# METHODS FOR CHOOSING THE RIGHT SITE

## Introduction

This paper provides a report for public discussion on Phase 1 of a project to identify a suitable site for a national repository for radioactive waste. The project was announced by the Hon. Simon Crean, Minister for Primary Industries and Energy on 1 June 1992.

Computer-based systems enabled the assembly and evaluation of large amounts of geographic information and the analysis of this information against internationally accepted radioactive waste repository site selection criteria.

**This paper provides examples of the application of this approach to identifying regions likely to contain sites suitable for a national repository.**

### Background

Australia currently has less than 3,300 cubic metres of radioactive waste, arising from over forty years of research, medical and industrial use of radionuclides. This figure does not include mining wastes which are generally disposed of at the mine site.

The wastes generated in Australia typically consist of contaminated paper, plastic, glassware, protective clothing and laboratory equipment, radiation sources, electron tubes, smoke detectors, luminescent signs, watch faces and compasses.

**Over half of Australia's current waste inventory consists of lightly contaminated soil.**

Radioactive waste is presently held at some fifty interim storage sites throughout Australia. The waste is accumulating slowly, at a rate of less than 60 cubic metres per year, but it is, in many cases, held in buildings that were neither designed nor located for the storage of radioactive material. Some temporary stores are filled to capacity. Disposal at a purpose-built national repository is preferable to existing arrangements.

On 12 September 1991, Mr Crean sought the participation of State Governments in a Commonwealth co-ordinated site selection study for a national near-surface repository for Australia's radioactive wastes. The study commenced in June 1992 and is managed by the Department of Primary Industries and Energy (DPIE). The members of the study team are drawn from the National Resource Information Centre (NRIC), the Australian Geological Survey Organisation (formerly the Bureau of Mineral Resources), the Uranium & Nuclear Policy Branch of DPIE, and the Australian Nuclear Science and Technology Organisation (ANSTO).

Australia is not the only country to consider the problem of radioactive waste disposal. Other countries including the USA, United Kingdom, France, Spain, South Africa, and Japan have undertaken studies and located repositories.

Australia's Commonwealth, State and Territory governments are responsible for the management of radioactive wastes produced within their jurisdictions. Except for Western Australia, which is making its own arrangements, all States and Territories support the Commonwealth's proposal for a national facility.

Coordination is desirable because it would be inefficient to establish separate disposal facilities in each jurisdiction because of the relatively small quantities of stored wastes and low rate of annual increase.

All radioactivity decreases with time. Each radioactive element is characterised by a half-life, the time taken for half the radioactivity to decay. Half-lives vary from fractions of a second to millions of years.

Most of Australia's wastes have either a low concentration of radioactivity or contain radionuclides with half-lives short enough allow disposal in a near-surface facility.

**Near-surface disposal means that the waste is placed in an underground structure and then covered with layers of natural or artificial material to control infiltration of water and to prevent intrusion by people and wildlife.**

International practice indicates that a near-surface disposal facility located at a suitable site and surrounded by a buffer zone would be suitable for disposal of most of the radioactive waste arising in Australia. It is estimated that a site with a total area of about 225 hectares, containing a 25 hectare disposal and operational area surrounded by a 500 metre buffer zone would provide an adequate area for Australia's requirements for the next fifty years.

# Locating a Repository

The National Health and Medical Research Council (NHMRC) has prepared a *Code of Practice for the Near-Surface Disposal of Radioactive Waste in Australia* (1992). The purpose of this *Code* is to ensure that there is no unacceptable risk or detriment to humans, other biota or the environment, at present and in the future, as a result of the disposal of radioactive waste.

The *Code* is based on international guidelines and describes site selection - physical, ecological and sociological suitability, waste acceptance and disposal criteria, and provides guidelines on the design and management of a disposal facility.

Siting, development and management of Australia's repository will be in accordance with the clearly-defined requirements of the *Code*.

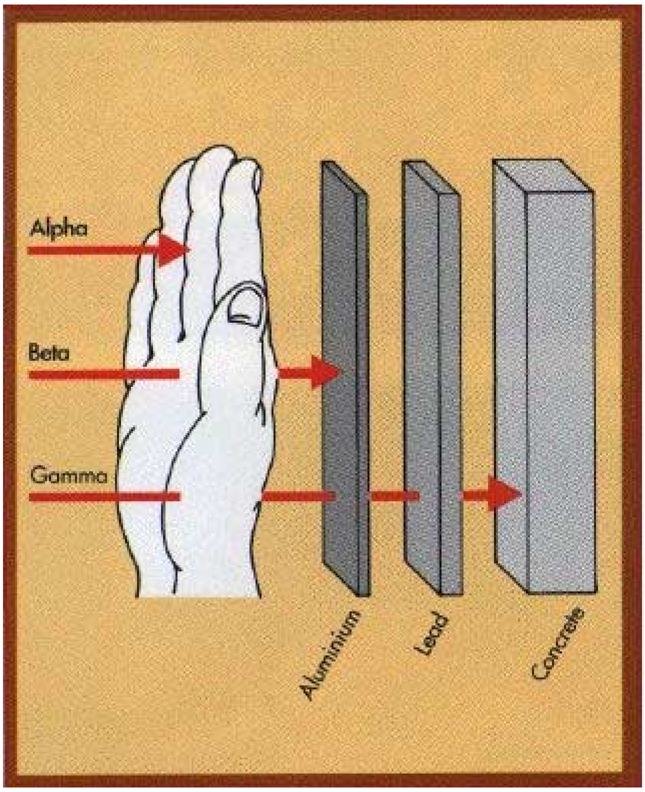
In addition, the final design will be influenced by the specific characteristics of the selected site. A possible design for the facility and details of its operation are provided in Appendix 1.

# Categories of Radioactive Waste

## Types of Radiation

Naturally occurring radioactive materials and those used in medicine, industry and research emit three forms of radiation: alpha, beta and gamma radiation. All are potentially harmful, but they differ in penetrating power and in the way they affect human tissue.

**Diagram 1:**
**The ability of different types of radiation to penetrate materials**




The wastes proposed for disposal in a national near-surface repository are all solid wastes of relatively low concentration or radiotoxicity. They should not be confused with high level wastes arising in other countries from the reprocessing of spent nuclear fuel, that generate a lot of heat and require heavy shielding to control penetrating radiation.

The NHMRC *Code* defines four categories of radioactive waste for disposal and management purposes. Wastes suitable for shallow ground burial are separated into categories A, B and C. The fourth category - S, describes wastes that are not suitable for shallow ground burial.

**Category A**
Wastes contain short-lived radionuclides (half-lives of around 30 years or less), mainly emitting beta/gamma radiation. Long-lived radionuclides emitting alpha radiation are only present at very low concentrations. Typically they are lightly contaminated items such as plastics, protective clothing, laboratory equipment and industrial tools compacted into 200 litre steel drums. Category A may also include lightly contaminated bulk wastes from mineral processing or lightly contaminated soils.

**Category B**
Wastes emit considerably higher levels of beta or gamma radiation than Category A wastes. Radionuclides emitting alpha radiation are at relatively low levels. This category includes gauges and sealed sources used in industry, and medical diagnostics and therapy, that are then enclosed in concrete.

**Category C**
Wastes contain mainly radionuclides emitting alpha radiation . These wastes could include bulk waste materials arising from the processing of radioactive minerals, significantly contaminated soils, or large

items of contaminated equipment.

**Category S**
Wastes are those with higher levels of radiation than categories A, B and C. The amount of category S wastes is very small and consists mainly of sealed radium sources. These wastes will be retained in storage until a deep underground disposal facility is established.

The concentration limits for specific radionuclides in each category of waste are given in the *Code*.

Australia's inventory of radioactive wastes is outlined in Table 1.

Spent fuel from ANSTO's nuclear research reactor (HIFAR) is not regarded as part of Australia's radioactive waste inventory. This material is securely stored in lined boreholes at ANSTO's Lucas Heights (NSW) research laboratories pending reprocessing overseas.

The proposed national near-surface repository will be for the disposal of A, B and C category radioactive wastes generated in Australia. International practice recognises that these wastes are suitable for near-surface disposal.

The facility will be carefully designed, engineered and managed to ensure containment of the waste and its radioactivity.

The repository could also provide interim on-site surface storage facilities for category S wastes, those not considered suitable for shallow burial in the ground.

In moving waste to a repository, the *Code of Practice for the Safe Transport of Radioactive Substances, 1990*, which sets maximum external radiation levels for radioactive materials to be transported in Australia, will be adhered to.

**Table 1: Commonwealth/State Waste Holdings**

| **Organisation** | **Description of waste** | **Volume cubic metres)** | **Annual arisings (cubic metres)** |
|---|---|---|---|
| ANSTO | Compacted wastes (paper, plastics, protective clothing, laboratory glassware, dried sludge) | 795 | 40 - 50 |
| | Uncompacted wastes (laboratory equipment) | 360 | - |
| Defence | Electron tubes, radium painted watches, compasses; sealed sources | 60 | < 5 |
| State wastes | Industrial gauges, exit signs, smoke detectors, medical sources | 100 | 5 - 10 |
| Contaminated soil | (ex CSIRO, Victoria) | 1950 | - |
| **Total** | | 3265 | 50 - 65 |

# Selecting a repository site

## Site Selection Criteria

A suitable repository site must have long-term stability and attributes that will enable the wastes to be isolated so that there is no unacceptable risk to people or the environment either while it is operating or after the site has closed. Criteria for site selection include natural physical characteristics as well as socio-economic, ecological and land-use factors.

## Primary selection criteria are:

- low rainfall, free from flooding, good surface drainage, stable geomorphology;
- a generally stable hydrogeological setting and a water table at least 5 metres below the buried waste;
- geology and hydrogeology amenable to modelling groundwater and radionuclide movements;
- away from known or anticipated tectonic, seismic or volcanic activity that could destabilise disposal structures or affect the containment of the waste;
- no groundwater that is potable or suitable for agriculture can be contaminated;
- low population density with little prospect for increase or development;
- geochemical and geotechnical properties that inhibit radionuclide migration and facilitate repository operations.

## Other considerations are:

- no known significant natural resources (e.g. potentially valuable mineral deposits) and little or no potential for agriculture or outdoor recreation;
- reasonable access for transport of materials during construction and operation;
- no special environmental attraction nor ecological significance;
- no special cultural or historical significance;
- not within reserves for regional services such as electricity, gas, oil or water;
- no ownership rights or control that could compromise retention of long-term control.

A potential site may not necessarily fully comply with all these criteria. However, there should be compensating factors in the design of the facility to overcome any deficiency in the physical characteristics of the site.

## Site Selection Process

The site selection process will involve four phases:

### PHASE 1: (this study) June - September 1992

- Prepare a methodology to identify suitable sites
- Assemble relevant digital information at a continental scale
- Categorise all information to indicate suitability in terms of the selection criteria
- Apply the methodology and demonstrate its use
- Identify potentially suitable regions at a continental scale
- Release the public discussion paper

## PHASE 2: Late 1992 - 1993

- Review public comment on the discussion paper
- Assemble the more detailed information.
- Re-apply the methodology.
- Identify potentially suitable areas at a regional scale
- Conduct reconnaissance field surveys over suitable areas.
- Prepare a report for public comment.

## PHASE 3: 1993 - 1994

- Conduct detailed field investigation of suitable areas
- Identify potentially suitable sites
- Conduct detailed field studies including drilling and surface monitoring
- Identify the site potentially most suitable
- Prepare a report for public comment.

Phase 1 was a three month preliminary study to trial the method for assembling datasets and to demonstrate the selection process that is described in this paper. Phase 2 will be a one year study to short list the most suitable areas for detailed field assessment.

Detailed field studies conducted in Phase 3 will determine the relative suitability of areas and conclude with the identification of the most suitable site for the repository.

A report will be prepared for public comment. The report will include discussions of alternative sites; description of existing environmental conditions; description of the repository, its construction and operation; assessment of its potential impacts on the environment and human safety; and proposed safeguards and monitoring requirements.

Members of the Commonwealth site selection study team and State and Territory representatives will be consulted during the study program. Once a preferred site has been identified the Commonwealth will negotiate its use with the host State or Territory and may, if necessary, acquire the site for use as a national repository.

## Methodology

The trial selection process was applied to the whole of Australia using data at a continental scale only. This required Australia-wide coverage by 'themes' relating to the attributes referred to in the site selection criteria.

For example, the soil theme used a map of the distribution of soils as determined by their physical and chemical characteristics. The information was categorised to indicate the relative suitability of each soil type.

Computer-based methods of ranking are sufficiently versatile to allow the testing of different mixes' or weightings of the themes.

It must be noted that the continental-scale data used in Phase 1 of the study cannot be applied reliably at a local scale. In addition, the various datasets used in Phase 1 have different degrees of accuracy and errors are compounded whenever such datasets are integrated. Regional and local-scale studies as mentioned in the descriptions of Phases 2 and 3 of the study will require collection and analysis of more detailed information in order to refine the site-selection process.

## Application

**A geographic information system (GIS) is a computer-based suite of software and hardware used to organise and manage spatial information.**

A GIS provided the tools to apply the methodology of this study. Modelling was done at a base scale of 1:5,000,000 (1mm on a map = 5km on the ground), resulting in a minimum cell size of 25 square km.

Eighteen themes were assembled for the Phase 1 assessment of the selection criteria:

- Locations - cities, towns, homesteads, water bores, tanks
- Population density
- Water balance - precipitation/evaporation
- Bedrock geology
- Earthquake risk
- Lakes, rivers, streams, swamps
- Vegetation
- Hydrogeology - aquifer type
- Groundwater - quality
- Relief and landforms
- Soils
- Regolith - weathered surface materials
- Cainozoic geology (younger than 60 million years)
- Faults
- Cyclone risk
- Thunderstorm frequency
- Land ownership
- Transport - roads, railways

Data for each theme was classified according to potential suitability:

**Class 1** = suitable
**Class 2** = mainly suitable
**Class 3** = intermediate or indeterminate
**Class 4** = mainly unsuitable
**Class 5** = unsuitable

The sources of the information and the basis for classifying each theme are presented in Appendix 2.

An indication of the overall suitability of all regions was determined by combining the suitability values for all the individual themes. If all the themes are treated as equally important, the result is as shown in Figure 1. If the themes that directly impact on radiological safety (the primary selection criteria) are used exclusively, then the suitability of regions is as shown in Figure 2.

This system allows for many options to be tested, but a suggested best application of the selection criteria is given by. Figure 3. This figure illustrates the outcome of excluding any area with an unsuitable or mainly unsuitable ranking in any of the eighteen themes. The remaining areas require further detailed study using data at regional and local scales.

All of these applications of the methodology use continental-scale information and should only be considered as a first attempt at the site selection process. Different potential regions are identified depending on the weighting given to each theme.

**Figure 1: Example using all themes with equal weighting**

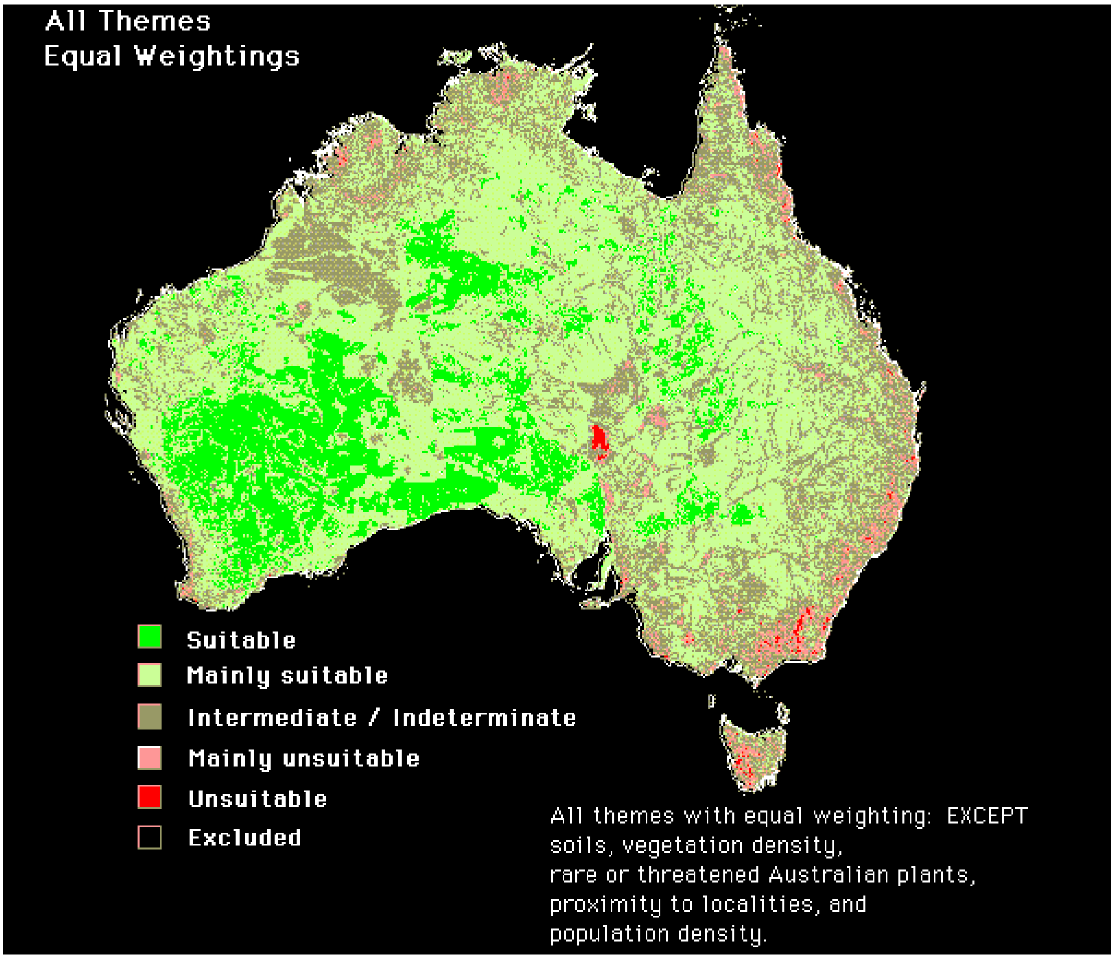



**Figure 2: Example using primary selection criteria only with equal weighting.**

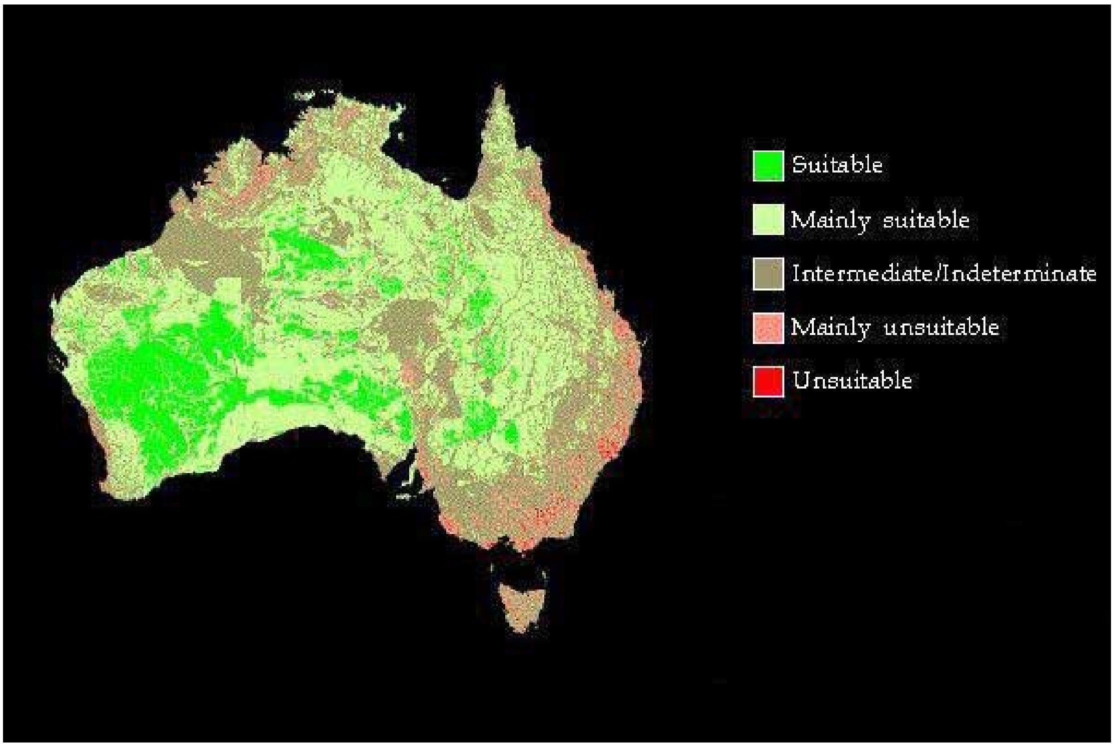
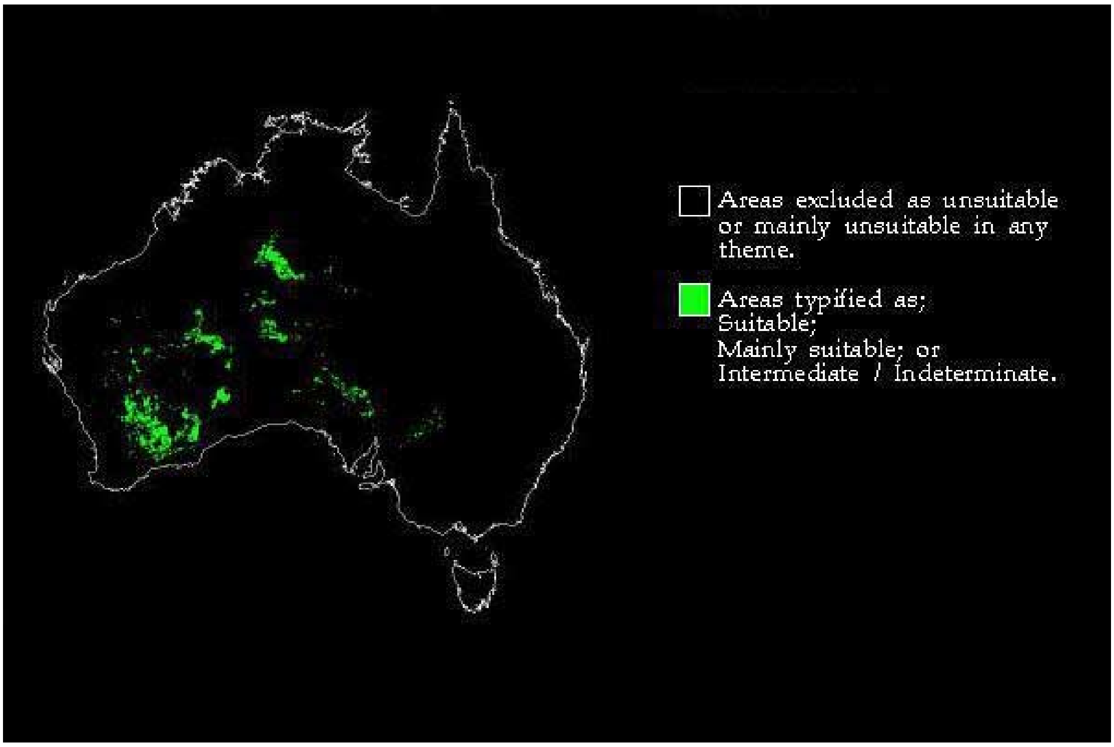


**Figure 3: Example excluding unsuitable or mainly unsuitable areas from any theme.**




## Conclusion

This study has developed and used an open and objective approach to site selection. A geographical information system was used to assemble continental-scale information. The information was classified according to suitability criteria and processed to show how the most suitable areas for locating Australia's low-level radioactive waste repository could be identified.

The test results show that different regions are identified when different selection criteria are used. The results in this discussion paper are indicative only and are intended to provide a focus for more detailed studies at regional and local levels following public comment on the criteria and methodology.

The methodology for identifying a suitable site for a national repository for radioactive wastes will be re-applied with more detailed information to areas identified in this study and on the basis of public comments.

# Appendix 1: Repository design and operation

## Design

The repository will include disposal facilities for Class A, B and C wastes, a buffer zone, a building for receipt, handling, and short term storage of the wastes, accommodation and amenities for staff, an access road from the nearest highway or railhead, roads and tracks on the site, electrical power and freshwater, site drainage and pondage, security fences, monitoring equipment, and instruments for radiological surveillance and the detection of groundwater movement.

The disposal facilities will take the form of structures designed and engineered to control infiltration of water, to provide structural stability to limit subsidence, and to ensure concentrations of radionuclides in groundwater leaving the buffer zone do not exceed limits set by the regulatory authorities.

The radioactive waste in the structures will be contained by a series of barriers of different types depending on the characteristics of the site. The barriers will prevent release of radionuclides and protect against inadvertent intrusion into the disposal structure. Barriers could be the waste form; the waste packaging; engineered structures, or the natural site characteristics. In an optimum situation (e.g. in an area where migration of radionuclides is inhibited by natural barriers) artificial barriers in addition to packaging might not be necessary.

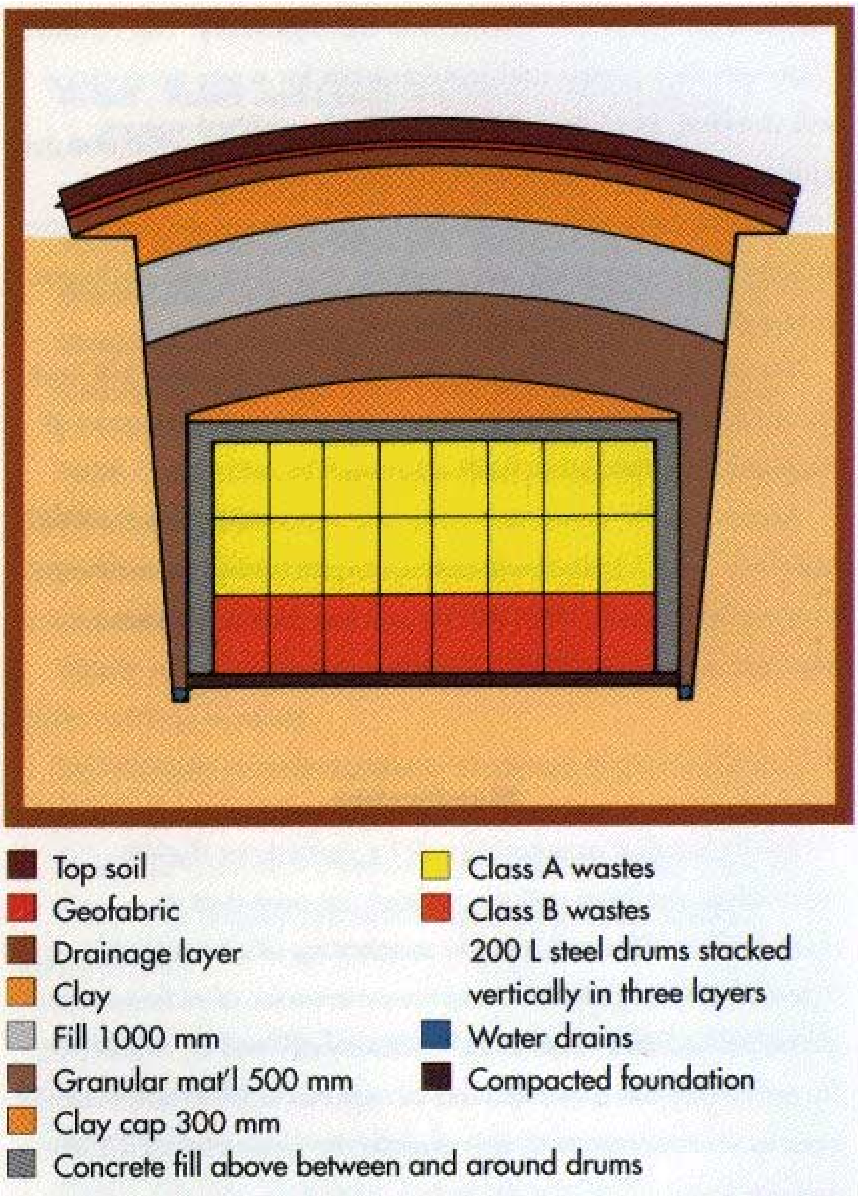
A suitably engineered cover will be designed for the disposal structure to exclude water and control erosion. For each category of waste the minimum cover requirements will meet the standards of the NHMRC *Code*, with a distance of two metres between the top of the waste and the surface for Category A waste and five metres for Category B or C waste.

A surface water management system will be incorporated to control water erosion of the cover and to divert water away from the partially filled disposal structure. Drainage will be provided so that any water entering the structure during and after operation can be removed to minimise the time that it stays in contact with waste items. This water can be disposed of by evaporation

Figure 4 provides a general overview of the elements that could be used in the design of the structure. Combinations of elements will be used depending on the site's specific characteristics. The design in Figure 4 includes a cover of natural materials such as clay but engineered artificial barriers could replace some of these components.

A buffer zone will be large enough to conduct environmental monitoring, to allow for any remedial measures, and to ensure an adequate distance between the facility and the public.

**Figure 4: Conceptual trench design (cross-sectional view).**




## Operation

Given the relatively small annual rate of increase in the radioactive waste inventory, waste holders will arrange for their wastes to be delivered to the facility during one or two weeks each year. For the rest of the year the facility will require minimal staff on site for surveillance and security. Interim storage facilities will be required for central collection points for wastes pending transport to the disposal facility once a year. These storage facilities will sort, package and label the wastes, and may also provide facilities for waste conditioning.

Appropriate conditioning, packaging and labelling of waste will be required before transport to the repository. The NHMRC Code specifies criteria and requirements for waste acceptance and disposal, including control of liquids, unfilled spaces, structural stability, chemical characteristics and external radiation. Quality controls will be in place to ensure that wastes arriving at the repository are properly described and packaged in compliance with the NHMRC Code.

Transport of the radioactive waste to the repository will be in accordance with the *Code of Practice for the Safe Transport of Radioactive Substances, 1990.*

Access will be controlled while the repository is operational. After it is closed control will continue until wastes have decayed to acceptable levels. This will be not less than 100 years, as required under the NHMRC Code.

## Monitoring

Environmental monitoring will be carried out during repository operation and throughout the period of its management. This will include monitoring of groundwater, external gamma radiation, and concentrations of radionuclides in the air, soil and vegetation. Groundwater will be monitored by measuring the concentration of radionuclides in bore water at various locations both in and outside the perimeter of the site.

Figure 5 shows a conceptual plan of the site and indicates possible locations of bores for monitoring groundwater. Figure 6 shows a conceptual layout of the repository.

**Figure 5: Repository area lay-out.**

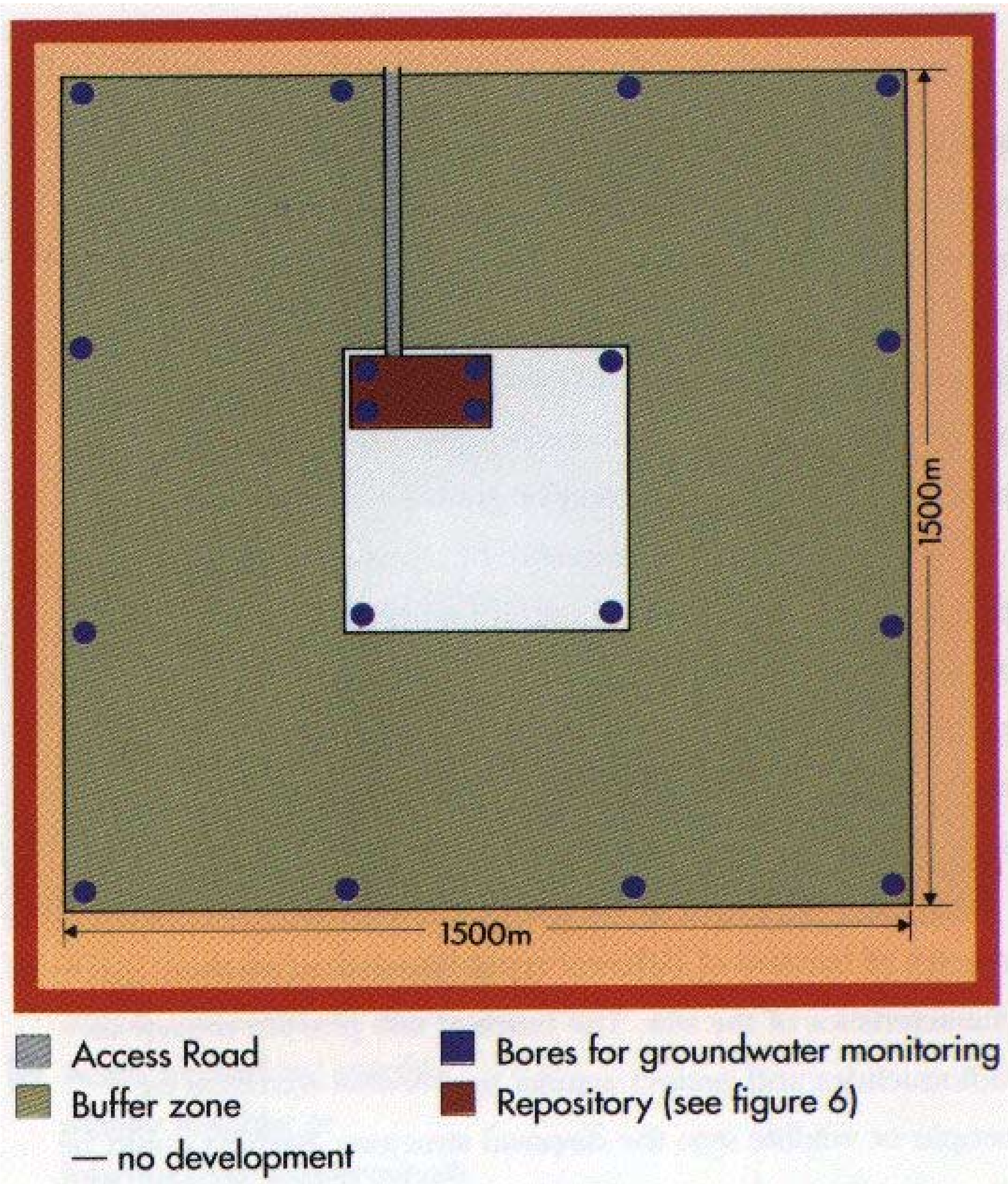
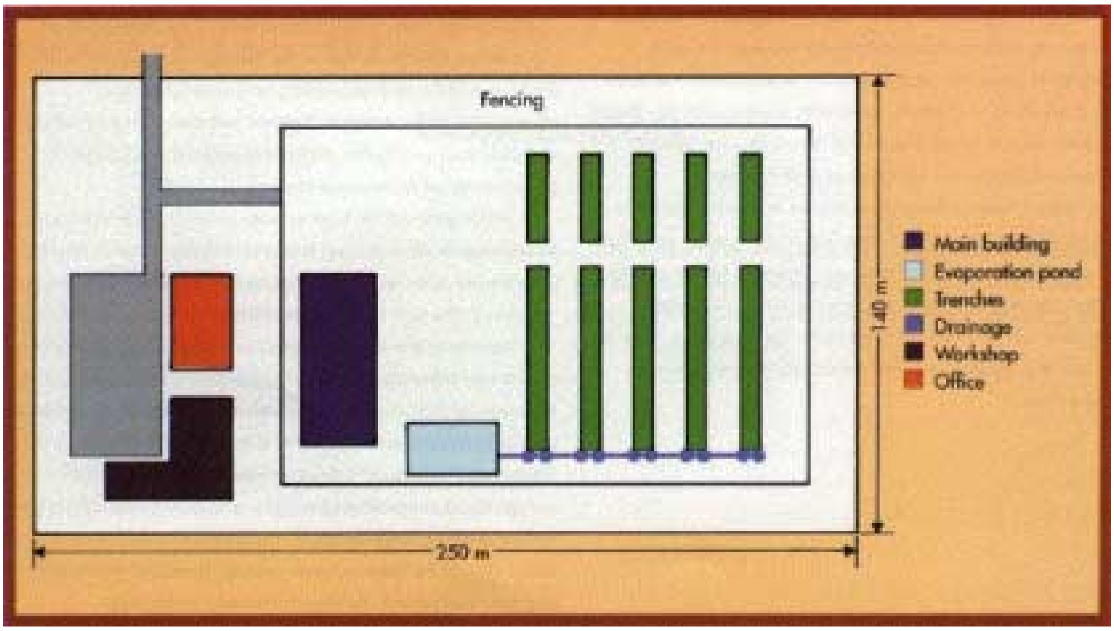


**Figure 6: Disposal site plan.**



# Appendix 2: Information sources and category descriptions

**Vegetation** - *Vegetation of Australia, 1:5,000,000 scale; AUSLIG, 1990.*

- Suitable: Hummock or tufted grass; other herbaceous plants
- Mainly suitable: Low and medium trees, shrubs; less than 10% foliage cover
- Intermediate/indeterminate: Low and medium trees, shrubs; 10- 30% foliage cover
- Mainly unsuitable: Medium trees, 30-70% foliage cover; Tall trees, 10-30% foliage cover
- Unsuitable: Medium trees; greater than 70% foliage cover

**Lakes, Rivers, Streams, Swamps** - *Hydrography, 1:2,500,000 scale; AUSLIG, 1987*.

- Suitable 1: Areas more than 2.5km distant from any lake, river, stream or swamp
- Unsuitable 5: Areas less than 2.5km distant from any lake, river, stream or swamp

**Hydrogeology** - *Hydrogeology of Australia, 1:5,000,000 scale; BMR, 1987.*

- Suitable: Local aquifer, low productivity
- Mainly suitable: Fractured or fissured, extensive, low-moderate productivity
- Intermediate/indeterminate: Fractured or fissured, extensive, highly productive
- Mainly unsuitable: Porous, extensive, low-moderate productivity
- Unsuitable: Porous, extensive, highly productive

**Groundwater quality** - *Beneficial Use Classification, 1:5,000,000 scale; BMR, 1992.*

- Suitable: No beneficial use
- Mainly suitable: Ecosystems, mining
- Intermediate/indeterminate: Stock
- Mainly unsuitable: Intensive industry/irrigation
- Unsuitable: Human consumption

**Water Balance** - *Rainfall/Pan Evaporation, 1:2,500,000 scale; modelled by NRIC, 1992; using digital elevation data, rainfall and pan evaporation data and climate estimation software, CRES, 1990, 1992.*

- Suitable: Rainfall/evaporation ratio 0 - 88 (Lowest rainfall, highest evaporation)
- Mainly suitable: Rainfall/evaporation ratio 89 - 125
- Intermediate/indeterminate: Rainfall/evaporation ratio 126 - 200
- Mainly unsuitable: Rainfall/evaporation ratio 201 - 400
- Unsuitable: Rainfall/evaporation ratio 401 - 7000 (Highest rainfall, lowest evaporation)

**Relief** - *Relief and Landform Map of Australia, 1:5,000,000 scale; CSIRO, 1969.*

- Suitable: Plainlands (relief less than 30m)
- Mainly suitable: Low relief (30 - 90m)
- Intermediate/indeterminate: Moderate relief (90 - 180m)
- Mainly unsuitable: High relief (180 - 365m)
- Unsuitable: Very high relief (over 365m); or tidal zones

**Soils** - *The Atlas of Australian Soils,* *1:2,000,000 scale; CSIRO, 1960-1968.*

- Suitable: Very high impermeability; very high water holding capacity
- Mainly suitable: High impermeability; high water holding capacity
- Intermediate/indeterminate: Moderate impermeability; moderate water holding capacity
- Mainly unsuitable: Permeable; low water holding capacity
- Unsuitable: Highly permeable; very low water holding capacity; rock

**Regolith** - *Regolith Terrain Map of Australia, 1:5,000,000 scale; BMR, 1986.*

- Suitable: Erosional, low relief, deep weathering, lateritic, clayey
- Mainly suitable: Erosional, low-moderate relief, weathered, fine- grained materials
- Intermediate/indeterminate: Erosional/depositional, moderate- high relief, variably weathered, stony
- Mainly unsuitable: Erosional, mountainous, minor weathering; or depositional, plains with water courses; or basalt, minor weathering
- Unsuitable: Depositional, flood plains, coastal plains, salt lakes, alluvial plains, swamps, dune fields; or bare rock

**Cainozoic cover** - *The Geology of Australia, 1:2,500,000 scale; BMR, 1976.*

- Suitable: Sand, silt, clay and gravel- alluvial, lacustrine, colluvial; clay, silt, minor sand- residual, some alluvial
- Mainly suitable: Quartz sand- aeolian and residual; minor ferruginous, aluminous and siliceous duricrust
- Intermediate/indeterminate: Gypsum, halite, clay, sand- evaporitic
- Mainly unsuitable: Ferruginous, aluminous, siliceous duricrust; calcareous sand and limestone- coastal aeolian
- Unsuitable: Limestone, terrestrial; minor and sand clay

**Bedrock geology** - *The Geology of Australia, 1:2,500,000 scale; BMR, 1976.*

- Suitable: Fine-grained clayey sediments
- Mainly suitable: Granitic rocks; gneiss; acid volcanics and intrusives; large mafic intrusives
- Intermediate/indeterminate: Metasediments; sediments with minor carbonates; coarse-grained sediments; basic volcanics
- Mainly unsuitable: Sediments with substantial carbonates; ultramafic and mafic intrusives
- Unsuitable: Limestone, dolomite

**Faults** - *The Geology of Australia, 1:2,500,000 scale; BMR, 1976.*

- Suitable: Greater than 2.5 kilometres from a major fault
- Unsuitable: Less than 2.5 kilometres from a major fault

**Earthquake hazard** - *Earthquake Hazard Map of Australia, 1:10,000,000 scale; BMR, 1992.*

- Suitable: Low frequency, less than 0.05m/s/s
- Intermediate/indeterminate: Intermediate frequency, greater than 0.05 &less than 0.10m/s/s
- Unsuitable: High frequency, greater than 0.10m/s/s

**Thunderdays** - *Average Annual Thunderday Map of Australia, 1:10,000,000 scale; Bureau of Meteorology, 1967.*

- Suitable: 0 to 10 days/year
- Mainly suitable: 10 to 20 days/year
- Intermediate/indeterminate: 20 to 40 days/year
- Mainly unsuitable: 40 to 60 days/year
- Unsuitable: 60 or more days/year

**Cyclone risk** - *Average decadal incidence of tropical cyclones, July 1959 - June 1990, 1:10,000,000 scale; Bureau of Meteorology, 1990.*

- Suitable: Less than 5 cyclones/decade
- Unsuitable: Greater than 5 cyclones/decade

**Population density** - *Population density based on Statistical Local Areas, 1:250,000 scale; NRIC, 1992; using Australian Bureau of Statistics, 1986 Census statistics; SLA's, AUSLIG, 1986.*

- Suitable: up to 1 person/1000 hectares
- Mainly suitable: 1 to 5 people/1000 hectares
- Intermediate/indeterminate: 5 to 10 people/1000 hectares
- Mainly unsuitable: 10 to 50 people/1000 hectares
- Unsuitable: 50 or more people/1000 hectares

**Locations** - *Master Names File, 1:2,500,000 scale; AUSLIG, 1987 (for example: towns, homesteads, water bores).*

- Suitable: Areas beyond a 35km square
- Mainly suitable: Areas between a 25 and 35km square
- Intermediate/indeterminate: Areas between a 15 and 25km square
- Mainly unsuitable: Areas between a 5 and 15km square
- Unsuitable: Areas within a 5 km square

**Tenure** - *Land tenure, 1:250,000 scale; AUSLIG, 1991.*

Suitable: Vacant Crown lands

- Mainly suitable: Reserved Crown lands
- Intermediate/indeterminate: Private lands, Aboriginal lands, two or more other types applicable
- Mainly unsuitable: Defence; forestry; mining reserve; other institutional Crown lands
- Unsuitable: Nature conservation reserve; water supply reserves

**Roads & Railways** - *Main roads, Railways, 1:2,500,000 scale; Topographic Culture, AUSLIG, 1987.*

- Suitable: Less than 10km distant from ...
- Mainly suitable: Between 10 and 25km distant from ...
- Intermediate/indeterminate: Between 25 and 50km distant from ...
- Mainly unsuitable: Between 50 and 100km distant from ...
- Unsuitable: Greater than 100km distant from ...