE)[5] reviewed the EPBC Act site suitability assessment and indicated their comfort with the assessment, while retaining the department's right to make a different assessment when considering completed regulatory applications in the future.

This section presents information compiled from extracts showing the results of the EPBC Act site suitability assessment (see attachment C).

The assessment process involved the following steps:

1. Identified criteria: based on the assumed requirements for an Environmental Impact Statement (EIS) for EPBC Act approval for a nuclear action using DAWE guidance[6].
2. Assessment Part 1: compared the available site characterisation information against the identified criteria, selecting the factors most likely to be differentiators between sites.
3. Assessment Part 2: undertook a more detailed assessment against the criteria that were chosen as possible differentiators, and identified the potential extent of regulatory risk and the facility mitigations required.

The criteria that were identified as potential differentiators for the assessment, and were subsequently assessed in part 2 of the EPBC Act site suitability assessment report, were:

1. water management, infrastructure, supply, storage, monitoring, sewage and treatment;
2. surface water quality and hydrology;
3. groundwater;

[5] Under machinery of government changes on 1 February 2020 the Department of Environment and Energy (Environment portfolio) was incorporated into the Department of Agriculture, Water and the Environment.
[6] DAWE guidance document 'Significant impact guidelines 1.2-Actions on or impacting upon Commonwealth land and Actions by Commonwealth Agencies'.

4. seismic risk;
5. flora and fauna;
6. landscape and visual amenity;
7. traffic and transport;
8. Aboriginal cultural heritage;
9. land use planning;
10. agriculture.

In the tables set out from pages 35 to 45 below, the department has provided its rating of the risk that a regulator will be concerned about particular characteristics of a site when assessing a referral of a proposal to establish the facility at each site (the 'risk rating'). The department has used ANSTO's risk methodology determination matrix to arrive at those risk ratings, having regard to the likelihood and regulatory consequence associated with each characteristic (see table 11). In this matrix, 'likelihood' is the department's assessment of the probability that the regulator will have concern that the particular site characteristic will affect approval. This is not the likelihood of a significant or catastrophic event resulting from one of the assessment factors and is not an assessment of the design risks against reference events.

The consequence assigned per characteristic, indicates the department's assessment of the level of potential regulator concern. This is the overall consequence for achieving facility approval. For example, 'catastrophic impact' means the worst case scenario that regulatory approval may not be attainable. 'Severe impact' indicates significant regulatory impact, and additional mitigation work and/or studies may be required to satisfy the regulator. This is not the consequence of an issue concerning a certain characteristic. For example, it is not the consequence of a seismic event. Impact can additionally indicate need for the mitigations to be addressed and integrated in facility siting or design.

For 'consequence', the ANSTO matrix descriptions from negligible to catastrophic were used and a consequence in terms of regulatory outcome was developed for each description. The department then used the ANSTO risk assessment methodology risk determination matrix to combine likelihood and consequence to determine a final risk rating.

Table 11: Risk determination matrix, combining likelihood and consequence levels to determine a final risk rating (adapted from the ANSTO risk assessment methodology)

Medium	High	High	Very High	Very High	Very High	Very High	6	Catastrophic
Low	Medium	Medium	High	High	Very High	Very High	5	Severe
Low	Low	Medium	Medium	High	High	Very High	4	Major
Very Low	Very Low	Low	Low	Medium	Medium	High	3	Moderate
Very Low	Very Low	Very Low	Very Low	Low	Low	Medium	2	Minor
Very Low	Very Low	Very Low	Very Low	Very Low	Low	Low	1	Negligible
A	B	C	D	E	F	G		
Extremely Unlikely	Highly Unlikely	Very Unlikely	Unlikely	Likely	Very Likely	Almost Certain		
Likelihood								

Consequence

Table 12: non-technical description of the criteria used in the EPBC assessment

Criterion included in assessment	Criterion characteristics
Water management (infrastructure, supply, storage, monitoring, sewage, treatment)	Assessment of the extent to which water supply from either mains or groundwater might have consequences for other users and the environment. Understanding the current groundwaters, their depth and quality. Evaluation of subsequent management and treatment of process and wastewaters on the environment.
Surface water quality and hydrology	Evaluation of the meteorological and surface processes which would affect the candidate sites, including the likelihood (and environmental safety implications) of flood events. Assessment of the potential need for additional facility design requirements (such as the addition of ground raising for buildings and formation of raised flood banks) which could affect the environment.
Groundwater	Understanding the site groundwaters; depth, salinity, flow rate, flow direction and environmental receptors. Understanding the properties of the site soil strata which would prevent or delay migration of radionuclides into the groundwaters. Evaluate the implication of different building foundation design options on the potential for radionuclides to enter the groundwater/environment.

Seismic Risk	Understanding the historic and current seismic activity for the sites, including the position and type of potentially active near surface faults, which might affect the environmental safety of the facility. Evaluating the consequence for the environment of the facility design mitigations for site seismic risk.
Flora and fauna	Understanding and evaluating the conservation importance and sensitivity of the flora and fauna present on the sites, and any potential mitigations which might be required.
Landscape and visual amenity	Evaluating the implications of the facility design and site-specific layouts on the landscape and visual amenity of the locale.
Traffic and transport	Evaluating the environmental implications of creating or upgrading existing access roads from the sites to the highways. Understanding and evaluating the implication of traffic to the sites on local townships.
Aboriginal cultural heritage	Investigating and evaluating the aboriginal heritage value of the sites and aspects which could be affected by the facility. Evaluation includes registered aboriginal heritage site information, site archaeological investigations, and include consultation with Traditional Owners.
Land use planning	Investigation of the sensitive land uses in the area which could affect, or could be affected by, the facility. This includes residential development and mineral and mining tenements.
Facility Agriculture	Understanding the agricultural land uses at the candidate sites and evaluating the implication of the facility on farm viability and agricultural output. Understanding and developing radiation monitoring requirements (such as for air, soil, biota and crops) which would demonstrate environmental protection and reassure farmers and customers.

The tables below have been compiled with information extracted from ‘Part 2: assessment of regulatory risk from the identified potential differentiators’ of the EPBC Act assessment at attachment C. They show: the risk rating assigned to the criteria for each approved site, comments/details of the reason for potential differentiation (between the sites), and mitigation measures. Costs associated with these mitigations are captured in site suitability criterion 2.

Water management (infrastructure, supply, storage, monitoring, sewage and treatment)

This summary is compiled from information extracted from the EPBC Act site suitability assessment (attachment C). The department and AECOM have assessed this element, and this was reviewed by AECOM, ANSTO and DoEE.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**Very low**	**Very low**	**Very low**
Risk conclusion	Water management is not considered a differentiator between the approved sites. There is considered to be a very low risk that the regulator will have concerns about this site characteristic affecting regulatory approval for Lyndhurst, Napandee or Wallerberdina, even with a slightly higher consequence for Wallerberdina.		
Risk likelihood and consequence	It is **very unlikely** that utilising water from the mains supply would cause regulator concern that would affect EPBC approval.		It is **very unlikely** that utilising water from the groundwater aquifer would cause regulator concern that would affect EPBC approval.
Mitigation	N/A	N/A	Pump/yield testing of the groundwater formation at Wallerberdina, and modelling of any drawdown that will occur from extraction of groundwater for use on the site, will be undertaken prior to the formal EPBC Act assessment process. A groundwater extraction network would need to be designed in a manner that does not impact current or realistic future users of groundwater.
General comments	This criterion considers the use of water as a service/supply to the site; consequences of groundwater have been assessed separately. At this stage of design, there are no differentiators in the facility design and water management on site. From an EPBC perspective, the potential consequences of on-site management, storage, monitoring and treatment of water/wastewater can be considered the same across all sites.		
Specific site comments	N/A	N/A	For Wallerberdina, an environmental assessment will need to consider the consequence of drawing groundwater for use on the site, and demonstrate that this will not have consequences for other users of groundwater (for example, those using groundwater for stock watering) from the same groundwater formation.
Detail	Water proposed to be sourced from SA Water mains supply with a new dedicated connection and pipeline at the SA Water Kimba tanks. No mains sewer connection point available (on site treatment included in facility design).	Water proposed to be sourced from SA Water mains supply with a new dedicated connection and pipeline at the SA Water Kimba tanks. No mains sewer connection point available (on site treatment included in facility design).	Water proposed to be sourced from groundwater aquifer and pumped to surface. Potable water (and water for other industrial applications) will be treated with a desalination plant, which features a brine evaporation pond. There are other potential local users for this aquifer. No mains sewer connection point available (on site treatment included in facility design).

Surface water quality and hydrology

This summary is compiled from information extracted from the EPBC Act site suitability assessment (attachment C). The department and AECOM have assessed this element, and this was reviewed by AECOM, ANSTO and DoEE.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**High**	**Very low**	**Very high**
Risk conclusion	Hydrology is considered a differentiator between the approved sites. While the risks can be mitigated, there is a high risk that identified mitigations for Lyndhurst and Wallerberdina will not fully satisfy the regulator, and additional mitigations will be required.		
Risk likelihood and consequence	It is **very likely** that flooding would cause regulator concern that would affect EPBC approval.	It is **highly unlikely** that flooding would cause regulator concern that would affect EPBC approval.	It is **very likely** that flooding would cause regulator concern that would affect EPBC approval.
Mitigation	The separate ARPANSA/ASNO regulatory assessment (p. 13) for site suitability criterion 1 considers potential flooding risk mitigations for this hydrology differentiator. Any potential impacts on surface water quality would be mitigated by the multiple barriers of protection.		
General comments	Climatic conditions are typically consistent across the three sites and climate change impacts are also expected to be consistent (lower average rainfall, higher average temperatures and increased intensity in episodic rainfall events). Future environmental assessment development will require review of the impact of flooding on: • containment of radioactive waste materials and other stored substances, including wastewater • the flow paths of existing water channels • the erosion of landforms from any flood water diversions.		
Specific site comments	Lyndhurst is expected to experience ponding of water in flood events due to the larger catchment and the site topography which does not allow the water to flow off site. For both Lyndhurst and Wallerberdina, the potential for flooding and ponding poses a risk to the isolation of stored radioactive waste and any other stored materials from the environment, and could impact access to the site during a flood event. Use of Lyndhurst and Wallerberdina as a facility site would therefore require the introduction of significant engineering mitigations.	The Napandee site is expected to be minimally impacted by episodic flooding events with typical mitigations for stormwater management.	From predictive flood modelling already undertaken, the Wallerberdina site is at risk of flooding during the lifetime of the facility. For both Lyndhurst and Wallerberdina, the potential for flooding and ponding poses a risk to the isolation of stored radioactive waste and any other stored materials from the environment, and could impact access to the site during a flood event. Use of Lyndhurst and Wallerberdina as a facility site would therefore require the introduction of significant engineering mitigations.

	Lyndhurst	Napandee	Wallerberdina
Detail	Conditions on site are normally arid, and there are no creek lines on site. The site is located within an approximate 10km^2 local catchment, located to the south east of the site. The main overland flow path flows from the south-east onto the site. Hydraulic modelling indicates that in its current form significant flooding will occur on the site at relatively low recurrence intervals (i.e. high frequency). The topology promotes ponding of water at two main locations however these undrained low points are not distributed across the whole site and despite the depth of this ponding (for existing climate conditions approximately 2.0m for the 1 in 5 AEP (Annual Exceedance Probability), 3.6m for the 1 in 100 AEP and 5.6m in the PMF (Probable Maximum Flood event) sufficient unimpacted land can be made available to site the facility and engineering measures may be employed to mitigate this issue. The localised flooding at Lyndhurst is more significant than at Napandee but can be more easily mitigated that the regional flooding identified at the Wallerberdina site. The land surrounding the Lyndhurst site is relatively elevated, whereas the site itself is situated in a depression, receiving inflows from the south-east that contribute to flooding from a larger regional upstream catchment of 142km^2. A number of flow paths from this regional catchment also cross the proposed site access road (Aerodrome Road). Flooding across the access road occurs in a 1 in 5 AEP event with maximum depths estimated up to 1.2m, at a point 4.8km along Aerodrome Rd, towards the site. In extreme flood events (PMF event), depths of up to 3.0m are estimated along the road. Flood data for the access road is based on SRTM terrain data of much lower accuracy than the LiDAR terrain data for the site, thus the information provides an indication only of the extent and potential scale of flood risks along the road. Engineering/design mitigations for the site would be required based on the modelling for the local catchment to ensure safety of facility, staff and continuation of site safety functions.	Conditions on site are normally arid, and there are no creek lines on site or in the local area, but some drainage channels exist within the site between the sand ridges. The site promotes the free flow of water given its topology and location on a ridge within the larger catchment. The site is located within an approximate 5km^2 local catchment. Hydraulic modelling indicates isolated flooding is largely contained to local site drainage paths, with areas of ponding predicted in the lower lying areas of the site predominantly along the southern boundary of the site adjacent to Tola Road. For existing climate conditions, depth of flood waters is approximately 0.3m for the 1 in 5 AEP (Annual Exceedance Probability), 0.7m for the 1 in 100 AEP and 1m in the PMF. It is anticipated these local catchment flooding impacts could be mitigated through diversion and/or on-site stormwater management. At the regional scale, the site is well elevated relative to its surrounding area. As the site is situated on higher ground it is not inundated from flood water from regional creeks, waterways or overland flow paths from the wider regional catchment in which it is located. Hydraulic modelling at the regional scale indicates that the main risk to this site from regional scale flooding relates to access to the site. However, there are no major overland flow paths that cross the site from a regional perspective. Modelling also confirms that the previously anticipated flow path to the south western portion of the site would not impact the site. Flooding across the access road (Tola Road) occurs in a 1 in 5 AEP event. Maximum depths are estimated up to 2.5m at a point 4.5km east of the site along Tola Road. In extreme flood events (1 in 10,000 AEP and PMF) depths of up to 9.8m are estimated at a road crossing located within the main flood plain, located approximately 1km from the south eastern corner of the site. Flood data for the access road is based on SRTM terrain data of much lower accuracy than the LiDAR terrain data for the site, thus the information provides an indication only of the extent and potential scale of flood risks along the road. Engineering/design mitigations for the site would be required based on the modelling results for both the local site catchment with site drainage design and earthworks considering the anticipated local catchment flooding impacts, to ensure safety of the facility, staff and continuation of site safety functions.	Conditions on site are normally arid. The site is located on an alluvial fan of the ephemeral Hookina Creek, which is located approximately 2.5km south of the site and flows north-west away from the site into Lake Torrens. Flows in the creek are of a semi-arid nature with long dry period between flows. There is a large (1700km^2) catchment upstream of the site, and there is a depression 1km east of the site which conveys stormwater from catchments further east. A non-perennial drainage line is also present to within 1km east of the site, but is associated with a minor catchment in comparison to Hookina Creek. Hydraulic modelling indicates the site is subject to regional flooding by surface water from a number of sources including breakout from Hookina Creek and catchments to the south and east. A flow path runs from the south-east corner to the south-west corner of the site parallel to Lake Torrens Homestead Road. Another flow path flows north from the middle of the site. Due to the topography on the site there are some areas of ponding in the flow path running parallel to Lake Torrens Homestead Road. For the high frequency events, flooding is due to localised overland surface flow from rain. Maximum flood depths predicted for the existing climate conditions range from 0.2m for the 1 in 5 AEP to 0.3m in the 1 in 100 AEP. In less frequent events, such as the 1 in 1000 AEP, breakout flows from Hookina Creek contribute to flooding across the whole site, by contributing to the flow along local drainage lines. Maximum flood depths range from to 0.7m in the 1 in 1000 AEP and 2.5m in the PMF event (across considerable portions of the site). There is a risk of bank erosion and streambed realignment or avulsion (relocation of stream change during major floods) on rare or repeated events at Hookina Creek which could exacerbate the impact of future flooding. Further, in a 1 in 100 AEP event, maximum depths of around 8m are experienced on the access road to the site at the Hookina Creek crossing approximately 10km south-east from the site. In extreme flood events (i.e. PMF) depths of up to 13.2m are estimated where this road crosses the creek. Significant engineering/design mitigations would be required to ensure the safety of the facility and staff and the continuation of site safety functions. These would need to address the ongoing risk of erosion of engineered barriers, principally engineered cap over the vaults. It is noted that due to the complex nature of the catchment and some built structures (railway line) the impact on flood patterns and effects will need further investigation including the consideration of geomorphological impacts.

Groundwater

This summary is compiled from information extracted from the EPBC Act site suitability assessment (attachment C). The department and AECOM have assessed this element, and this was reviewed by AECOM, ANSTO and DoEE.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**Very low**	**Very low**	**High**
Risk conclusion	Groundwater is considered a differentiator between the approved sites. There is considered to be a very low risk that the regulator will have concerns about this site characteristic affecting regulatory approval for Lyndhurst or Napandee. While the risks at Wallerberdina can be mitigated, there is a high risk that Wallerberdina would require additional mitigations beyond those identified.		
Risk likelihood and consequence	It is **unlikely** that groundwater would cause regulator concern that would affect EPBC approval.	It is **highly unlikely** that groundwater would cause regulator concern that would affect EPBC approval.	It is **likely** that groundwater would cause regulator concern that would affect EPBC approval.
Mitigation	The separate ARPANSA/ASNO regulatory assessment for site suitability criterion 1 will consider potential groundwater risk mitigations for this differentiator. Potential mitigation and planning actions considered include: • implementing institutional controls to prevent extraction of groundwater by other users in the close vicinity of the site • separating the radioactive waste from groundwater (through waste acceptance criteria, defence-in-depth barriers and design of foundations) • detailed groundwater investigations to determine the groundwater flow direction and velocity • detailed site characterisation and modelling to determine radionuclide transport mechanisms in groundwater.		
General comments	All sites contain groundwater at depth, together with clayey geological profiles or profiles with clayey layers present. Presence of these characteristics limits the potential for radionuclide transport from the surface to the underlying groundwater formation. Note: depth to groundwater is as observed in site characterisation monitoring rounds. Groundwater depths can experience seasonal change.		
Specific site comments	The saline groundwater at the Lyndhurst and Napandee sites will act as a deterrent to other future groundwater use (the water is salty therefore people are less likely to want to use it for drinking water or for stock). The use of Lyndhurst and Napandee groundwater by other future users cannot however be ruled out.		At Wallerberdina, groundwater is currently used for stock watering on Wallerberdina Station and on surrounding station properties.
Detail	Depth to groundwater is 10m or greater. Groundwater has low yield and is saline. There are no current or realistic future users in the local area. Investigations suggest there is limited connectivity between the water table and deeper aquifers which would prevent transport of potential contaminants between these layers. The environmental receptor of groundwater in the local area is unknown. Groundwater-surface water interaction with the ephemeral Lake Gilles to the north-east of the site is yet to be investigated. The subsurface clays provide a substantial sorption capacity which may limit the transport of radionuclides in the unlikely event of a subsurface release of waste material. Underlying soil conditions include shallow sands, overlying interbedded clayey sands/sandy clays, underlain by silty sands and marl clay, with groundwater observed in the clayey sand and sandy clay layers. The presence of clayey soil conditions above the groundwater will limit potential vertical migration to groundwater. Preliminary analysis suggests that a shallow raft slab is structurally viable, particularly for the LLW vaults where this may be required for the safety case, but is not as cost effective as piles. Piles could interact with the groundwater at this site. However, from an EPBC perspective, if piles are used for waste vaults, this may provide an additional pathway for potential contamination into ground water.	Depth to groundwater is 24m or greater. Groundwater has low yield and is saline. There are no current or realistic future users in the local area. There are no known ecological receptors of groundwater within the vicinity of the site. Investigations suggest there is limited connectivity between the water table and deeper aquifers which would prevent transport of potential contaminants between these layers. There are no known environmental receptors of groundwater within the vicinity of the site. The subsurface clays provide a substantial sorption capacity which may limit the transport of radionuclides in the unlikely event of a subsurface release of waste material. Underlying soil conditions include shallow sands, overlying sandy clay and kaolin (where groundwater is present), underlain by weathered bedrock. The presence of clayey soil conditions above the groundwater will limit potential vertical migration to groundwater. Preliminary analysis suggests that a shallow raft slab is structurally viable, particularly for the LLW vaults where this may be required for the safety case, but is not as cost effective as piles. Piles could interact with the groundwater at this site. However, from an EPBC perspective, if piles are used for waste vaults, this may provide an additional pathway for potential contamination into ground water.	Depth to groundwater is in excess of 20m. Groundwater is used for stock watering on Wallerberdina Station and surrounding station properties. Groundwater could potentially be utilised for domestic uses at homesteads (with or without pre-treatment). The depth of and flow of groundwater between the site and Hookina Creek still requires assessment. The subsurface clays provide a substantial sorption capacity which may limit the transport of radionuclides in the unlikely event of a subsurface release of waste material. Underlying soils included clay and gravelly silts, underlain by interbedded sand and clay layers, with groundwater observed in the sand and clay layers. The presence of clayey soil conditions above the groundwater will limit potential vertical migration to groundwater, however it is noted the upper soil layers include clayey and gravelly silts that have a reduced potential to limit vertical migration to the clays observed at the Lyndhurst and Napandee sites. While stock watering bores exist in shallow aquifers in the area, the enabling works currently suggests a groundwater source on-site with a desalination unit which would provide a further and deeper linkage between the groundwater and human receptors/the biosphere. Preliminary analysis suggests that a shallow raft slab is structurally viable, particularly for the LLW vaults where this may be required for the safety case, but is not as cost effective as piles. Piles could interact with the groundwater at this site. However, from an EPBC perspective, if piles are used for waste vaults, this may provide an additional pathway for potential contamination into ground water.

Seismic risk

This summary is compiled from information extracted from the EPBC Act site suitability assessment (attachment C). The department and AECOM have assessed this element, and this was reviewed by AECOM, ANSTO and DoEE.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**Low**	**Low**	**Medium**
Risk conclusion	Seismic risk is considered a differentiator between the approved sites. There is considered to be a low risk that the regulator will have concerns about this site characteristic affecting regulatory approval for Lyndhurst or Napandee, and a medium risk for Wallerberdina.		
Risk likelihood and consequence	It is **extremely unlikely** that seismic activity would cause regulator concern that would affect EPBC approval. However, further site investigations are required.	It is **extremely unlikely** that seismic activity would cause regulator concern that would affect EPBC approval. However, further site investigations are required.	It is **very unlikely** that seismic activity would cause regulator concern that would affect EPBC approval. However, further site investigations are required.
Mitigation	The separate ARPANSA/ASNO site suitability assessment for site suitability criterion 1 (p. 13) will consider potential seismic risk mitigations for this differentiator. The structural design for the facility can accommodate increased accelerations caused by a seismic event, but cannot mitigate the impact if the facility was located on an active fault. More detailed site investigations are required to determine the location and types of faults. Items that are important to safety (and therefore minimising impacts to the environment) could be moved away from such a feature[7].		
General comments	N/A		
Specific site comments	N/A	N/A	Potentially active faults in or near the facility foundation are expected to be present in direct proximity to Wallerberdina, which could lead to ground shaking occurring on site in the event of a rare seismic event.
Detail	The site is within a seismically stable area, the Gawler Craton. A seismic survey has determined an absence of potentially active faults.	The site is within a seismically stable area, the Gawler Craton. A seismic survey has determined an absence of potentially active faults.	The site lies within a seismically active region on the western range front of the central Flinders Ranges, which comprises a series of prominent and identifiable active faults, and an earthquake-generating feature in Australia. The site is expected to be located between these major fault lines; a seismic survey has not identified any potentially active fault in the foundation (ground) directly beneath the site. Further seismic survey is required to identify the locality of these potentially active faults in reference to the site. Hazard analysis modelling indicates that peak accelerations to be expected during an event (1 in 2,500 and 1 in 10,000 annual exceedance probability: AEP) are over double that of what would occur at the Lyndhurst and Napandee sites. The Wallerberdina site is located in a relatively active seismic area for Australia, but notably less than would be expected in seismically active regions elsewhere in the world, such as California in the USA.

[7] Sufficient land is being acquired to manage this risk.

Flora and fauna

This summary is compiled from information extracted from the EPBC Act site suitability assessment (attachment C). The department and AECOM have assessed this element, and this was reviewed by AECOM, ANSTO and DoEE.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**Very low**	**Very low**	**Very low**
Risk conclusion	Presence of flora and fauna is not considered a differentiator between the approved sites. There is considered to be a very low risk that the regulator will have concerns about this site characteristic affecting regulatory approval for Lyndhurst, Napandee or Wallerberdina.		
Risk likelihood and consequence	It is **unlikely** that flora and fauna considerations would cause regulator concern that would affect EPBC approval.	It is **highly unlikely** that flora and fauna considerations would cause regulator concern that would affect EPBC approval.	It is **highly unlikely** that flora and fauna considerations would cause regulator concern that would affect EPBC approval.
Mitigation	Further detailed surveys of all three sites are required, to assess presence of annual and ephemeral plant species (plants with a short life cycle that avoid drought periods or unfavourable conditions as seeds). A targeted survey is required for the Lyndhurst and Napandee sites, to formally confirm the presence of a state-listed threatened plant species in a vegetation patch and presence of Malleefowl. Facility design will need to include mitigations such as limiting vegetation clearance for facility construction, and light spill during facility operation. A mitigation action for any Malleefowl populations could include speed restrictions on roads.		Further detailed surveys are required of all three sites, to assess presence of annual and ephemeral plant species (plants with a short life cycle that avoid drought periods or unfavourable conditions as seeds). Facility design will need to include mitigations such as limiting vegetation clearance for facility construction, and light spill during facility operation.
General comments	None of the sites exhibit current evidence of any Commonwealth-listed threatened habitats or species. Vegetation in the road reserves has not yet been surveyed.		
Specific site comments	There is potential for Commonwealth-listed threatened species, the Malleefowl, to exist in habitats near the Lyndhurst site. Further work may be required on the Lyndhurst and Napandee sites to determine presence of Malleefowl on site or in adjacent vegetation.	There is potential for Commonwealth-listed threatened species, the Malleefowl, to exist in habitats near the Napandee site. Further surveying is required to confirm the presence of a state-listed threatened plant species, the Ridged Noon-flower, in the south-west corner of the Napandee site. Further work may be required on Lyndhurst and Napandee sites to determine presence of Malleefowl on site or in adjacent vegetation.	N/A
Detail	No Commonwealth-listed threatened ecological communities, flora or fauna species were observed during surveys of the site and its surrounds. Malleefowl, a Commonwealth-listed, threatened species, may be present in high quality, large patches of mallee woodland near to the site. Malleefowl would not occupy the poorer quality, small, fragmented patches of vegetation on the site and its immediate surrounds. The site is unlikely to provide suitable habitat for the Commonwealth-listed threatened Sandhill Dunnart, a small marsupial. It is possible that Sandhill Dunnarts are present in the larger area of mallee vegetation to the north-west and east of the site. This is due to records of the Mitchell's Hopping Mouse, which is known to occur in association with Sandhill Dunnarts and to occupy burrows.	No Commonwealth-listed threatened ecological communities, flora or fauna species were observed during surveys of the site and its surrounds. Malleefowl, a Commonwealth-listed, threatened species, may be present in high quality, large patches of mallee woodland near to the site. Malleefowl would not occupy the poorer quality, small, fragmented patches of vegetation on the site and its immediate surrounds. The state-listed threatened Ridged Noon-flower was recorded in the patch of vegetation in the south-west corner of the site; further assessment is required to obtain flower specimens for formal identification and confirmation. The site and the Tola Road Reserve are considered unlikely to support the Sandhill Dunnart.	The Wallerberdina site has no threatened ecological communities. There are no Commonwealth-listed species with potential for occurrence; but one plant (Desert Lime) and one bird (Elegant Parrot) that are state-listed species have been recorded more than 10km from the site but are considered unlikely to be present at the site and its immediate surrounds due to a lack of suitable habitat.

Landscape and visual amenity

This summary is compiled from information extracted from the EPBC Act site suitability assessment (attachment C). The department and AECOM have assessed this element, and this was reviewed by AECOM, ANSTO and DoEE.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**Very low**	**Very low**	**Very low**
Risk conclusion	Landscape and visual amenity is not considered a differentiator between the approved sites. There is considered to be a very low risk that the regulator will have concerns about this site characteristic affecting regulatory approval for Lyndhurst, Napandee or Wallerberdina.		
Risk likelihood and consequence	It is **highly unlikely** that landscape and visual amenity considerations would cause regulator concern that would affect EPBC approval.		
Mitigation	A landscape and visual impact assessment, as part of the environmental assessment process and using an industry standard approach, will need to be undertaken at the future declared site. Such an assessment will demonstrate the view of facility development at fixed points in the construction process and facility lifetime. A visual impact assessment can explore the use of buffers and visual breaks if desired. The visual impact of LLW vaults could be minimised through considered placement on site (utilising the existing topography of the site) and/or introduction of appropriate vegetation. Further community consultation is required to incorporate community preferences in the design and visual amenity, where possible.		
General comments	The conceptual facility layout differs for each the three sites; this is due to site shape, orientation and topography considerations. The size of the potential sites is however generically consistent, as is the number and the mass of the planned built structures. None of the sites are in the sight lines of significant local features or landmarks. For example, while the Wallerberdina site is located in the proximity to the Flinders Ranges, tourists or locals using highways to travel to attractions such as Wilpena Pound would not see the facility in the landscape as it's located on the eastern side of the Range. The highest impact, which is consistent for all sites, will be the TN81 building which stands 20m from natural ground level. There will also be up to six ILW buildings and six LLW cover buildings (over the vaults) that will be approximately 14 to 15m high that would be the dominant features in the landscape. In the long term, the LLW vault structures will be several metres high, and when earth-capped will be in the order of 12 to 14m high.		
Specific site comments	N/A	N/A	N/A
Detail	The site is located in a rural area, 16km from the Kimba township with access via local roads. The variance in landfall could be used to lower (or raise) built elements. Visual impact would be considered lower due to the vegetation and topography of the site.	The site is located in a rural area, 23km from the Kimba township with access via local roads. The roadside vegetation along the southern and western boundaries of the site currently limits visual impact.	The site is located in a rural area, 30km from the Hawker township with access via local roads. The site is not visible from the Outback Highway due to the presence of the ranges. The land is generally flat in the area of the site, and is located north of a local access road that is only used by a few pastoral stations.

Traffic and transport

This summary is compiled from information extracted from the EPBC Act site suitability assessment (attachment C). The department and AECOM have assessed this element, and this was reviewed by AECOM, ANSTO and DoEE.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**Very low**	**Very low**	**Low**
Risk conclusion	There is considered to be a very low risk for Lyndhurst or Napandee, and a low risk for Wallerberdina, that the regulator will have concerns about this site characteristic affecting regulatory approval.		
Risk likelihood and consequence	It is **unlikely** that traffic and transport considerations would cause regulator concern that would affect EPBC approval.	It is **highly unlikely** that traffic and transport considerations would cause regulator concern that would affect EPBC approval.	It is **unlikely** that traffic and transport considerations would cause regulator concern that would affect EPBC approval.
Mitigation	Road upgrade planning and design will need to minimise the extent of vegetation clearance along site access roads. Targeted vegetation studies as well as traffic surveys will need to be taken along the proposed access roads.		
General comments	Vegetation clearance may be required for local access road upgrades at Lyndhurst, Napandee and Wallerberdina. Traffic to the sites will be reasonably consistent, as all traffic will generally pass through the Kimba or Hawker townships to reach the sites.		
Specific site comments	N/A	N/A	N/A
Detail	Road widening could require vegetation clearance and additional road construction may be required with the potential for environmental impact. The primary site access may be impacted during flood events, however there are alternative access points to the site. Additional classified information on potential transport routes was also considered.	Road widening could require vegetation clearance. The primary site access may be impacted during flood events, however there are existing alternative access points to the site. Additional classified information on potential transport routes was also considered.	Road widening could require vegetation clearance and additional road construction may be required with the potential for environmental impact. Additional classified information on potential transport routes was also considered.

Aboriginal cultural heritage

This summary is compiled from information extracted from the EPBC Act site suitability assessment (attachment C). The department has assessed this element with specialist input from RPS, and this was reviewed by AECOM, ANSTO and DoEE.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**Very low**	**Very low**	**Medium**
Risk conclusion	Aboriginal cultural heritage is considered a differentiator between the approved sites. There is considered to be a very low risk for Lyndhurst or Napandee, and a medium risk for Wallerberdina, that the regulator will have concerns about this site characteristic affecting regulatory approval.		
Risk likelihood and consequence	It is **highly unlikely** that Aboriginal cultural heritage values would cause regulator concern that would affect EPBC approval.	It is **highly unlikely** that Aboriginal cultural heritage values would cause regulator concern that would affect EPBC approval.	It is **unlikely** that Aboriginal cultural heritage values would cause regulator concern that would affect EPBC approval.
Mitigation	While there is no registered Aboriginal cultural heritage value over the Lyndhurst and Napandee sites, comprehensive archaeological investigation, consultation and site visits with the relevant Traditional Owners will be required to fully assess the cultural values and to develop an Aboriginal Cultural Heritage Management Plan. Archaeological artefacts may be present in the vicinity of all the sites, and will require clearance and management during any future ground disturbance		A detailed, targeted anthropological and archaeological survey of the Wallerberdina site would need to be undertaken if it was selected. Archaeological artefacts may be present in the vicinity of all the sites, and will require clearance and management during any future ground disturbance.
General comments	N/A		
Specific site comments	The Lyndhurst and Napandee sites sit within recognised Barngarla land but there are no registered Aboriginal cultural heritage values. However, a detailed assessment of Aboriginal cultural heritage values has not been completed for the Lyndhurst and Napandee sites. As yet unrecorded sites, particularly areas with stone artefacts may be present in the vicinity of the sites.		A preliminary investigation has been undertaken for Wallerberdina and the land broadly surrounding Wallerberdina has both registered and unregistered Aboriginal cultural heritage sites, in addition to landscape features of anthropological value, such as creek lines, hills, and sand dunes.
Detail	There are no registered Aboriginal cultural heritage sites in the local area.	There are no registered Aboriginal cultural heritage sites in the local area.	There are no Aboriginal cultural heritage sites registered at the proposed acquisition parcel or in the immediate surrounds. Significant registered heritage sites occur near the southern boundary of the Wallerberdina approved site, for example, in association with Hookina Creek. Archaeological artefacts are expected to be present in the vicinity of the proposed acquisition parcel. However, the proposed acquisition parcel's archaeological potential has been mapped and classified as low in comparison to other areas on the property and its surrounds.

Land use planning

This summary is compiled from information extracted from the EPBC Act site suitability assessment (attachment C). The department and AECOM have assessed this element, and this was reviewed by AECOM, ANSTO and DoEE.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**Very low**	**Very low**	**Very low**
Risk conclusion	Land use planning is not considered a differentiator between the approved sites. There is considered to be a very low risk that the regulator will have concerns about this site characteristic affecting regulatory approval for Lyndhurst, Napandee or Wallerberdina.		
Risk likelihood and consequence	It is **very unlikely** that land use planning would cause regulator concern that would affect EPBC approval.	It is **very unlikely** that land use planning would cause regulator concern that would affect EPBC approval.	It is **very unlikely** that land use planning would cause regulator concern that would affect EPBC approval.
Mitigation	Exploration of planning and/or other statutory constraints on adverse, nearby development could be useful for Lyndhurst, Napandee and Wallerberdina. It is possible to rely upon the existing planning and development controls to limit the extent to which future development could impact on the site once developed (e.g. Local Government Planning Scheme provisions).		
General comments	N/A		
Specific site comments	Residential land use is found closer to the Lyndhurst and Napandee sites than to Wallerberdina, although not close enough that noise, light spill or visual impacts would be significant. The risk of development for the mineral and mining tenements near the Lyndhurst and Napandee sites is considered to be low.		Wallerberdina is located further away from any sensitive land uses.
Detail	The site is separate from existing sensitive land uses; no adverse effects are expected. No mining or exploration licences have been identified over the proposed acquisition parcel. There are mineral and mining tenements adjacent and near to the approved nominated area. These nearby tenements would not be extinguished by making a declaration selecting the site and specifying that all rights and interests in the site are extinguished.[8]	The site is separate from existing sensitive land uses; no adverse effects are expected. No mining or exploration licences have been identified over the proposed acquisition parcel. There are mineral and mining tenements that include and are near to the approved nominated area. These nearby tenements would not be extinguished by making a declaration selecting the site and specifying that all rights and interests in the site are extinguished.	The site is separate from existing sensitive land uses; no adverse effects are expected. There is one geothermal exploration licence over the proposed acquisition parcel, which would be extinguished by making a declaration selecting the site and specifying that all rights and interests in the site are extinguished. Two petroleum exploration licence applications are held over the proposed acquisition parcel, which would also be extinguished by making such a declaration.

[8] Under the NRWM Act, and the National Radioactive Waste Management Amendment (Site Specification, Community Fund and Other Measures) Bill 2020, the acquisition of a site has the effect of extinguishing any rights or interests in the site specified. Neither the NRWM Act, nor the National Radioactive Waste Management Amendment (Site Specification, Community Fund and Other Measures) Bill 2020, extinguish tenements that exist over any other properties, including properties neighbouring the declared site.

Agriculture

This summary is compiled from information extracted from the EPBC Act site suitability assessment (attachment C). The department and AECOM have assessed this element, and this was reviewed by AECOM, ANSTO and DoEE.

	Lyndhurst	Napandee	Wallerberdina
Risk rating	**Very low**	**Very low**	**Very low**
Risk conclusion	Agriculture is not considered a differentiator between the approved sites. There is considered to be a very low risk that the regulator will have concerns about this site characteristic affecting regulatory approval for Lyndhurst, Napandee or Wallerberdina.		
Risk likelihood and consequence	It is **very unlikely** that development of agricultural land would cause regulator concern that would affect EPBC approval.		
Mitigation	A radiation level baseline for soils, groundwater, surface water (ephemeral), air, native plants, crops and livestock should be established prior to facility construction. Ongoing radiation level monitoring during facility construction, operation and closure/maintenance activities is required to demonstrate that agricultural land and production is not impacted by the facility's presence. There is interest in the Kimba community to establish a cropping field trial area within facility infrastructure buffer zones.		
General comments	N/A		
Specific site comments	Facility development on either of the Lyndhurst and Napandee sites would use existing agricultural land, but the extent to which this would reduce overall agricultural potential for the region is negligible.		Facility development at Wallerberdina would not be expected to impact existing grazing use for the remainder of the Wallerberdina property, or for surrounding properties.
Detail	The site and its surrounds are used for broadacre dryland cropping.	The site and its surrounds are used for broadacre dryland cropping.	The site and surrounding properties are leasehold and are used for rangeland grazing of cattle (native vegetation, not pasture).

Future regulatory and other considerations

There will be several other regulatory requirements relevant to the facility and the acquired site, outside of the ARPANSA (*Australian Radiation Protection and Nuclear Safety Act 1998* (Cth) (the ARPANS Act)), ASNO (*Nuclear Non-Proliferation (Safeguards) Act 1987* (Cth) (the Safeguards Act)) and EPBC Act requirements considered in criterion 1. These include:

- Parliamentary Standing Committee on Public Works (PWC)
- Prohibition regulation
- Waste regulation
- Transport regulation
- Other regulation

While consideration was given to facility and site features that might affect whether approvals such as those listed above can be obtained, the site-specific information necessary to conduct additional comparative assessments is not yet available, and therefore risk ratings have not been applied.

Site suitability criterion 2

The costs to acquire the site and realise the facility at the site.

Consideration was given to two distinct financial costs associated with the facility: the cost of the facility itself and the compensation costs (initial and future) associated with acquiring land or property needed to support the facility. The cost of operating the facility has not been examined.

About costs

The former Minister was required to comply with the requirements of the *Public Governance, Performance and Accountability Act 2013* (PGPA Act). This includes being satisfied, in the context of achieving the Government's policy objective to establish a facility, that the expenditure required to establish the facility and pay reasonable compensation under section 35 or 36 could be approved as a 'proper[9] use of relevant money' (PGPA Act, section 71).

The department has assessed the risk that proposed expenditure may not result in a fit-for-purpose facility. A traffic light rating indicates if this risk is low, medium or high, and explanatory comments are provided. On assessment, the compensation costs across the three sites did not impact the risk ratings. The cost differentials reflect the complexity of mitigating risks to safety and security, as identified at site suitability criterion 1.

Table 13: The department's colour code for rating the risk that proposed expenditure would not result in a fit-for-purpose facility

Rating	Low	**Medium**	**High**
Traffic light			

[9] Proper is defined in section 8 of the PGPA Act as 'efficient, effective, economical and ethical'.

Facility cost estimates

The estimates provided below relate specifically to the costs of site-specific risk mitigations in response to criterion 1 regulatory assessments and were informed by these key documents:

- AECOM site characterisation reports and addendums for Lyndhurst, Napandee and Wallerberdina (see attachments E, F and G)
- AECOM enabling works reports and addendum
- Specialist report on costs.

The estimates exclude base-line costs for the facility development and planning, construction, asset replacement, operations and maintenance activities, which will be finalised for government consideration post site-specific design development and initial regulatory approvals.

All costs are current as of September 2019, noting ongoing departmental work may result in updates to these amounts throughout the facility development phase. All costs presented are real (or constant) dollars, as of 2018/19.

Additional works

The assessment identified some additional capital mitigation works to address the following risks:

Flood/Hydrology/radionuclide dispersion in surface water risks

Lyndhurst, and to a lesser extent Napandee, have potential for localised undrained low points that may create localised ponding risks. At both sites, additional stormwater works could help respond to the IAEA SSG-29 requirements (see attachment A) to keep the site well drained and free of areas subject to flooding or frequent ponding.

There is a low risk of ponding at Wallerberdina, however hydrological modelling indicates there is a high risk of flood at the site from Hookina Creek. Capital costs already included significant provision for raising infrastructure and levee work at this site.

Geotechnical risks

Raft slab foundations will likely be required for LLW vault structures built at any of the three sites.

Emergency plan delivery/requirement risk

At Wallerberdina, it is highly likely that an alternate flood resistant emergency road

access would be required to support the anticipated facility emergency plans. The proposed alternate access road would run parallel to the Cotabena Railway for approximately 48 kilometres. The costs associated with the acquisition of land or easements are considered in the compensation section of this report.

While flood mitigation works will reduce the potential impact and/or probability of an adverse event, some residual risks remain for Wallerberdina (and to a much lesser extent at Lyndhurst). It is uncertain the regulator will be satisfied with the risk outcomes achieved by the proposed mitigation works. For more information see the ARPANSA/ASNO/IAEA and EPBC Act site suitability assessments at attachments A and C.

Capital Cost Differentials

Each site has unique challenges which are reflected in the design and functional solutions adopted for enabling works (transport, water, power, and communications) and in the contingency allowances (both inherent and contingent). Napandee has the lowest overall site-specific delivery costs and has therefore been selected as a baseline to compare the sites (see table 14). Compared to Napandee it is estimated Lyndhurst would cost an additional $22.5 million, and Wallerberdina would cost an additional $150.9 million.

Component	**Lyndhurst Delta $M**	**Napandee (baseline)**	**Wallerberdina Delta $M**
Enabling Works			
Transport	-22.7	-	+69.0
Communications	-0.8	-	+2.8
Water	-0.7	-	+1.7
Power	+0.1	-	-51.7
Facility buildings	+42.3	-	+88.7
Inherent Risks	+3.3	-	+35.7
Contingent Risks	+1.0	-	+4.7
Total Capital Cost (relative to Napandee)	**+22.5**	**-**	**+150.9**

Table 14: P80 Capital cost differentials, site-specific elements (real dollars, 2018 –19)

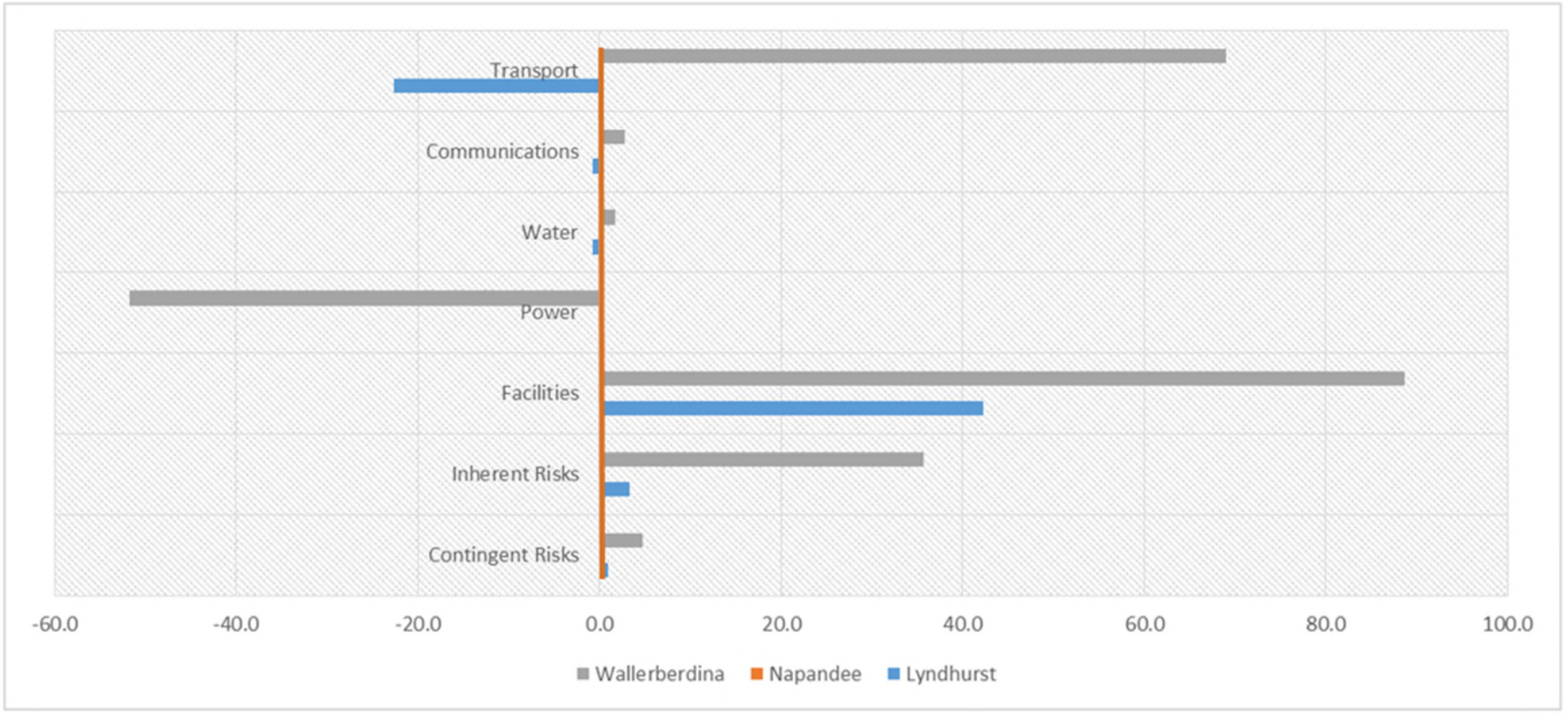


Figure 10: Cost advantage or disadvantage of Lyndhurst, Napandee (baseline) and Wallerberdina

Lyndhurst has an overall cost disadvantage relating primarily to ponding issues and the associated mitigation costs for the facility buildings.

Napandee has an overall cost advantage because the increased costs of road works (compared with Lyndhurst) or power (compared with Wallerberdina) is offset by the cost savings associated with the lower risk of flooding and ponding at the site.

Wallerberdina has an overall cost disadvantage relating to flooding risks and the construction of roads. The flooding risks require both levee works and raising of critical infrastructure in order to mitigate the risks. The road construction costs in table 14 and figure 10 are reflective of work required to build roads to the site. Although there is a cost advantage associated with the ease of connecting to existing power infrastructure, this saving does not overcome the costs associated with mitigating flooding risk and constructing roads.

Assessment of estimated facility costs

Table 15: The department's assessment of the risk that estimated facility capital costs would not result in a fit-for-purpose facility

	Lyndhurst	Napandee	Wallerberdina
Capital cost Differentials	+$22.5m	$0 (baseline)	+$150.9m
Rating and comment	This site has a capital cost differential of +$22.5m to mitigate against identified risks. This is likely to deliver the mitigations required to satisfy the regulator.	This site has a capital cost differential of $0 to mitigate against identified risks. Of the three sites under consideration, this is the baseline and minimum amount required to establish the facility to a standard which is likely to satisfy the regulator.	This site has a capital cost differential of +$150.9m to mitigate against identified risks. While more than $120m has been identified to support measures to mitigate flood risk, there is a residual risk the identified mitigations may not be adequate to develop a safety case that satisfies the regulator, and additional mitigations that have not been factored into this assessment may be necessary.

Compensation

Sections 35 and 36 of the NRWM Act describe when the Commonwealth will be liable to pay a ‘reasonable amount of compensation’ to certain persons in relation to the acquisition, extinguishment or other impact on rights or interests under the NRWM Act. These compensation requirements are maintained in the *National Radioactive Waste Management Amendment (Site Specification, Community Fund and Other Measures) Bill 2020*.

Specific costs are subject to commercial in confidence.

The department has assessed that there is a **low risk** for Lyndhurst, Napandee and Wallerberdina that proposed expenditure for compensation would not result in a fit-for-purpose facility at the site.

	Lyndhurst	Napandee	Wallerberdina
Compensation costs (estimated)			

Site suitability criterion 3

Other matters relevant to the suitability of the site for the establishment and operation of the facility.

The object of the NRWM Act (section 3) suggests a broad interpretation can be applied when identifying factors relevant to selecting a site on which to establish and operate a facility. The facility will have a presence in the local area over hundreds of years across the pre-operational, operational and post operational phases. Beyond the consideration of regulatory approvals, costs and community sentiment as examined in criterion 1, 2 and 4, criterion 3 considers other matters that could potentially impact the suitability of each site across the lifecycle of the facility. This includes the consideration of the possible practical, policy, legal and stakeholder risks associated with the program of discrete tasks necessary to establish and operate a facility on each site to safely and securely manage radioactive waste. This criterion, where necessary, considers the suitability of each site at pre-operational, operational and post-operational phases. The key phases of facility development are:

- pre-operational (regulatory approvals, site preparation and construction—10 years)
- operational (receiving waste and environmental monitoring—100 years)
- post-operational (decommissioning and long term monitoring—300 years).

The criterion considers practical, legal and stakeholder management perspectives for a ranger of factors, including[10]:

- Aboriginal cultural heritage and Native Title
- transport and road use
- noise, dust, visual and other disturbance
- security
- future land use and activities
- additional land or property acquisitions
- environment
- socio-economic factors.

These factors are assessed comparatively for each site. This criterion assessment is based on site information available at the time of writing. This criterion assessment does not present an exhaustive list of potential influencing factors, and should be considered independent of the site assessments conducted under criteria 1, 2 and 4. The assessment of the risks for this criterion is generally conservative, to account for the uncertainty in available information.

[10] Two factors have not been included because they are subject to legal professional privilege.

Assessment approach

This assessment details the department's evaluation of the risks for the approved sites in the context of 'other matters' (apart from criteria 1, 2 and 4) that could potentially impact the suitability of the site for facility establishment, operation and decommissioning. The assessment provides a basis for broad consideration of the factors relevant to the safe and secure management of radioactive waste over the full span of the facility's development, in relation to each of the approved sites.

The factors used to assess this criterion were identified by the department based on a review of the preliminary assessments undertaken for the other site selection criteria and the risk assessments related to the National Radioactive Waste Management Program. The department's risk management framework was used to make the assessment of factors against the criterion, undertaken by the department (attachment D). The assessment of the probability of the occurrence/recurrence of certain risk events was made in the knowledge of the historical and future projections made in the other criterion assessments, other risk assessment work undertaken for the NRWM program, and with reference to the facility phases.

This assessment considers whether a particular factor or characteristic could lead to an impact on the site's suitability. A risk rating is determined for each factor identified in the assessment, based on risk *likelihood* and *consequence*. For the risk assessment conducted, 'likelihood' is the department's assessment of the probability that particular risk events associated with the factor will impact the establishment, operation and decommissioning of the facility (for example, the discovery of new heritage sites). The 'consequence' for a factor indicates the level of potential severity of the impact should it occur (for example, the level of public or stakeholder concern about risks to Aboriginal cultural heritage and possible legal action). The assessment of likelihood and consequences takes into account any mitigation measures that are planned or recommended.

The department's risk management framework risk determination matrix was used to evaluate the likelihood of risk (refer to table 16). For consequence, the department's matrix descriptions (from insignificant to severe) were used, and consequence is described in terms of the potential impacts on the establishment, operation and decommissioning of the facility. The department's risk determination matrix was then used to combine likelihood and consequence to determine a final risk rating, from low to very high.

Table 16: The d*epartment's risk determination matrix, combining likelihood and consequence levels to determine a final risk ratings*

Likelihood Rating	Consequence Ratings				
	Insignificant	Minimal	Moderate	Substantial	Severe
Almost Certain	Minor	Medium	High	Very High	Very High
Likely	Minor	Medium	Medium	High	Very High
Possible	Low	Minor	Medium	High	Very High
Unlikely	Low	Minor	Minor	Medium	High
Rare	Low	Low	Minor	Medium	High

A relatively higher risk rating generally means that additional mitigations, beyond those identified, may be required to address the risks, rather than that the site would be unsuitable. A higher risk rating indicates that there are concerns or questions based on the findings or information available at the present time, and that additional information is required to clarify site or broader operational characteristics, impacts or mitigation strategies. It is anticipated that the pre-operational phase draws much of the apparent risk as this is when there is the most potential for disruption, and creates the most interaction with regulators and the community.

Assessment of other matters

The results of the assessment are shown in table 17.

The yellow ratings for ‘Aboriginal cultural heritage’ reflect that appropriate management of Aboriginal cultural heritage is essential. Further detailed site-specific assessment work is required at all sites to identify any Aboriginal cultural heritage that may be present and to prepare a cultural heritage management plan. The Government is committed to minimising and mitigating any impact from facility activities on cultural heritage.

The yellow ratings for ‘Utility supply’ reflect that those sites will require access to the local water supply. Appropriate management will be required to ensure there is no detrimental impact to the local community supply.

The orange rating for ‘Additional land or property acquisitions’ reflects the extent of the additional land acquisition required for emergency road access at the site.

The red and yellow ratings for ‘Community relationships’ reflect the strong stakeholder interest and views on the facility, and the fact that these views will need to be managed appropriately.

Table 17: The department’s assessment of the risk that a particular factor would impact the suitability of the site for the establishment and operation of the facility

	Lyndhurst	Napandee	Wallerberdina
Aboriginal cultural heritage			
Transport and road use			
Noise, dust, visual and other disturbance			
Security			
Utilities supply			
Future land use and activities			
Additional land or property acquisitions			

Environment			
Socio-economic			
Community relationships			
Legislative override provisions of the NRWM Act			

Additional resources

Glossary

TERM	DESCRIPTION
A	
Absorbed dose	The fundamental dosimetric quantity. Absorbed dose is a measure of the energy deposited in matter by ionizing radiation per unit mass. It is equal to the energy deposited per unit mass of medium, and so has the unit J/kg, with adopted name of gray (Gy) where 1Gy = 1J/kg.
Active drainage	Liquid that has percolated through the disposal vault or drainage from any active area (such as an active processing area or an active laboratory) and is potentially radioactive, normally collected in an active drainage system and then monitored and or treated.
Activity	The average number of spontaneous nuclear transformations of a radionuclide occurring in unit time. The International System of Units (SI) unit of activity is the Becquerel (Bq) which is equal to one nuclear transformation per second.
Activity concentration	The concentration of a radioactive substance in any particular material expressed in terms of the activity in Becquerel per unit mass (or volume) of the material.
Alluvial fan	A triangle-shaped water-transported deposit of gravel, sand, and even smaller pieces of sediment, such as silt. Alluvial fans typically form where there is a rapid change in slope from a high to low gradient. Sediments are deposited as they spread out on a flat plain after flowing down a slope.
Ambient radioactivity	Refers to natural background radiation levels at and around a site.
Approved site (or approved land)	Land which was voluntarily nominated and approved under the processes specified in the NRWM Act. There are three approved sites under consideration as the site for the facility, at Lyndhurst, Napandee and Wallerberdina.
Annual Exceedance Probability (AEP)	Refers to the probability of a flood event occurring in any year. The probability is expressed as a percentage. The AEP can also be expressed as a frequency of occurrence, for example, 1 in 2000 is equivalent to 0.05%.
Aquifer	An underground zone of rock or sediment containing a body of water.

As Low As Reasonably Achievable (ALARA), similar to ALARP (as low as reasonably practicable)	A mindset or approach used to achieve low radiation doses to individuals and to limit the number of people exposed to radiation, economic and social factors being taken into account. This generally employs the use of best available techniques and practices.
Attenuation (soil)	Also termed natural attenuation, is a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in situ processes include: biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants.
Avulsion	An abrupt change in the river course or the rapid abandonment of a river channel and the formation of a new river channel.
B	
Baseline (radiological baseline)	Assessment of the current radiological characteristics of the site to establish a baseline from which to measure or detect future environmental impacts, and to inform a safety case. Determining baseline radiological levels is also important to ensure that the radiation levels at the sites are within normal ranges and that a facility could be operated within the ARPANSA requirements for worker safety.
Biosphere	That part of the environment normally inhabited by living organisms. In practice, the biosphere is not usually defined with great precision, but is generally taken to include the atmosphere and the Earth's surface, including the soil, surface water bodies, seas and oceans and their sediments. There is no generally accepted definition of the depth below the surface at which soil or sediment ceases to be part of the biosphere, but this might typically be taken to be the depth affected by basic human actions, particularly farming.
Becquerel (Bq)	Unit of radioactivity in the International System of Units. The Becquerel (Bq) is equal to one nuclear transformation per second.
Bund or levee	A flood wall or embankment built to prevent water inundation of a site or facility from flooding.
C	
Capping	The engineered layers of materials that will cover a vault complex after it is filled and closed with a concrete lid. The physical properties and expected performance of these layers will be used in the post closure safety case.
Capital costs (baseline)	The least expensive option, of the approved sites, for Government to deliver the facility.

Capital cost differential	The variance in capital cost, compared to baseline, of establishing the facility at a specific site.
Closure (of disposal facility)	The administrative and technical actions required to put a disposal facility in its intended final state on completion of waste disposal.
Commonwealth	Refer to Government.
Contact dose	The radiation rate at the surface of a waste package.
Containment	Methods or physical structures designed to prevent the dispersion of radioactive substances.
Corrosive materials	A corrosive substance or material is one that will damage or destroy other substances with which it comes into contact by means of a chemical reaction.
D	
Decommissioning	Administrative and technical actions taken to allow the removal of some or all of the regulatory controls from a facility (except for a repository which is closed and not decommissioned). Decommissioning implies that no further use of the facility (or part thereof) for its existing purpose is foreseen.
Defence-in-depth	The application of more than a single protective measure, such as barriers, controls, monitoring devices, protective equipment and emergency response measures for a given safety objective, such that the objective is achieved even if one or more of the protective measures fails.
Design life	The period after completion of an engineered disposal structure during which the structure and all its components are expected to perform in accordance with the design objectives.
Disposal	The placement of radioactive waste in a structure and in a manner such that there is no intention of retrieval.
Disposal facility	The land, buildings and equipment which are intended to be used for the disposal of radioactive waste.
Differentiator (or criterion differentiator)	An aspect of a site which when evaluated has a significant or different performance level compared to other sites.
Drainage line/path	Indicates the direction of water flow after rainfall throughout the site.

Dose	A measure of the energy deposited by radiation in a substance. A generic term that may mean absorbed dose, equivalent dose or effective dose depending on context. Here, it generally refers to equivalent dose (which relates the absorbed dose in human tissue to the effective biological damage of the radiation), measured in Sieverts.
Dose limit	The dose limit represents the upper bound of acceptable additional dose (above natural background and elective doses, such as for medical imaging) for an individual worker or member of the public and is normally the legal limit.
Dose rate	The dose of ionizing radiation delivered per unit of time (measured in Sv per time unit).
E	
Enabling works	The preliminary constructed works required for the facility to be constructed. This may include the provision of infrastructure such as roads, water supply, power and communications.
Engineered barrier	A feature made or altered by humans which delays or prevents radionuclide migration from the waste or the storage/disposal structure into its surroundings; it may include the waste package and/or part of the storage/disposal structure.
Environmental management plan	A document which sets out a system of management based on social, economic and environmental aims within which the decision-making process takes place.
Erosion	A process by which the disposal vaults might be damaged in the long term by the actions of wind, water and/or ice.
F	
Facility	Means the facility referred to in the NRWM Act, for the management of controlled material generated, possess or controlled by the Commonwealth or a Commonwealth entity.
Fluvial	Processes that are associated with rivers and streams and the deposits and landforms created by them.
Foundation (or vault foundation)	The primary load-bearing part of a vault structure, normally below ground level.
G	
Geotechnical	Relates to the application of technology to engineering problems caused by geological factors.

Government	The government of the Commonwealth of Australia or of a state or territory of the Commonwealth.
Graded approach	A system of control, such as a regulatory system or a safety system, a process or method in which the stringency of the control measures and conditions to be applied is commensurate, to the extent practicable, with the likelihood and possible consequences of, and the level of risk associated with, a loss of control.
Ground truth	Refers to information provided by direct observation.
Groundwater	Water held in soil or within pores and fractures in rock beneath Earth's surface.
H	
Hydrology	Encompasses the study of water on the Earth's surface and beneath the surface of the Earth, the occurrence and movement of water, the physical and chemical properties of water, and its relationship with the living and material components of the environment.
Hydrological modelling	The characterisation of real hydrologic features and system using small-scale physical models, mathematical analogues, and computer simulations.
I	
Institutional control	Control of a radioactive waste site by an authority or institution designated under the laws of a State. This control may be active (monitoring, surveillance, remedial work) or passive (land use control) and may be a factor in the design of a facility (e.g. a near surface disposal facility). A period of institutional control follows cessation of operations and site closure. A period of 200-300 years is generally attributed to the Institutional control period: considered as a reasonable period to assume for continued organized human institutions/existence of a State.
Intermediate Level Waste (ILW)	Waste that, because of its content, particularly of long-lived radionuclides, requires a greater degree of containment and isolation than that provided by near surface disposal. However, ILW needs little or no provision for heat dissipation during its storage and disposal. Intermediate level waste may contain long lived radionuclides, in particular alpha emitting radionuclides, which will not decay to an activity concentration acceptable for near surface disposal during the time for which institutional controls can be relied upon. Therefore, waste in this class requires disposal at greater depths, in the order of tens of metres to a few hundred metres.

International Atomic Energy Agency (IAEA)	World's centre for cooperation in the nuclear field, promoting the safe, secure and peaceful use of nuclear technology.
International best practice	Codes, standards, recommendations and guides that are produced by the international organisations listed below. 1. United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) 2. International Atomic Energy Agency (IAEA) 3. World Health Organisation (WHO) 4. International Commission on Radiological Protection (ICRP) 5. International Commission on Non-Ionizing Radiation Protection (ICNRP) 6. Nuclear Energy Agency (NEA) of the Organisation for Economic Co-operation and Development (OECD). NB The *Australian Radiation Protection and Nuclear Safety Act 1998* (the ARPANS Act) states that the CEO of ARPANSA must take into account international best practice in relation to radiation protection and nuclear safety when making licensing decisions. Although the ARPANS Act does not define the term 'international best practice', the CEO has taken it into account by, among other things, the codes, standards, recommendations and guides produced by the above organisations.
Intrusion	The process by which living organisms, including humans, may come in contact with disposed or stored waste. For example, burrowing animals might be able to damage the protective layers and access the radioactive waste.
Ionising radiation	For the purposes of radiation protection, radiation capable of producing ion pairs in biological material(s).
Isolation	Containment of radioactive waste to ensure separation from the environment.
J	
K	
Kaolin	Rock that is rich in kaolinite, a clay mineral.
L	

Levee or bund	A flood wall or embankment built to prevent water inundation of a site or facility from flooding.
Long-lived radionuclides	Radionuclides with half-life greater than 31 years.
Long term safety	Facility safety including the post-closure phase.
Low Level Waste (LLW)	Waste that is above exemption levels, but with limited amounts of long-lived radionuclides. Such waste requires robust isolation and containment for periods of up to a few hundred years and is suitable for disposal in engineered surface facilities. This class covers a very broad range of waste. Low Level waste may include: • short lived radionuclides at higher activity concentration levels, and • long lived radionuclides, but only at relatively low activity concentration.
M	
Marl (or marl clay)	A calcium carbonate-rich mud (sediment) which contains variable amounts of clays and silt.
Mitigation	Measures taken to reduce the severity or seriousness of an identified hazard. The aim of mitigations may be to decrease or eliminate the impact on society and environment.
N	
Non-active drainage	General drainage for surface and groundwater that will not come in contact with radioactive materials.
Nuclear material	See Safeguards Material.
O	
Optimisation (of radiation protection and safety)	The process of determining what level of protection and safety makes exposures, and the probability and magnitude of potential exposures, 'as low as reasonably achievable, economic and social factors being taken into account' (ALARA), as required by the International Commission on Radiological Protection System of Radiological Protection.
Overland flow	Water which has fallen as rain a distance away from a site and then flows over the surface of the land to the site.

P	
Package	The product of conditioning and placement in an approved container. A waste package is the combination of the waste form, any container(s) and internal barriers (e.g. absorbing materials and liner), as prepared in accordance with requirements for handling and storage or disposal.
Peak (ground) acceleration	Measure of the maximum ground shaking that occurs at a location during an earthquake.
Probable Maximum Flood event (PMF)	The largest flood that could conceivably be expected to occur at a location, usually estimated from probable maximum precipitation. It defines the maximum extent of flood prone land, that is, the floodplain.
Proposed acquisition parcel	Approximately 160ha of the approved site, which would be acquired as the site for the facility if a declaration is made under section 14(2) of the NRWM Act.
Q	
R	
Radiation	See ionising radiation.
Radioactive	Exhibiting radioactivity; emitting or relating to the emission of ionising radiation or particles.
Radioactive waste	Waste that contains or is contaminated with radioactive substances and has an activity or activity concentration higher than the level for clearance from regulatory requirements, and for which no further use in Australia is envisaged.
Radionuclides	An unstable nuclide that emits ionising radiation. A nuclide is a species of atom characterised by the number of protons and neutrons and, in some cases, by the energy state of the nucleus.
Raft slab	A type of building foundation. Reinforced concrete slab that rests on the ground and extends over the entire footprint of the building structure.
Receptor	When undertaking environmental or radiological impact assessment modelling, a receptor is chosen as part of the source-pathway-receptor approach to evaluating potential impacts. The source is where the pollution/hazardous material or radiation came from. The pathway is how that material or radiation can travel through the environment. The

	receptor is the human or environment which could be impacted by the transport of that material, hazard or radiation.
Residual risk	Residual risk is the risk remaining after risk treatment (mitigation measures).
RESRAD-OFFSITE	A computer code modelling tool used to assess radiation exposures of a human receptor located on top of or at some distance from soils contaminated with radioactive materials.
Risk, contingent	Risk estimates that make allowance for the unknown risks associated with a project. Generally reduce as better quality information becomes available and some risks have passed or been overcome.
Risk, inherent	Inherent risks are those that exist based on the general characteristics of the project.
S	
Safeguards	Describes the system of inspection and verification of the peaceful uses of nuclear materials as part of the Nuclear Non-Proliferation Treaty (NPT), supervised by the International Atomic Energy Agency.
Safeguards material	Any uranium, thorium or plutonium held in Australia under ASNO permits, or otherwise subject to the *Nuclear Non-Proliferation (Safeguards) Act 1987* (Cth) (Safeguards Act), with limited exceptions as described in the Nuclear Non-Proliferation (Safeguards) Regulations 1987[11].
Safety Case	The safety case is the collection of scientific, technical, administrative and managerial arguments and evidence in support of the safety of a disposal or storage facility. The Safety Case includes the safety case context; safety strategy; system description; safety assessment; limits, controls and conditions; integration of safety arguments; management of uncertainty and iteration and design optimisation.
Seismic	Effects due to shaking of the land (often associated with earthquakes).
Short-lived radionuclides	Radionuclides with half-life less than 31 years.
Sievert (Sv)	Unit of ionising radiation dose in the International System of Units.
Site characterisation	Desktop and field-based investigations of aspects of a site which can be used to assess its suitability.

[11] The definition of 'nuclear material' for the purposes of IAEA safeguards does not apply to ores and ore residues.

Site suitability criteria	Site suitability criteria have been developed to enable a suitability assessment to support a decision about site selection. The legislatively-driven criteria (1, 2 and 3) are centred on the regulatory, cost and other relevant considerations of selecting a site for a radioactive waste management facility and of establishing and operating such a facility on the selected site to ensure that radioactive waste generated, possessed or controlled by the Commonwealth or a Commonwealth entity is safely and securely managed. The additional criterion 4, is driven by a commitment by successive ministers that the facility will be established in a community where there is broad community support.
Sorption	Absorption and adsorption considered as a single process (physical and chemical), by which one substance becomes attached to another.
Solar exposure (diffuse)	The total amount of solar energy falling on a horizontal surface from all parts of the sky apart from the direct sun. Different to global solar exposure which is the total amount of solar energy falling on a horizontal. Diffuse solar exposure is always less than or equal to the global exposure for the same period.
Storage	The emplacement of waste in a facility with the intent and in a manner such that it is being temporarily stored, and later can be retrieved.
Structural design life	The period over which a structure is expected to continue to perform its basic functions and beyond its intended operational life, even at a reduced level. It is also a measure of the useful life of a disposal structure.
Surface disposal	The disposal of radioactive waste in structures located above the natural ground surface and covered by layer(s) of natural and/or manufactured materials.
Surface engineered disposal facility	A disposal facility that is an engineered structure comprising vaults and cells that is located on a founding horizon at the surface.
T	
Traditional Owners	For the purposes of this report, this refers to Native Title holders near the: Lyndhurst site (the Barngarla People and the Gawler Ranges People), the Napandee site (the Barngarla People) and the Wallerberdina site (the Adnyamathanha People). The relevant registered Native Title bodies corporate (RNTBC) are the Barngarla Determination Aboriginal Corporation (BDAC), Gawler Ranges Aboriginal Corporation (GRAC) and the Adnyamathanha Traditional Lands Association (ATLA). Another relevant Traditional Owner organisation is the Viliwarinha Yura Aboriginal Corporation (VYAC).
U	

V	
Vault	A large engineered concrete disposal structure into which LLW waste packages are placed for disposal.
Vault complex	At the facility a group of approximately six (6) vaults used for disposal of LLW waste packages.
Volcanism	Various processes and phenomena associated with the surficial discharge of molten rock (magma), pyroclastic fragments, or hot water and steam.
W	
Waste Acceptance Criteria (WAC)	Quantitative and qualitative criteria specified by the facility operator and approved by the regulators (ARPANSA and, for nuclear material, ASNO), for radioactive waste to be accepted by the operator of a repository for disposal or storage.
Waste conditioning	Treatment operations that produce a stable waste form that together with the waste container/s, provides a waste package that is suitable for handling and storage and/or disposal. Conditioning may include the conversion of the waste to a solid waste form and enclosure of the waste in one or more containers. For waste transport, an additional overpack (an extra container) may be required until the waste is disposed or stored at the facility.
Waste package	The product of conditioning and placement in an approved container. A waste package is the combination of the waste form, any container(s) and internal barriers (e.g. absorbing materials and liner), as prepared in accordance with requirements for handling and storage or disposal.

Abbreviations

AECOM	AECOM Australia Pty Ltd
AEP	Annual Exceedance Probability
ACHA	Aboriginal Cultural Heritage Assessment
ANSTO	Australian Nuclear Science and Technology Organisation
ARPANS Act	*Australian Radiation Protection and Nuclear Safety Act 1998* (Cth)
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
ASNO	Australian Safeguards and Non-Proliferation Office
ATLA	Adnyamathanha Traditional Lands Association
ATSIHP Act	*Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth)
BDAC	Barngarla Determination Aboriginal Corporation
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CBP	Community Benefits Programme
CSM	Conceptual Site Model
DEM	Digital Elevation Model
DIIS	Department of Industry, Innovation and Science
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
FRC	Flinders Ranges Council
FTE	Full Time Employment
GRAC	Gawler Ranges Aboriginal Corporation
GRN	Ground Radio Network
GRP	Gross Regional Product
HWG	Heritage Working Group
HLW	High level waste
IAEA	International Atomic Energy Agency
ICP	Institutional Control Period
ILW	Intermediate Level Waste
LAA	*Lands Acquisition Act 1989* (Cth)
LLW	Low Level Waste
LYN	Lyndhurst site, near Kimba

Mining Act	*Mining Act 1971* (SA)
NAP	Napandee site, near Kimba
NVP	Newer Volcanics Province
NPW Act	*National Parks and Wildlife Act 1972 (SA)*
NRWMF	National Radioactive Waste Management Facility (the facility)
NRWM Act	*National Radioactive Waste Management Act 2012* (Cth)
ORIMA	Orima Research Pty Ltd
OCA	Outback Communities Authority
PGPA Act	*Public Governance, Performance and Accountability Act 2013* (Cth)
PMF	Probable Maximum Flood event
Prohibition Act	*Nuclear Waste Storage Facility (Prohibition) Act 2000* (SA)
RPS	RPS Group (global professional services firm)
SA	South Australia
Safeguards Act	*Nuclear Non-Proliferation (Safeguards) Act 1987* (Cth)
STEM	Science, Technology, Engineering and Mathematics
VHF	Very High Frequency
VYAC	Viliwarinha Yura Aboriginal Corporation
VSAT	Very Small Aperture Terminal
WAC	Waste Acceptance Criteria
WBD	Wallerberdina site, near Hawker, Flinders Ranges

Summaries of independent reports

During the site selection phase, the department commissioned independent reports covering a wide range of material including site physical characteristics, enabling infrastructure, Aboriginal cultural heritage and socio-economic impact to the communities.

The site suitability assessments against site selection criteria 1, 2 and 3 draw on the information in the independent reports and for ease of reference, a summary of each independent report is included below. Each summary identifies:

- the name and author of the independent report
- the reason for gathering information about the topic
- the preferred site characteristics
- the work completed to date
- limitations of the data
- site, community and district-specific information.

Each summary has been prepared by the department and reviewed by the independent report author. This public summary does not include information which is subject to legal privilege, Cabinet-in-Confidence, private or commercial-in-confidence, which was also considered by the former Minister.

Site physical characteristics

The following information summaries of the physical characteristics of the sites are based on preliminary studies conducted by AECOM, which were reported in the 2018 Site Characterisation Technical Reports and 2019 Technical addendums (see full reports at attachments E, F and G).

AECOM site definitions

- Nominated site: the site approved under the NRWM Act.
- 100 hectare site: the original indicative location for the facility selected for the studies to be undertaken.
  - The preliminary data collected to date (February to November 2018) is based on the 100 hectares identified in 2018 for the AECOM site assessment work.
- Revised site: the current portion of the nominated site (approximately 160 hectares) identified as the indicative location for the facility.
  - AECOM undertook further site assessment studies (from April to October 2019) to confirm the information gathered for the original 100 hectare sites were still applicable to the larger footprint of the approximately 160 hectare sites now chosen on each of the nominated sites.

Flora and fauna

Reason for gathering information:

To characterise flora and fauna present on and adjacent to the nominated site, identify any threatened ecological communities or threatened species12 and their supporting habitats which could preclude use of the nominated site for the proposed facility.

The EPBC Act, *Native Vegetation Act 1991* (SA) and the *National Parks and Wildlife Act 1972* (SA) (NPW Act) informed the assessments undertaken by AECOM.

Preferred site characteristics:

Absence of Commonwealth and South Australian-listed (state-listed) threatened species and supporting habitat, and limited requirement for vegetation clearance.

Work completed to date:

- Desktop assessment, including searches of federal and state databases, undertaken in February 2018 that included the site and a 10 kilometre radius area around the site.
- On-site field work assessment, including a preliminary field survey, undertaken in April 2018 to verify the desktop assessment and gather additional data. The field survey covered the 100ha area and approximately 1km surrounding the site.
- Additional targeted surveys were conducted in September 2018 (spring) focussed on assessing the presence/absence of Commonwealth and state-listed threatened species on the nominated sites and their surrounds. These surveys including the site, the nominated property, its immediate surrounds and in some cases a few locations adjacent to the local access roads

Limitations of the data:

A lack of rainfall at Wallerberdina limited the assessment of shrub diversity and composition. Assessment following further significant rainfall events at Wallerberdina will be required to be able to address this data gap and record any ephemeral flora species.
Further field surveys will be required to determine the presence and extent or likelihood of occurrence and significance of any potential impacts on the listed species.

[12] Commonwealth-listed threatened species include those categorised under the EPBC Act as extinct, extinct in the wild, critically endangered, endangered, vulnerable, and conservation dependent. State-listed threatened species include those categorised under the NPW Act as extinct, critically endangered, endangered, vulnerable and rare (near threatened) species.

Lyndhurst

- Minimal clearance of native vegetation will be required given the site has been used for cropping and only 7 per cent of the site contains native vegetation.
- No Commonwealth-listed threatened ecological communities are present within the nominated site or its surrounds.
- There is an area of high quality mallee scrub located approximately 1.5 kilometre north north-west of the site that is protected under a heritage agreement (between the land owner and the South Australian Government).
- The habitat within the site is unlikely to provide important habitat for Commonwealth or state-listed threatened flora and fauna species as the vegetation is fragmented.
- No Commonwealth-listed threatened fauna species were recorded within the site or are considered likely to occur (other than passing through the landscape). The Malleefowl, a Commonwealth-listed vulnerable species, has been identified as a possible species that may occur in the area surrounding the nominated site. There is evidence of the Malleefowl in the area surrounding the nominated the site, although the likelihood of its occurrence on the site is considered low. Further targeted surveys will be required to determine the likelihood of occurrence and significance of any potential impacts.
- No flora and fauna constraints were identified that would preclude the future development of the facility at the nominated site. This is based on the absence of any identified Commonwealth-listed threatened ecological communities on the nominated site and surrounds, no records of Commonwealth listed species present within the nominated site (or significant habitat to support such species).

Napandee

- Minimal clearance of native vegetation will be required given the site has been used for cropping and less than 5 per cent of the site contains native vegetation.
- No Commonwealth-listed threatened ecological communities are present within the nominated site or its surrounds.
- One flora species listed as rare under the NPW Act, the Ridged Noon-flower, was recorded in vegetation in the south-west corner of the nominated site (which sits adjacent to roadside vegetation) and in adjacent roadside vegetation. Further long-term field surveys will be required to determine the likelihood of occurrence and the significance of any potential impacts on the listed species.
- No Commonwealth-listed threatened fauna species were recorded within the nominated site, or are considered likely to occur (other than passing through the landscape) given the lack of suitable habitat. The Malleefowl, a Commonwealth-listed vulnerable species, has been identified as a possible species that may occur in the area surrounding the nominated site. Further targeted surveys will be required to determine the likelihood of occurrence and significance of any potential impacts. The state-listed rare Scarlet-chested Parrot was observed in the area surrounding the site during survey however the species is only expected to be present on an occasional and opportunistic basis within the remnant vegetation in the south western portion of the site.

- No flora and fauna constraints were identified that would preclude the future development of the facility at the nominated site. This is based on the absence of any identified Commonwealth-listed threatened ecological communities on the nominated site and surrounds, and no Commonwealth listed species present within the nominated site (or significant habitat to support such species).

Wallerberdina

- The site is covered by open chenopod shrubland which will need to be cleared to enable development of the facility.
- No Commonwealth-listed threatened ecological communities are present within the nominated site or its surrounds.
- No Commonwealth or state-listed threatened species were recorded within the nominated site or are considered likely to occur given the lack of suitable habitat.
- There are two state-listed threatened species, the Desert Lime (flora, vulnerable) and Elegant Parrot (fauna, rare), that have been recorded in the broader area beyond a 10 kilometres radius around the site. There is no habitat present within the Wallerberdina site that is considered to be of importance for these species so the likelihood of occurrence is considered low.
- A lack of rainfall prior to surveys at Wallerberdina limited the assessment of shrub diversity and composition. Further surveys following significant rainfall events at Wallerberdina will be required to be able to address this data gap and record any ephemeral flora species that may be present. This is not considered a significant limitation due to the lack of identification of any expected annual species through desktop assessment.
- No flora and fauna constraints were identified that would preclude the future development of the facility at the nominated site. This is based on the absence of any identified Commonwealth-listed threatened ecological communities on the nominated site and surrounds, and absence of any listed species within the nominated site (or suitable habitat to support such species).

Conservation and special use areas

Reason for gathering information:

To identify any conservation or recreational parks in close proximity to the nominated site, and any Aboriginal cultural heritage or state and local-listed heritage sites which could preclude use of the site for the proposed facility. The NPW Act and *Heritage Places Act 1993* (SA) informed assessments undertaken by AECOM.

Preferred site characteristics:

Absence of parks (national parks, conservation parks, conservation reserves, recreational parks, wilderness protected areas and Native Vegetation Heritage Agreements) and Aboriginal or state and local heritage sites on or adjacent to the site.

Work completed to date:

Desktop assessment including review of registered parks and land uses.

Limitations of the data:

No known limitations.

Note:

A separate Aboriginal cultural heritage information summary (p. LI) has been prepared based on two reports prepared by RPS: the *Kimba Aboriginal Heritage Desktop Assessment Report* and the *Wallerberdina Aboriginal Cultural Heritage Report*. The Aboriginal cultural heritage summary addresses Native Title considerations, potential archaeological sites and research, cultural practices, connection to Country and recommendations for continued Traditional Owner engagement.

Once a site has been acquired, a comprehensive archaeological investigation and consultation with the relevant Traditional Owners will be required to fully assess the cultural values that may be impacted and to develop an Aboriginal Cultural Heritage Management Plan.

Lyndhurst

- No identified registered Aboriginal heritage sites or state or local heritage sites are present on site or within a 10 kilometres radius of the site.
- Five areas of native vegetation conserved under heritage agreements are present within 5 kilometres of the site, including the area of mallee vegetation located around 1.5 kilometres north north-west of the site (see flora and fauna summary, p. XVII].
- Lake Gilles Conservation Park is located approximately 4 kilometres north to north-east from the site.
- Any future facility development on this site is unlikely to be restricted based on conservation or special use areas.

Napandee

- No identified registered Aboriginal heritage sites or state and local heritage sites within the site or within a 10 kilometre radius of the site.
- Pinkawillinie Conservation Park is 2 kilometres south of the site.
- Any future facility development on this site is unlikely to be restricted based on conservation or special use areas.

Wallerberdina

- No national or state conservation parks and reserves near the site or the nominated property.
- Twenty-six registered and three restricted Aboriginal heritage sites are located in the local area, but well separated from the site. For example, Hookina Spring and Hookina Waterhole are located around 8 and 12 kilometres respectively from the site, adjacent to Lake Torrens Road which is the designated local access road. Refer to the separate Aboriginal cultural heritage information summary (p. LI) for further details.
- Any future facility development on this site is unlikely to be restricted based on conservation or special use areas.

Bushfire risks

Reason for gathering information:

To characterise the extent to which local bushfire risk is increased by vegetation/fuel hazard and other potential sources for ignition including: site slopes, bushfire weather frequency/severity, and the likelihood and nature of the bushfire impact.

Australian Standard (AS) 3959-2009 *Construction of buildings in bushfire-prone areas,* South Australian Government Department of Environment, Water and Natural Resources, 2012 *Overall Fuel Hazard Guide for South Australia*, informed assessments undertaken by AECOM.

Preferred site characteristics:

A combination of climatic conditions, fuel loadings, topography and ability to create buffers which minimises the risk and potential severity of bushfires and allows for sufficient setbacks/buffers to meet the Australian Standard for building in bushfire prone areas.

Work completed to date:

Desktop assessments including a review of the topography from LiDAR (Light Detection and Radar) data, mapped vegetation from desktop and field work, and weather and climatic conditions.

Limitations of the data:

Assessment of bushfire risk was carried out for the original 100 hectare site, completed without reference to site-specific facility designs and layouts, which will be considered post-site selection. The assessment of bushfire risk shall be updated for the revised site area for the selected site.

Lyndhurst

- An extensive area of Mallee woodland and shrubland vegetation is located 1.5 kilometres north of the revised current approximately 160 hectare site which is located south of the original 100 hectare site. Mallee woodland and shrubland are recognised as the most highly flammable and fire prone plant communities of all plant communities in semi-arid and arid zones. The site could be exposed to large, intense and fast moving fire from this area. The site is also surrounded by cropping land.
- The site vegetation includes cropping land and a few small areas of tree and shrub vegetation which are greater than one hectare in size.
- The nominated site is not unduly impacted by bushfire hazards, including fuel load from surrounding vegetation (including the large area of mallee woodland 1.5 kilometres north north-west of the site) and site vegetation, if appropriate low threat setbacks are established for development of the site.
- Bushfire risk will also be mitigated through detailed bushfire risk assessments of the site and proposed infrastructure with setbacks being determined based on asset vulnerability to bushfire attack, building design measures, and the level of provision of firefighting infrastructure.
- There is sufficient space to allow for necessary setbacks/buffers to meet the Australian Standard for building in bushfire prone areas.

Napandee

- The site and surrounding vegetation is predominantly cropping and grazing land. Tree and shrub vegetation is present along the road to the west of the site and in small patches on the site, however it is unlikely to sustain a wide fire front.
- The nominated site is not unduly impacted by bushfire hazards if setbacks/areas of cleared vegetation are established around assets, commensurate with asset vulnerability to bushfire attack, building design measures, and provision of firefighting infrastructure. There is sufficient space to allow for necessary setbacks/buffers to meet the Australian Standard for building in bushfire prone areas.

Wallerberdina

- The bushfire hazard at this site is low due to the benign topography and lower-hazard nature of the predominantly open shrubland vegetation on and around the site.
- Bushfire risk could be readily mitigated by implementing appropriate setbacks and buffer areas from vegetation and through building design measures.

Hydrology and flood risks

Reason for gathering information:

Assess the potential for localised flooding, episodic major flooding and/or the sudden change in landform (avulsion) from upstream catchments, both now and in the future as a result of climate change, which could impact safety, operations and site access without mitigation.

The International Atomic Energy Agency (IAEA) SSG-18 Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations (2011) and Australian Rainfall and Runoff (ARR): A Guide to Flood Estimation (Geoscience Australia, 2016), informed assessments undertaken by AECOM.

This information summary is relevant to the 'climatic conditions and climate change' (p. XXXVIII) and 'geology and hydrogeology, and soil, geochemistry and geotechnical considerations' (p. XXIX) information summaries.

Preferred site characteristics:

Minimal catchment areas and watercourses draining into the site, an absence of non-absorbing (hydrophobic) soils, high soil conductivity rates (indicator of soil health), and fewer lower intensity rainfall events.

Work completed to date:

A desktop assessment was completed, covering rainfall depth and intensity, topography (for example; watercourses, terrain elevation (from LiDAR surveys) and satellite and aerial photography) and available anecdotal flood information or previous flood studies.

The potential impacts associated with localised and catchment scale flooding were assessed through the development of a hydrological model for each site and the conduct of predictive flood modelling for events ranging from frequent to very rare in occurrence. The assessment considered not only potential for inundation of the site but also the potential for site access via local roads to be impacted during potential flooding events. The impact of climate change (in particular an increase in rainfall intensity during flood events) was assessed through flood modelling the 2090 predictions for comparison against model outputs under current conditions.

Limitations of the data:

Modelling at Wallerberdina was limited by a lack of available data for the 1955 and 2007 flood events limited calibration and verification of the hydrological and hydraulic models.

The predictive flood modelling is limited by the accuracy and uncertainty of the terrain, inflow and other data. Whilst terrain data has been captured for a large area surrounding the sites (LiDAR survey with vertical accuracy of 0.1m), the available terrain data (SRTM, vertical accuracy in metres) of the broader local and regional catchments that contribute to flood risk at the site or along local access routes is of much lower accuracy.

LiDAR data was captured along the entire route of local access roads from the highway to the Wallerberdina site. LiDAR data along the route of local access roads at the Napandee and Lyndhurst sites was captured in an area limited to small sections closer to the site and thus only lower accuracy terrain data (SRTM, vertical accuracy in metres) was used to conduct the flood modelling along most of the length of the local access routes. The flood modelling along the Napandee and Lyndhurst local access road therefore only provides an indication of the potential broad zones which might be subject to flooding but does not currently provide reliable data regarding the level of inundation.

The predictive flood modelling for the sites is based both on current site terrain information and estimated surface flow paths. Further flood modelling will need to be undertaken upon completion of a concept design for the facility on the selected site and design updates for any upgrades to local access roads.

The predictive flood modelling that incorporates climate change impacts includes predictions which extend to 2090, which does not extend across the entire assumed operational period of the facility of 100 years nor does it include the subsequent period required for post-closure monitoring.

Lyndhurst

- There are no creek lines (lines that usually flow) in the local area (within 10 kilometres of the site). Drainage lines (lines that can flow after rainfall) exist through the site. The topography of the site is undulating and forms areas of low-lying land that has the capacity to capture flood waters that enter the site.
- Flood modelling indicates significant flooding within sections of the site originating from the small local upstream catchment at the south-east of the site. Estimated depths of water reach a maximum of 3.6 metres (1 in 100 annual exceedance probability: AEP flood event) within a few hours of the storm event and is concentrated in the low-lying areas of the site where it will pond and slowly recede (via infiltration).
- Access to the site is expected to be impacted at several locations in more frequent 1 in 5 AEP flood events. Additional terrain data with high vertical accuracy (e.g. LiDAR survey) will needed to undertake flood modelling that provides more accurate predictions of flow paths and the depth of inundation at specific points along the local access roads.
- The site is not inundated by flooding from the extensive regional catchment floodplain to the north and north-west that conveys regional flood flows to Lake Gilles (4 kilometres to the north north-east) as the site is located on elevated ground compared to the surrounding floodplain.

Napandee

- There are no creek lines in the local area (within 10 kilometres of the site), however drainage lines exist in the vicinity of the nominated site, and local drainage paths exist through the site.
- A large regional catchment (upstream, approximately 150 square kilometres) drains past the south-western corner of the nominated site. The site is located on elevated ground compared to the catchment floodplain and is not inundated by such floodwaters.
- Flood modelling indicates that flooding on the site is contained within the localised drainage paths that exist in and surrounding the site. The predicted depth of flood water is up to 0.7 metre on the site during a 1 in 100 AEP flood event which occurs within a few hours of the storm event, receding in a similar timeframe after. Small amounts of ponding are indicated across the southern boundary of the site, along Tola Rd. The maximum depths of flood water reach 1 metre on the site in a probable maximum flood (PMF) flood event.

- At a 1 in 5 AEP flood event, flood water is expected to recede shortly after the event. Additional terrain data with high vertical accuracy (e.g. LiDAR survey) will need to be undertaken to provide accurate predictions regarding the depth of inundation at specific points along the local access roads during flood events.

Wallerberdina

- Hookina Creek passes through and outside the southern edge of nominated site at Wallerberdina and passes within 2.5 kilometres of the site, with a tributary located 1.5 kilometres east of the site.
- Hydrological modelling indicates that the site is subject to shallow flooding from local catchments in smaller, localised flood events. Flood water that overtops the banks of Hookina Creek contributes to flood waters on the site during rarer flood events (greater than 1 in 200 AEP).
- The highest predicted depth of water produced from the smaller flood events from local catchments is up to 0.3 metre in a 1 in 100 AEP flood event, 0.5 metre at a 1 in 200 AEP flood event, and up to 2.5 metres in a PMF flood event. Maximum depths are expected within a few hours of the event and will recede within a day of the end of the event.
- Flood water is predicted to reach up to 3.8 metres depth along the access roads during more frequent 1 in 5 AEP flood events but recedes shortly thereafter.

Impact of nearby human activities and land use planning

Reason for gathering information:

Identifying existing and potential future land uses in proximity to the nominated site (sensitive land uses, extractive or hazardous activities) that may adversely impact on the site or be impacted by the establishment of the facility.

The IAEA Safety Requirements No. NS-R-3 (Rev. 1) *Site Evaluation for Nuclear Installations* (2016) and the *Kimba Council Development Plan* (consolidated 25 October 2012) informed assessments undertaken by AECOM.

Preferred site characteristics:

Minimal sensitive land uses such as residences and community facilities in close proximity to the nominated site, and suitable buffer distances from the nearest sensitive land uses.

No or minimal competing land uses (for example, mining tenements, hazardous facilities, and airfields) close to the nominated site which could adversely impact the safety or operations at the facility.

Work completed to date:

A desktop assessment was undertaken including a review of relevant publicly accessible databases, planning documents and property information.

Limitations of the data

The likelihood of development of adjacent mining tenements in some areas is unknown. Further review of flight paths, runway orientation and crash data is required.

Lyndhurst

- The nominated site is well separated from adversely affecting development and sensitive land uses.
- The surrounding land zoning, the physical characteristic of land within the locality, and the declining population trend, suggest the likelihood of development of any intensive residential or urban development in proximity of the site in the future would be low.
- There are a number of mineral tenements close to the site. If the tenements located off-site proceed to production, the associated activities may have the potential to impact the facility or its enabling infrastructure.
- The nominated site lies in the vicinity (8 kilometres) of the Kimba Aerodrome (Civil Aviation Safety Authority registered). The IAEA guidelines indicate any adverse impact of off-site installations should be evaluated and that a site should be considered less suitable where present or future activities could create significant release pathways between the waste and the biosphere. For an airport, this could arise via an accident or a security incident of a plane crashing into or near the facility area. Acquisition of the site by the Commonwealth would extinguish the tenements on the site.

Napandee

- The site is well separated from adversely affecting development and sensitive land uses.
- There are a number of mineral tenements close to the site. If the tenements located off-site proceed to production, the associated activities may have the potential to impact the facility or its enabling infrastructure.
- Acquisition of the site by the Commonwealth would extinguish the tenements on the site.

Wallerberdina

- The site is well separated from adversely affecting development and sensitive land uses.
- There are a number of mineral and geothermal tenements over and within close proximity to the site. If the tenements located off-site proceed to production, the associated activities may have the potential to impact the facility or its enabling infrastructure.
- Acquisition of the site by the Commonwealth would extinguish the tenements on the site.

Geology and hydrogeology, and soil, geochemistry and geotechnical considerations

Reason for gathering information:

Characterise the sub-surface environment to determine the following characteristics:

- the distribution and movement of groundwater (hydrogeological)
- the chemical composition and interactions (geochemical)
- the physical structure, strength and characteristics (geological and geotechnical).

These characteristics may have an impact on design and construction (in particular, foundations and disposal vault design), the cost of construction, the safety case or the strategy for providing utilities to the site.

Standards and guides, including AS 1726:2017 *Australian Standard Geotechnical Site Investigations*, AS 1289 series *Australian Standard Method of testing soils for engineering purposes*, AS/NZS 5667.1:1998 *Water quality — Sampling Guidance on the design of sampling programs, sampling techniques and preservation and handling of samples*, and the National Uniform Drillers Licensing Committee (NUDLC) *Minimum Construction Requirements for Water Bores in Australia Version 3* (February 2012) informed assessments undertaken by AECOM.

Preferred site characteristics:

- deep water table
- low potential for vertical or horizontal migration of water through underlying soil
- presence of subsurface material with properties that limit water flow
- limited or no groundwater users
- absence of geotechnical hazards such as the potential for slope instability and/or erosion, soil liquefaction, collapsing or expansive soils, subsidence due to ground features or long-term settlement
- subsurface conditions that will support an efficient foundation/footing design.

Work completed to date:

Desktop assessment including review of publicly available datasets, including the natural resource management setting for the site (such as potential groundwater use).

A drilling and test pitting programme was carried out in 2018. Boreholes were converted into groundwater bores. Soil and groundwater samples were collected and analysed by laboratories.

A subsequent test pitting and drilling program was completed in 2019 due to fill data gaps due to relocation of the Lyndhurst site to the south of the nominated property and a change in shape and increase in area of the Napandee site. The 2019 intrusive works included four new boreholes and four new test pits at Lyndhurst and one new borehole and two new test pits for Napandee.

No additional intrusive works were undertaken in 2019 on the revised Wallerberdina site. Subsurface data is yet to be obtained in the southern portion of the site (formed due to the increased site area).

Limitations of the data:

Investigations to date have been preliminary only and further drilling and testing will be required to further characterise the site to input into the design, safety case and environmental approvals.

A preliminary subsurface conceptual site model (CSM) was prepared for each of the sites which considers the site, local and regional setting, and the subsurface conditions which influence the fate and transport of a contaminant release, and the potential receptors that could be impacted.

Lyndhurst

- Groundwater in the water table aquifer was found to be present at depths generally exceeding 10 metres below ground surface. Groundwater is estimated to move very slowly beneath the site, and is expected, but yet to be confirmed, to discharge to salt lakes to the north and north-east of the site, which form part of the Lake Gilles complex.
- Groundwater was found to be of very limited beneficial use (for instance, cannot be drunk or used for irrigation) due to its high salinity and low yield. There are no known groundwater bores in the local area from which water is being abstracted for a beneficial use.
- Investigations suggest there is limited connectivity between the water table and deeper aquifers which would prevent transport of contaminants between these layers.
- The subsurface kaolin clays may limit the transport of radionuclides in the unlikely event of a subsurface release of waste material. Extent, thickness and continuity of clays is currently unknown.
- Preliminary soil testing indicates that geological hazards and foundation stability (such as slope instability or soil liquefaction) are unlikely to be present at the site.

Napandee

- Groundwater in the water table aquifer was found to be present at depths exceeding 24 metres below ground surface, which provides separation between the facility foundations and the water table in the unlikely event of a subsurface release of waste material (for instance, radionuclides).Groundwater is estimated to move very slowly beneath the site , and is expected, but yet to be confirmed, to discharge to salt lakes to the far west and north-west of the site at distances at least in excess of 50 kilometres.
- Groundwater was found to be of very limited beneficial use (for instance, cannot be drunk or used for irrigation) due to its high salinity and low yield. There are no known groundwater bores in the local area from which water is being abstracted for a beneficial use.
- An unregistered bore was found on site with remnants of storage infrastructure, however it has been abandoned.
- The subsurface kaolin clays may limit the transport of radionuclides in the unlikely event of a subsurface release of waste material.
- Preliminary soil testing indicates that geological hazards and foundation stability (such as slope instability or soil liquefaction) are unlikely to be present at the site.

Wallerberdina

- Groundwater was found to be present at depths greater than 20 metres below surface, which provides separation between the foundations of the facility and the water table in the unlikely event of a subsurface release of waste material (for instance, radionuclides).
- The groundwater was found to be potentially usable for a range of uses including abstraction for use on the facility. Groundwater is currently used within Wallerberdina Station and the surrounding stations for stock watering, although of a salinity that is not considered suitable for drinking.
- Preliminary soil testing indicates that geological hazards and foundation stability (such as slope instability or soil liquefaction) are unlikely to be present at the site.

Landform stability

Reason for gathering information:

Identify if there is the potential for geomorphological processes, including fluvial (deposits made by rivers/stream), aeolian (wind) or slope/mass movement with the potential to impact on long term site stability, including consideration of how other characteristics (overland flow, soils, flooding etc.) may influence this.

Preferred site characteristics:

Long-term stable landform, and minimal potential for slope or mass movement processes.

Work completed to date:

A desktop assessment including: a review of published topographic maps, digital elevation models (DEMs), published geological mapping, aerial imagery, subsurface data from bores and test pits, relevant geomorphological literature and other factors was undertaken during the study. A field inspection was also undertaken.

To assess the risk of a change in the course (avulsion) of Hookina Creek towards the Wallerberdina site, a scenario in which a blockage occurs in the main channel causing increased flows via an existing breakout channel was run through the predictive flood model.

Limitations of the data:

The hydraulic model used for the Wallerberdina site is a fixed-bed model and thus assumes no changes in channel or floodplain topography from avulsion nor simulates scour behaviour from an avulsion.

The geomorphological assessment is based on the current site terrain and not a concept design for the facility that includes cut and fill works, and the potential establishment of infrastructure that may divert and concentrate surface waters within or around the site.

Lyndhurst

- The shoreline of Lakes Gilles is substantially lower than the site and hence the potential for shoreline erosion to impact the site) is unlikely.
- The velocity and shear strength of flood waters over undulating ground is relatively low even during rare, more extreme flood events and thus unlikely to result in slope and mass movement of soil over the site.

Napandee

- The site is situated on dunes which appear to have formed during a Quaternary period of greater aeolian (wind) activity. The dunes remain potentially susceptible to further wind or water erosion, particularly if the vegetation cover is disturbed
- The velocity and shear strength of flood waters over the site is low and therefore there is a low risk of water erosion and mass movement of soil to impact the site during such events.

Wallerberdina

- The site is situated on the Hookina Creek alluvial fan. It is subject to changes resulting from rare infrequent major flood events such as change in course or avulsion of the creek lines in the local area (either further away from or closer to the site), creek bank erosion and channel migration, and the deposition of sediment of scouring of the floodplain. The site is also likely to be impacted by the deposition of wind-blow sand from nearby dune fields during extended dry periods.
- To assess the risk of a change in the course (avulsion) of Hookina Creek towards the Wallerberdina site, a scenario in which a blockage occurs in the main channel causing increased flows via an existing breakout channel was run through the predictive flood model. It was established that only in a very rare 1 in 10000 AEP flood event would the stream power along the breakout channel, 300 W/m^2, be considered sufficient by Yochum et al. 2017 (i.e. above 230 W/m^2) to represent a credible risk of avulsion.

Seismic activity

Reason for gathering information:

To characterise potential seismic hazards with an emphasis on active faults beneath or near the site, near surface faults, and the presence of ridge crests in the site vicinity (as a result of uplift). This includes the identification of the potential for ground movement and the expected peak ground accelerations to be used in design of the facility.

The IAEA SSG-9 *Seismic Hazards in Site Evaluation for Nuclear Installations* (2010), together with relevant peer-reviewed technical information listed in the methodology and scope of the commissioned AECOM reports and other referenced IAEA documents, informed assessments undertaken by AECOM.

Preferred site characteristics:

Absence of potentially active faults that could cause surface faulting through the facility site, near-surface faults that could cause folding or other deformation within the facility site, nearby faults that could cause hanging wall or rupture directivity effects which amplify ground motions, and ridge crests which amplify ground motions, together with generally low potential for ground motion.

Work completed to date:

The desktop assessment included a review of published reports and the collection of data from accessible databases and historical records, including the Geoscience Australia earthquake catalogue.

On-site field work at Wallerberdina included geophysical acquisition of two shallow seismic reflection profiles within the original 100ha site together with a preliminary interpretation of the results.

Limitations of the data:

The location of the major fault expected to be present near the Wallerberdina site was not located during the seismic survey completed across the original 100ha site. Further seismic surveying and analysis would need to be undertaken to locate the range-front should the Wallerberdina site be selected. This would determine the likely impact of any seismic event on ground motion and to inform design parameters.

Additional seismic survey data will also need to be obtained on the selected site within any areas not covered by the previous survey in which radioactive waste storage and disposal infrastructure is proposed to be located.

Lyndhurst

- The data indicates no potentially active faults in the foundation, and no near-surface faults beneath or near the foundation or in the nearby area (excluding the possibility of one-off faulting) of the location of the original 100 hectare site. The revised approximately 160 hectare site was relocated to the south of the approved site.

Napandee

- The data indicates no potentially active faults in the foundation, and no near-surface faults beneath or near the foundation or in the nearby area (excluding the possibility of one-off faulting) of the original 100 hectare site.

Wallerberdina

- The seismic data collected during the site field surveys has not identified any potentially active faults in the foundation beneath the original 100 hectare site, but there is potential for near-surface faults beneath or near the foundation.
- The Western Range range-front faults (which are east of the nominated site) are anticipated to be adjacent to the nominated site. The exact location of the range-front faults has not been defined; further assessment would be required.
- Seismic hazards from ground shaking and deformation would need to be considered in facility design and implementation of structural engineering measures drawn from industry standards and methods.

Background radiation

Reason for gathering information:

To establish a baseline for future environmental radiation monitoring (to inform possible licence applications), and to identify potential elevated background radiation conditions that could affect safety of personnel.

The International Atomic Energy Agency (IAEA) IAEA-TECDOC-1363 *Guidelines for radioelement mapping using gamma ray spectrometry data* and the IAEA Safety Requirements No. NS-R-3 (Rev. 1) *Site Evaluation for Nuclear Installations* informed the assessments undertaken by AECOM.

Preferred site characteristics:

Background radiation levels within the ARPANSA action levels.

Background radiation levels that are not elevated and will not impact the effectiveness of environmental monitoring.

Work completed to date:

- For Lyndhurst and Napandee, reviews of published historical data and targeted intensive aerial radiometric surveying.
- For Wallerberdina, a review of published historical radiometric aerial survey data on a 200 metre grid.

Limitations of the data:

The data has a coarse level of detail, being derived from an aerial survey and published records. As part of the next stage of works, ground truthing (direct, on-site observation) of the results is required to map the specific radiation profile of the site.

Lyndhurst

- Results from published and collected data do not indicate the presence of elevated background radiation levels.
- As part of the next stage of works, ground truthing of the results is required to map the specific profile of the site.

Napandee

- Results from published and collected data do not indicate the presence of elevated background radiation levels.
- As part of the next stage of works, ground truthing of the results is required to map the specific profile of the site.
- Traces of thorium were discovered to the east of the site during aerial surveying. Thorium is a naturally occurring heavy metal that undergoes long-term radioactive decay, and as such it is expected to have negligible impact on the site background radiation levels to be used for monitoring.

Wallerberdina

- Results from published and collected data do not indicate the presence of elevated background radiation levels.
- The data has a coarse level of detail, being derived from an aerial survey and published records. As part of the next stage of works, ground truthing of the results is required to map the specific profile of the site.

Climatic conditions and climate change

Reason for gathering information:

To establish existing climatic conditions for the site based on historic averages, identify any likely changes to climate, and identify the resulting climate-related hazards that could impact on the facility and its workers.

Australian Standard (AS) 5534-2013 *Climate change adaptation for settlement and infrastructure — A risk based approach*, and the IAEA Specific Safety Guide No. SSG-18 *Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations* informed assessments undertaken by AECOM.

This information summary is relevant to the hydrology and flood risks information summary (p. XXIV).

Preferred site characteristics:

Projected climate conditions where the frequency and intensity of climatic events has minimal impact upon the site and facility, or where design intervention can reasonably mitigate risks.

Work completed to date:

- A desktop assessment, including obtaining and analysing data from the closest weather station and collation of historical climate data from the Bureau of Meteorology (BoM).
- Identification of relevant climate hazards.
- Collation of climate projections from the *Climate Change in Australia Technical Report* (CSIRO/BoM, 2015).

Limitations of the data:

Climate projections are inherently uncertain due to limits in the theoretical understanding of the Earth's climate. Historical records and trends can be extrapolated but do not necessarily provide a high level of certainty.

Lyndhurst

- The site has low annual rainfall (347 millimetres) predominately during winter and spring, with a mild annual average daily maximum temperature (23.6 degrees Celsius), but with an average of 20 days over 35 degrees Celsius, with the highest recorded temperature of 46 degrees Celsius.
- Climate projections indicate hotter and drier conditions, with higher intensity rainfall events.

Napandee

- The site has low annual rainfall (347 millimetres) predominately during winter and spring, with a mild annual average daily maximum temperature (23.6 degrees Celsius), but with an average of 20 days over 35 degrees Celsius, with the highest recorded temperature of 46 degrees Celsius.

- Climate projections indicate hotter and drier conditions, with higher intensity rainfall events.

Wallerberdina

- The site has low annual rainfall (308 millimetres) predominately during winter and spring, with a mild annual average daily maximum temperature (25.2 degrees Celsius), but with an average of 20 days over 35 degrees Celsius, with the highest recorded temperature of 46 degrees Celsius.
- Climate projections indicate hotter and drier conditions, with higher intensity rainfall events.

Enabling infrastructure

The following enabling infrastructure information summaries are based upon three February 2019 Enabling Infrastructure Design Works Reports prepared by AECOM.

Road transport to site

Reason for gathering information:

To facilitate the effective operation of the facility, a network of local roads is required to support the movement of LLW and ILW from the national highway network (National Land Transport Network) to the facility.

Access to the site for the TN 81 containers (approximately 150 tonnes), being the potentially largest and heaviest movement of radioactive waste for the facility, was considered. This helped develop a strategy for the efficient movement of the waste, considering the overall complexity of the movement which is influenced by the route itself.

The IAEA SSR-6 *Regulations for the Safe Transport of Radioactive Material* (2018), the ARPANSA *Australian Code for the Transport of Dangerous Goods by Road & Rail* (2017), various codes and guides (South Australia) for dangerous goods transport, and other relevant Australian Standards for design of roads, informed assessments undertaken by AECOM.

Preferred site characteristics:

- Major highway access from waste sources around Australia.
- A good local access road network with minimal upgrade requirements and potential for multi-modal transport options to the site.
- Spatial capacity to upgrade roads, if required, to suit the expected volume of traffic.
  - It is noted that rail and port access were also considered, but not in a primary sense, due to the dispersed locations of waste sources around Australia.

Work completed to date:

A desktop assessment of the likely paths of travel for waste from the largest waste holders (CSIRO and ANSTO) and capital cities to the sites, including a review of the National Land Transport Network and other modes of transport (sea and rail). A desktop assessment of the local access roads from the closest point of the National Land Transport Network to the site was completed, including a review of the road reserve width and horizontal and vertical alignment. On-site field work included inspection and video recordings of the local access routes to the site.

Limitations of the data:

The extent of survey information on the road network is limited at this stage of the project. Further work such as survey, service identification, storm-water and 3D design for the road access will be undertaken post site selection. Subsurface and surface conditions that may affect the design and construction of the access road will be investigated and considered in more detail post-site selection.

Lyndhurst

- The Lyndhurst site is located approximately 15 kilometres north-east of the Kimba township.
- The National Land Transport Network (Eyre Highway) passes within approximately 16 kilometres of the Lyndhurst site.
- Additional classified information on transport and communications was also considered.

Napandee

- The Napandee site is located approximately 20 kilometres west of the Kimba township.
- The National Land Transport Network (Eyre Highway) passes through the Kimba township and within approximately 23 kilometres of the nominated site.
- Additional classified information on transport and communications was also considered.

Wallerberdina

- The Wallerberdina site is located approximately 30 kilometres north-west of the Hawker township.
- The National Land Transport Network (The Outback Highway) passes through the Hawker township and within approximately 26 kilometres of the nominated site.
- Additional classified information on transport and communications was also considered.

Power supply to site

Reason for gathering information:

The facility requires electrical power for operation. Provision of this power for site requirements is required either from the National Electricity Market (grid) or by power generated on site.

The cost of providing a power supply to the site is a key consideration in the overall facility costs.

Various Australian Standards for building and construction informed assessments and design undertaken by AECOM.

Preferred site characteristics:

Access to high voltage power lines with sufficient capacity to service the demands of the site and with a suitable level of reliability inherent in the system.

For on-site generation, access to an area sufficiently large enough to facilitate the placement of a solar array and with little to no overshadowing by local features, to ensure the access to solar energy is maximised.

Work completed to date:

A desktop assessment including discussions with energy companies, reviews of available data on the local electricity networks, and modelling and preliminary design works for solar.

Limitations of the data:

Load profiles of the facility are not yet established, and specific power quality requirements have not been defined. Planning estimates have been developed in line with the concept design phase. An assessment of the potential to export solar-generated electricity has not been undertaken. No assessments have been made to provide power to the surrounding area outside the nominated sites.

Lyndhurst

- The nominated site is approximately 55 kilometres from the closest transmission substation and approximately 45 kilometres from any transmission line (132 kilovolt). Most of the region is serviced by a single-phase network, which is not suitable to supply power to the nominated site and the site requires connection to a substation or medium voltage grid connection.
- The closest substation is approximately 18 kilometres from the nominated site and provides an 11 kilovolt supply to the area. A power supply option is the connection to the 11 kilovolt substation via a new 20 kilometre power line, with an upgrade of the substation required and multiple regulator stations along the power line due to the long distance and potential for voltage drops. This presents reliability issues with the 11 kilovolt supply option. A micro-grid could be coupled with this connection.
- The development of an on-site micro-grid, to meet site-facility demands only, was assessed to address the lack of access to existing power infrastructure.

Napandee

- The nominated site is approximately 65 kilometres from the closest transmission substation and approximately 50 kilometres from any transmission line (132 kilovolt). Most of the region is serviced by a single-phase network, which is not suitable to supply power to the nominated site and the site requires connection to a substation or medium voltage grid connection.
- The closest substation is approximately 22 kilometres from the nominated site and provides an 11 kilovolt supply to the area. A power supply option is the connection to the 11 kilovolt substation via a new 20 kilometre power line, with an upgrade of the substation required and multiple regulator stations along the power line due to the long distance and potential for voltage drops. A micro-grid could be coupled with this connection.
- The development of an on-site micro-grid, to meet site-facility demands only, was assessed to address the lack of access to existing power infrastructure.

Wallerberdina

- The Wallerberdina nominated site is adjacent to a 132 kilovolt above-ground transmission line that connects from Leigh Creek to Neuroodla.
- The proximity of this high voltage line is favourable for a connection to a high reliability power source.
- The existing line has capacity to service the expected demand for the facility, with the closure of the Leigh Creek Coal Mine in 2015 reducing the existing load significantly.
- A substation would need to be constructed for the facility as part of grid connection to reduce the voltage supplied to the nominated site.

Water supply to site

Reason for gathering information:

The facility requires a reliable water supply to facilitate the effective handling and processing of material, and for ongoing operations at the site.

Preferred site characteristics:

The supply of water to the site to the boundary for potable and non-potable purposes from a reliable source, preferably via mains supplied water or a suitable underground aquifer. The water needs to be of sufficient capacity and quality to meet facility demand.

Relevant Australian Standards including AS 3500.1:2018 *Plumbing and drainage — Water services,* informed assessments undertaken by AECOM.

Work completed to date:

- A desktop assessment including the review of borehole records, local geological conditions and discussions with water supply authorities.
- On-site field work including drilling and placement of new groundwater monitoring bores, sampling and testing of any water present and assessment of the potential for that water to be a source for the site. This work was completed through the siting assessment hydrogeological investigation.
- Preliminary design and costing of solutions to provide water to the site.

Limitations of the data:

For the Lyndhurst and Napandee sites, the exact connection point to the existing SA Water network and vertical alignment (depth and profile of depth along the pipeline) of the water supply route are unknown. Flow, pressure and quality have not been fully tested and capacity has been derived from discussions with the supply authority only.

For the Wallerberdina site, the long term drawdown impacts on the local groundwater sources will require further review during the concept and detailed design phases. No assessments have been made to provide water to the surrounding area outside the nominated sites.

Lyndhurst

- There is no existing water supply to the Lyndhurst nominated site. Groundwater in the area is saline and would require significant treatment for the supply to be suitable for potable usage.
- There is an existing water mains along the southern boundary to the nominated site, but it would not have the capacity to support the required demand for the nominated site.
- Supply options include a new 9 kilometre pipeline to the site from the supply on Wilcherry Road, connection to the Iron Knob to Kimba pipeline located 10 kilometres to the south of the site or connection to the Kimba tanks.
- The preferred option to address water requirements for the site includes a new supply main, connecting downstream of the existing Kimba tanks. This option would require the construction of approximately 18 kilometres of new pipe work from the tanks to the site and would provide the best security of supply.

Napandee

- There is no existing water supply to the Napandee site. Groundwater in the area is saline and would require significant treatment for the supply to be used for potable usage.
- There is an existing water main north and east of the site, while likely to provide sufficient capacity, it is made with asbestos cement piping which presents a risk to reliability of supply and longevity.
- Supply options include a new 6 kilometre pipeline to the site from the supply from the existing local network, connection to the Iron Knob to Kimba pipeline located 24 kilometres to the east of the site or connection to the Kimba tanks.
- The preferred option to address water requirements for the site includes a new supply main, connecting downstream of the existing Kimba tanks. This option would require the construction of approximately 24 kilometres of new pipe work from the tanks to the site and would provide the best security of supply.

Wallerberdina

- There is no reticulated water infrastructure at or adjacent to the nominated site. The nearest reticulated water infrastructure is located approximately 37 kilometres from the nominated site in the Hawker township, which comprises of a treated groundwater supply.
- A review of groundwater at the nominated site indicates that while slightly brackish, the groundwater is expected to be suitable for extraction with treatment (using a desalination plant) for potable and non-potable uses. Other treatment may be required, and would be dependent on the incoming water supply quality requirements of the package desalination plant selected. Water sourced for firefighting purposes would not be treated in the desalination plant as this is not required.
- For the Wallerberdina site, the long term drawdown impacts on the local groundwater sources would require further review during the concept and detailed design phases. No assessments have been made to provide water to the surrounding area outside the nominated sites.

Site communications

Reason for gathering information:

The facility requires external communication infrastructure to provide communications for the facility.

Preferred site characteristics:

- The key design objective is the supply of three independent forms of communication to support the facility, including:
- a primary fibre connection to support data and voice service connectivity with a minimum of 25 megabits per second
- a secondary diverse radio communication path to support data and voice service connectivity
- mobile coverage to the site
- very high frequency (VHF) radio coverage to the site.

Work completed to date:

- A desktop assessment including discussions with supply authorities and review of likely routes/paths for communications infrastructure.
- Preliminary design and costing of options.

Limitations of the data:

A small-cell for the provision of mobile coverage requires the support of a telecommunications carrier, and is subject to a formal application. The fee structure for the supply of the infrastructure and the services has been estimated only. No assessments have been made to provide communication services to the surrounding area outside the nominated sites.

Additional classified information on transport and communications was also considered for each site.

Waste generated on site

Reason for gathering information:

To assess the availability and proximity of facilities to treat, recycle or dispose of non-radioactive on-site generated waste streams, and to consider the potential for on-site treatment, recycling and disposal.

Preferred site characteristics:

Proximity to suitable waste management facilities, and site attributes that can accommodate potential on-site waste management options.

Work completed to date:

Desktop assessment including research and information review regarding the presence, capacity and location of waste facilities in proximity to the site.

Limitations of the data:

Only licenced waste facilities were reviewed during the searches undertaken. The actual waste streams to be generated, together with quantity of waste, are not yet confirmed. Therefore, the extent to which waste will need to be managed is unknown. Confirmation of the capacity of the identified waste facilities will be required.

Lyndhurst

- There are a number of local recycling and waste depots capable of accepting/receiving waste.
- Certain types of waste generated on site (listed or hazardous types) may need to be managed on site prior to being transported to a suitable facility outside the local area, due to the lack of suitable facilities nearby.

Napandee

- There are a number of local recycling and waste depots capable of accepting/receiving waste.
- Certain types of waste (listed or hazardous types) may need to be managed on site prior to being transported to a suitable facility outside the local area, due to the lack of suitable facilities nearby.

Wallerberdina

- There are a limited number of waste and recycling depots in close proximity to the site, and on-site management and transport/disposal may need to be considered.

Renewable energy

Reason for gathering information:

To assess the availability of renewable resources in the site area, to provide power to the site, and to offset grid-supplied energy.

Preferred site characteristics:

Location which has high potential to generate renewable energy, particularly solar and wind energy, that can be harnessed to increase the network reliability of power supply to the site.

Work completed to date:

- Desktop assessment including review of the sites for wind, solar, hydro and geothermal resources (tidal excluded because of distance of all sites from the sea).
- Review of capital expenditure and operating expenses, and land required to facilitate harnessing the resource.
- Review of connecting infrastructure surrounding the site.

Limitations of the data:

All studies completed are preliminary in nature, with the exception of solar photovoltaic energy which is explored further in the power supply to site information summary (p. XLIII). Further information including the likely load profile, equipment and site requirements is required before further assessment can be made.

Lyndhurst

- Located in an area of moderate to high solar exposure, and a moderate wind resource area.
- Both wind and solar power would require connection to a high voltage network. This would require construction of new long transmission lines to connect to the existing transmission network (refer to power supply to site information summary (p. XLIII) for more detail).

Napandee

- Located in an area of moderate to high solar exposure, and a moderate wind resource area.
- Both wind and solar power would require connection to a high voltage network. This would require construction of new long transmission lines to connect to the existing transmission network (refer to power supply to site information summary (p. XLIII) for more detail).

Wallerberdina

- Located in an area of high solar exposure, and low wind resources.
- Site is close in proximity to existing high-voltage transmission network. A thermal limit exists for the line and export of power would likely require an upgrade to the 132 kilovolt line. However, it is noted that the closure of the Leigh Creek mine has significantly reduced the load required on the end of the transmission line. A connection enquiry would be required for future stages.

Aboriginal cultural heritage

The following Aboriginal cultural heritage information summary is based on two reports prepared by RPS: the July 2018 Kimba Aboriginal Heritage Desktop Assessment Report and the July 2018 Wallerberdina Aboriginal Cultural Heritage Report (public version). These reports are provided at attachments H and I.

Aboriginal cultural heritage

Reason for gathering information:

Aboriginal cultural heritage values are broadly represented in Australia's landscapes. A cultural heritage assessment of each of the nominated sites is essential to ensure cultural values are appropriately managed and potential impacts minimised for the lifetime of the facility.

Aboriginal cultural heritage assessments were undertaken with respect to definitions of heritage and Traditional Owners, existing site registers and future approval processes that may be required once a site is selected, which were drawn from the following relevant legislation: *Aboriginal Heritage Act 1988* (SA), EPBC Act, ATSIHP Act, and the *Native Title Act 1993* (Cth).

Preferred site characteristics:

Protection of Aboriginal cultural heritage values that may be impacted by the project, including demonstrated opportunities for local Traditional Owners to be involved in the planning, construction and operational phases of the project to help achieve this.

Work completed to date:

The department has undertaken preliminary Aboriginal Cultural Heritage Assessments (ACHAs) of the nominated sites. The work reported here draws on the findings of independent cultural heritage consultants from RPS who were engaged to conduct two separate ACHAs: one for the Lyndhurst and Napandee sites and one for the Wallerberdina site. This includes evaluations of the specific land areas within each of the nominated sites that have been selected as preferred locations for the facility.

The Wallerberdina ACHA was conducted from late-2017 to mid-2018. The Kimba ACHA was conducted from early to mid-2018. Both ACHAs included:

- desktop research to identify existing and potential Aboriginal cultural heritage values across the sites, which included use of the South Australia Register of Aboriginal Sites and Objects
- landscape mapping and LiDAR surveys to enable predictive modelling of archaeological site locations.

The Wallerberdina ACHA additionally included:

- establishment of a Heritage Working Group (HWG) to facilitate discussions and consultation for the assessment at Wallerberdina
- consultation and cultural heritage site visits with HWG members at Wallerberdina.

Limitations of the data:

The Kimba ACHA is limited in scope as consultation with relevant Traditional Owners was unable to occur. If either site at Kimba is selected to host the facility, the Government will continue to seek the involvement of the local Traditional Owners in all stages of the project.

Once a site has been acquired a comprehensive archaeological investigation and consultation with the relevant Traditional Owners will be required. This process will fully assess the cultural values that may be impacted and to develop an Aboriginal Cultural Heritage Management Plan.

Lyndhurst and Napandee (Kimba)

- Although Native Title has been extinguished in both nominated sites, the Barngarla and Gawler Ranges Traditional Owners hold Native Title in surrounding lands.
- No registered or listed sites were identified within a 10 kilometre radius from either the Lyndhurst or Napandee sites although unregistered sites may exist.
- Archaeological research is limited within the general area, although predictive landscape mapping identified features such as dunes throughout the area that have potential for archaeological sites, most likely to be stone artefact scatters.
    - The Lyndhurst block has a greater presence of landscape features with archaeological potential than the Napandee block, which has very limited archaeological potential.
- If the project should proceed in either area, comprehensive archaeological investigation, consultation and site visits with the Traditional Owners would be required to fully assess the cultural values that may be impacted and to develop an Aboriginal Cultural Heritage Management Plan.

Wallerberdina (Hawker)

- While Native Title has been extinguished on Wallerberdina, the Adnyamathanha People have a strong and ongoing connection to Country within the area and its surrounds as exemplified by the intangible and tangible heritage values associated with the Flinders Ranges.
- The selection of a preferred location for the facility in the western portion of Wallerberdina was chosen so as to not impact on any known Aboriginal cultural heritage sites and to limit impacts on potential archaeological sites (it has a moderate potential for stone artefact scatters, based on predictive landscape mapping).
- If Wallerberdina is selected to host the facility, there are opportunities for the Adnyamathanha community to be involved in all future stages of the project, including through employment and training, contributing to the aesthetic design of the facility, and cultural plantings. There is also opportunity to preserve and enhance heritage values through archaeological and ethnographic research in the wider region.
- A registered songline and associated archaeological site intersects with the southern edge of Wallerberdina (no other sites have been registered within the nominated site).
- Various portions of Wallerberdina have cultural significance, including areas with high potential for the location of unregistered archaeological sites (including stone artefact scatters, grinding grooves, scarred trees and rock shelter sites).

- The eastern portion of Wallerberdina is considered highly significant when considering heritage due to the presence of sensitive Aboriginal cultural heritage sites located adjacent to and within the site boundaries.
- Hookina Creek, which runs along, and generally just outside, the western and southern boundary of the proposed Wallerberdina site, has broad cultural significance.
- Access along Lake Torrens Homestead Road through Wallerberdina should be maintained throughout the life of the project if it proceeds, as this is considered important for ongoing cultural practices of hunting and gathering in the area and travel to and from Lake Torrens and Cotabena.
- If Wallerberdina is selected to host the facility, a comprehensive archaeological investigation and consultation with the Traditional Owners would be required to fully assess the cultural values that may be impacted and to develop an Aboriginal Cultural Heritage Management Plan.

Socio-economic impact

The following socio-economic impact information summaries are based on two social baseline reports prepared by the University of Queensland (November 2018, see full reports at attachment J), and two economic impact assessment reports prepared by Cadence Economics (July 2018, see full reports at attachment K).

Social impact

Reason for gathering information:

Obtain baseline measures of socio-economic indicators for the communities near the nominated sites, and community views about the facility, in order to assess potential social impacts and to inform strategies to enhance the benefits and minimise negative impacts from the siting of the facility near a community.

There is no legislative mandate to conduct a social impact assessment, however it is considered an important factor in the selection of a suitable site for the facility and is a relevant consideration should an environmental impact assessment be conducted under the EPBC Act. Non-statutory guidelines for social impact assessments are well established in expert literature and impact assessment guidance material published by various Governments.

Preferred site characteristics:

A community willing and able to harness expected opportunities and avoid or mitigate negative impacts from the facility.

Work completed to date:

The work reported here was undertaken in 2018 by The University of Queensland (UQ), which was engaged by the department to conduct social impact assessments of local communities near the sites being considered for the facility. Two reports were prepared: one focused on Kimba (near Lyndhurst and Napandee) and one focused on Hawker and Quorn (near Wallerberdina).

As part of the social impact assessments, UQ conducted a desktop review to construct community profiles based on key socio-economic indicators. This drew on ABS data and a wide range of administrative data sets. Subsequently, researchers conducted interviews in each of the towns (including several by telephone) and received emailed submissions and comments. There were 16 interviews undertaken either with individuals, pairs or small groups of community members in Hawker and Quorn, and over 30 in Kimba, the latter resulted in over 80 people being interviewed. The aim was to hear first-hand the views about possible impacts of the proposed facility and to 'ground-truth' the baseline data.

A separate economic impact report has been completed by Cadence Economics, which focuses on modelling the employment outcomes and value added to local economies (p. LXI).

Limitations of the data:

Sixteen interviews were conducted in Hawker and Quorn (combined total population: 1,368) and 80 interviewed in Kimba (total population: 629). As these were qualitative interviews the researchers succeeded in capturing a cross-section of community views.

The next section presents the community profile data for each of the towns associated with the nominated sites, followed by the results of the interviews and strategies identified by the researchers to address the issues raised.

Lyndhurst and Napandee (Kimba)

- Kimba's population has remained relatively constant, down slightly from 636 in 2006 to 629 in 2016, however it is ageing, reflected in a marginal contraction in the main adult working age group (25-59 years of age) from 255 in 2006 to 243 in 2016.
- Unemployment in Kimba over the past decade has been low (2 per cent in 2016), with the main industries providing employment also remaining relatively constant, led by agriculture at 21 per cent, followed by construction, retail trade, education and training, and health and social services.
- Over the past decade average personal incomes have generally remained just under the South Australian average, although in 2015–16 average income fell 10 per cent to $44,283 compared to the state average of $50,149.
- Total business income has fluctuated over the past few years and while there has been an observed decline in retail presence, the overall number of businesses (49 in 2016) has remained relatively constant.
- Twenty-five per cent of Kimba's population has a formal education or training qualification beyond high school, 11 per cent have a diploma or degree and 14 per cent have a certificate III or IV.
- School numbers were 173 in 2017 and have been around 170 to 180 for most of the past decade, except for the years 2014–16 when enrolments dipped to around 160.
- The total number of dwellings in Kimba was 356 in 2016, with a 28 per cent vacancy rate, a relatively low median weekly rent of $120 compared to the state median of $260 and low median weekly mortgage repayment of $200 compared to the state median of $344.

Wallerberdina (Hawker and Quorn)

Hawker community profile

- The population of Hawker has fluctuated over the past decade or so, rising from 334 in 2004 to 492 in 2011, then decreasing by 31 per cent to 341 by 2016, including a sharp decline in the main adult working age group from 241 (49 per cent of the population) in 2011 to 132 (38 per cent).
- The level of unemployment in Hawker has increased significantly in the past five years, up from 2 per cent in 2011 to 6 per cent in 2016 (coinciding with the closure of Leigh Creek Coal Mine).
- The main industries providing employment have remained the same since 2006, with agriculture at 20 per cent, followed by accommodation and food services, construction, and education and training, which each contribute over 10 per cent of employment.
- Average personal income has experienced modest growth in recent years, from $42,597 in 2013 to $47,446 in 2016, 5 per cent lower than the state average of $50,149.
- The number of businesses operating in Hawker declined from a peak of 30 in 2014–15 to 25 in 2015–16, which coincides with the Leigh Creek Coal Mine closure.

- 21 per cent of residents have a formal education or training qualification beyond high school, with 10 per cent holding a diploma or degree and 11 per cent with a certificate III or IV.
- Hawker school numbers have ranged between a low of 33 in 2008 and peak of 50 in 2013, and sat at 44 in 2017.
- The total number of dwellings in Hawker was 184 in 2016, with a 34 per cent vacancy rate, a median weekly rent of $123, compared to the state median of $260, and median weekly mortgage repayment of $160 compared to the state median of $344.

Quorn community profile

- Quorn's population has remained relatively constant, down slightly from 1,258 in 2006 to 1,230 people in 2016, however it is ageing, reflected in a marginal contraction in the main adult working age group from 542 in 2006 to 523 people in 2016.
- The unemployment rate has remained relatively constant since 2006, although after reaching a low of 5.5 per cent in 2011, it has increased to 7.2 per cent in 2016.
- The main industries providing employment have remained roughly the same since 2006, with healthcare and social assistance, education and training, public administration and retail each accounting for 10 per cent or more of local workers, and agriculture accounting for 9 per cent.
- Average annual personal income has experienced consistent growth of 7 per cent since 2012–13, with an average of $52,838 in 2015–16, which is 5.3 per cent above the state average of $50,149.
- Business income and numbers of businesses have also increased in recent years, with a notable jump in 2014–15 of 48 per cent in total business income and an increase from 53 to 60 in the number of businesses.
- There has been a significant increase in the percentage of residents who have a formal education or training qualification beyond high school—from 20 per cent in 2006 to 31 per cent in 2016, with 14 per cent holding a diploma or degree and 17 per cent with a certificate III or IV.
- From 2008 to 2017 there has been a significant decline in the number of students (from 265 to 138) and teachers (from 22 to 13) at the local school.
- The total number of dwellings in Quorn was 649 in 2016, with an 18 per cent vacancy rate, a relatively low median weekly rent of $172 compared to the state median of $260 and low median weekly mortgage repayments of $231 compared to the state median of $344.

Results from interviews (Lyndhurst, Napandee and Wallerberdina)

Kimba

Education and training pathways for local people (particularly youth) and additional opportunities for the current workforce were identified as the primary opportunities for the community. Emphasis was placed on the potential for local school students to improve STEM (Science, Technology, Engineering and Mathematics) subject offerings and uptake. The community identified the need for training programs to build skills that will be required for the construction and management of the facility.

A diversified and invigorated economy was also identified as a key benefit of the facility. Residents expect that the facility will create jobs for locals and bring additional workers to the community. These new arrivals and their families would likely increase student numbers, and create opportunities for local businesses. There is an expectation that hosting the facility would create an alternative and constant source of income that would help reduce the town's reliance on agriculture.

Some residents raised concerns that hosting a waste facility would create stigma and ultimately have a negative effect on property prices.

Despite having a hospital in town, the lack of a dedicated full-time doctor in Kimba was a concern for many who were interviewed. There was some discussion around the idea of Kimba becoming a 'government town', which would bring additional services including an increase in doctors.

The community raised concerns about uncertainty in particular aspects of the project, such as the facility operator. 'What if…?' was a commonly used phrase in interviews. The dominant concern was around possible threats to human and environmental safety if the integrity of the structure was compromised or damaged, deteriorated over time, or failed unexpectedly. Ensuring the community fully understand the high safety and security standards required under legislation, will be key in developing the facility.

Some people were concerned that while they might agree to a low or intermediate-level facility, that high level waste would be stored there.

Several local farmers who export internationally, expressed concern about the possibility that produce from the region would become stigmatised given its proximity to the facility.

Hawker and Quorn

A prevalent concern in interviews with community members from Hawker and Quorn was a reduction in social cohesion caused by the nomination process and community consultation. The majority of interviewees were uncertain how the temporary damage to community spirit could be repaired in future. Some social benefits were identified by those interviewed, including the injection of new people into the town and the range of opportunities this would present. The participation of newcomers to a number of community and sporting groups would be welcomed, as would families with children.

Both Aboriginal and non-Aboriginal interviewees expressed the need for respect for Traditional Ownership and concern about possible impacts the facility may have on Aboriginal cultural heritage. There were others (both Aboriginal and non-Aboriginal) who were excited by the opportunities that may arise for raising awareness of and preserving local Aboriginal culture.

Interviewees were split in their concern regarding risk to the environment posed by the facility. Many who supported the facility were convinced the structure would be sound—either from visiting the ANSTO facility at Lucas Heights or through talking with someone who had, or through information supplied by the department.

Some interviewees raised concerns that the facility would damage the area's reputation and industries, especially agriculture, tourism and property values. There was a concern that the facility would significantly and negatively impact on tourism and visitor numbers.

In Hawker, the proposed facility was said to provide a stabilising 'third leg' to the local economy, which is currently reliant on highly seasonal income from agriculture and tourism.

Some of those interviewed in Hawker and Quorn believed the facility would bring improvements to local roads. In Hawker, interviewees also looked forward to increased connectivity in terms of improved telecommunications, as well as connections to ANSTO in Sydney and other host communities globally.

Unfairness and mistrust in the site selection and community consultation process were highlighted as significant concerns for those opposed to the facility. Many opponents expressed the feeling that their concerns are not being listened to or 'seriously considered' by government decision-makers.

Economic impact

Reason for gathering information:

To estimate the economic impact from the development of the facility on local communities in terms of employment and value added to the local economies. There is no legislative mandate to conduct economic impact assessments, however it is considered an important factor in the selection of a suitable site for the facility and is a relevant consideration should an environmental impact assessment be conducted under the EPBC Act. Non-statutory guidelines for economic impact assessments are well established in the expert literature and impact assessment guidance material published by various Governments.

Preferred site characteristics:

Demonstrated positive economic impact for local communities at the construction and operational phases of the facility project. Little or no adverse economic impact from crowding out other activity or other excessive opportunity costs.

Work completed to date:

The work reported here was undertaken by Cadence Economics, which was engaged by the department to conduct two separate economic impact assessments: one for the Kimba community (covering the Kimba District Council area) and one for Hawker and Quorn (covering the Flinders Ranges District Council area). A desktop assessment was undertaken entailing macroeconomic modelling of the regional economies' responses to external funding resulting from the construction and operation of the facility. A theoretical cost curve (rate of spend) for the project was applied to demonstrate changes to production, wages, consumption and value added over time. The economic modelling is based on a set of assumptions in relation to the construction and operational phases of facility, known as the central case scenario, which was tested under various sensitivity analyses.

The modelling has considered 30 years of full operations for the facility, in addition to a construction and pre-operational phase, which extends the period modelled to 2054. This is consistent with Infrastructure Australia's suggestion that as a result of 'uncertainty of demand modelling over longer time horizons, many jurisdictions suggest 30-year appraisal periods' (*Assessment Framework*, March 2018), and recognises the uncertainty associated with predicting waste production and demand management activities post-2054.

Limitations of the data:

The analysis assumed a capital cost for the facility of $325m, spread over 2021–24. The final spend is subject to further analysis and will be updated as the concept design is progressed. Note, the geographic regions used in the economic analysis are not identical to those used in the social impact analysis due to the different levels of aggregation at which relevant data is available.

The regional economic impacts for Kimba, Hawker and Quorn under the central case scenario assumptions are summarised below.

Lyndhurst and Napandee (Kimba District Council area)

- A facility at Lyndhurst or Napandee is projected to confer economic benefits to the Kimba community in terms of economic output, economic welfare, employment and real wages.
- These benefits are driven by an increase in demand for goods and services through both the construction and operational phases of the facility, the increase in supply of workers moving to the region during the operational phase, as well as a wage premium for all workers at the facility.
- By 2030, after the facility is fully operational, real Gross Regional Product (GRP, which is a measure of the goods and services produced in the Kimba region) is projected to be 4.9 per cent higher, which equates to an $8.4 million increase in real 2018 dollars.
- Over the first 33 years of the project, from 2021–54, the Net Present Value (NPV) of the projected increase in real GRP in Kimba is just over $95 million.
- In economic welfare terms, real Gross Regional Income (GRI) is projected to be 4.7 per cent higher ($9.1 million in real 2018 dollars) in 2030.
- In terms of labour market outcomes, the facility will employ 45 FTE (full time equivalent employees). Of these, 34 FTE are to be drawn from the local labour market, redirected to work in this facility from the existing pool of employed persons in Kimba under conservative assumptions. The additional 11 FTE would be relocated to the region to work in the facility.
- The projected net additional economy-wide increase in employment in 2030 in Kimba is 16.6 FTE. This is comprised of the additional 11 FTE that relocate to the region to work in the facility, as well as 5.6 FTE being the result of positive flow-on economic effects of the facility.

Wallerberdina (Flinders Ranges District Council area)

- A facility at Wallerberdina is projected to confer economic benefits to the Flinders Ranges region, including Hawker, in terms of economic output, economic welfare, employment and real wages.
- These benefits are driven by an increase in demand for goods and services through both the construction and operational phases of the facility, the increase in supply of workers moving to the region during the operational phase, as well as a wage premium for all workers at the facility.
- By 2030, after the facility is fully operational, real GRP in the Flinders Ranges is projected to be 8.2 per cent higher which equates to an $8.3 million increase in real 2018 dollars.
- Over the first 33 years of the project, from 2021 to 2054, the NPV of the projected increase in real GRP in the Flinders Ranges is just over $95 million.
- In economic welfare terms, real Gross Regional Income is projected to be 7.8 per cent higher ($9.2 million in real 2018 dollars).
- In terms of labour market outcomes, the facility will employ 45 FTE directly. Of these, 34 FTE are to be drawn from the local labour market, redirected to work in this facility from the existing pool of employed persons in the Flinders Ranges under conservative assumptions. The additional 11 FTE would be relocated to the region to work in the facility.
- The projected net additional economy-wide increase in employment in 2030 in the Flinders Ranges is 18.0 FTE. This is comprised of the additional 11 FTE that relocate to the region to work in the facility, as well as seven FTE being the result of positive flow on economic effects of the facility.

Attachments

Site suitability assessments and supporting documents

A. Site suitability assessment: Technical Assessment (ARPANSA/ASNO/IAEA)
   - Record of authorship and review: Technical Assessment (ARPANSA/ASNO/IAEA)

B. Preliminary Safety and Waste Acceptance Report of the National Radioactive Waste Management Facility (NWRMF)

C. Site suitability assessment: EPBC Act
   - Appendix 2: EPBC Act assessment of potential differentiators
   - Record of authorship and review: EPBC Act Assessment

D. Site suitability assessment: Department of Industry, Innovation and Science Risk Management Framework 2018-2020

Independent reports

E. AECOM Site Characterisation - Technical Report Lyndhurst
   - Incorporating Technical Report Addendum - Site Characterisation Lyndhurst

F. AECOM Site Characterisation - Technical Report Napandee
   - Technical Report Addendum - Site Characterisation Napandee

G. AECOM Site Characterisation - Technical Report Wallerberdina
   - Technical Report Addendum - Site Characterisation Wallerberdina

H. RPS Kimba National Radioactive Waste Management Facility Aboriginal Heritage Desktop Assessment Report

I. RPS Wallerberdina Station National Radioactive Waste Management Facility Aboriginal Cultural Heritage Report – public version

J. University of Queensland Social Baseline Reports
   - Kimba
   - Hawker/Quorn

K. Cadence Economics Economic Impact Assessment of the National Radioactive Waste Management Facility
   - Kimba, South Australia
   - Hawker, South Australia