5 PROPOSAL DEFINITION

5.1 Proposal overview and key characteristics

5.1.1 Introduction

The proponent is seeking environmental approval to construct and operate a dual revenue business. The first aspect of the dual revenue model relates to the mining, processing and export of kaolin. The second aspect relates to the long-term storage, recovery and permanent isolation of hazardous and intractable wastes in mine voids. If approved, the Proposal would be located in remote WA (Figure 1-1 and Figure 1-3).

The placement of these wastes in a near surface repository, based on international best practice techniques, would isolate the wastes from the biosphere over geological time.

As descried in the ESD, work excluded from this Proposal includes the transport of waste materials to the Sandy Ridge Facility. This aspect of the Proposal would be addressed under the appropriate legislation, guidelines and codes.

Any low level radioactive waste transport would be carried out in accordance with the *Australian Code for the Transport of Dangerous Goods by Road & Rail* as class 7 Dangerous Goods if it is being transported as a consignment carrying additional classes of Dangerous Goods. In certain circumstances, radioactive wastes may need to be transported as "exclusive use" consignments in accordance with the ARPANSA *Code for the Safe Transport of Radioactive Material* (2014) which adopts the International Atomic Energy Agency *Regulations for the Safe Transport of Radioactive Material 2012 Edition (SSR-6).*

It would be the responsibility of appropriately licensed reputable logistics companies with trained drivers, roadworthy vehicles, and strict transport plans that include a detailed 24 hour and 7 day a week emergency response management plan in the unlikely event of an emergency. Transport to site would only occur with the proponent's approval (the proponent's QA/QC system).

5.1.2 Location

The Proposal is located approximately 75 km north-east of Koolyanobbing, WA (refer to Figure 1-1). Access is via a 95 km length of the IWDF access road that extends northward from Great Eastern Highway; a 4.5 km westwards section and a 5.3 km northwards section of site access road into the proposed development envelope (refer to Figure 1-4).

There are no sensitive environmental or human receptors within 5 km of the proposed cell area. The nearest operation is the IWDF located approximately 5.5 km to the east, which operates on a campaign basis and does not have permanent residents. The nearest permanent mining camp is the Carina Iron Ore Mine Accommodation Village located approximately 52 km to the south of the proposed development envelope (refer to Figure 1-4).

5.1.3 Kaolin

The Proposal would produce up to 40,000 tpa of refined kaolin for ceramic paint and other industrial uses (Plate 5-1). The ore would be processed via an onsite wet processing plant (refer to Section 5.4.4 for more information) and the kaolin products would be transferred from Sandy Ridge to the domestic market or to Fremantle Port for export overseas. All overburden (sandy clay, laterite gravel and silcrete) would be returned to the cells for use in backfill around buried waste. After a monitoring period the topsoil is returned and the surface revegetated using locally sourced plant material.

Plate 5-1 Ceramic and industrial uses of kaolin

5.1.4 Waste emplacement

The waste aspect of the Proposal involves storage of up to 100,000 tpa or up to 2.5 million tonnes of intractable, hazardous and low level radioactive wastes in the mine voids over a period of 25 years. Wastes would be accepted predominantly from within WA but also accepted from across Australia and from Australia's Exclusive Economic Zone.

Cells would be filled with wastes in layers with multiple sections in each layer. All space between waste packages would be backfilled and compacted to minimise air or void space which may result in settlement. Each layer would be compacted, until approximately 7 m below the ground surface, where a thick layer of low permeability clay would seal the waste layers to prevent water ingress into the cell.

Following this, compacted gravel and laterite backfill and a clay domed cap would be situated on the top of the cell, to horizontally shed any landing rainfall. At the completion of a subsidence monitoring period, soil would be placed over the domed clay cap to enable re-vegetation. During the waste disposal process a roof canopy would be positioned over the cell to exclude rainfall prior to the capping layer being installed.

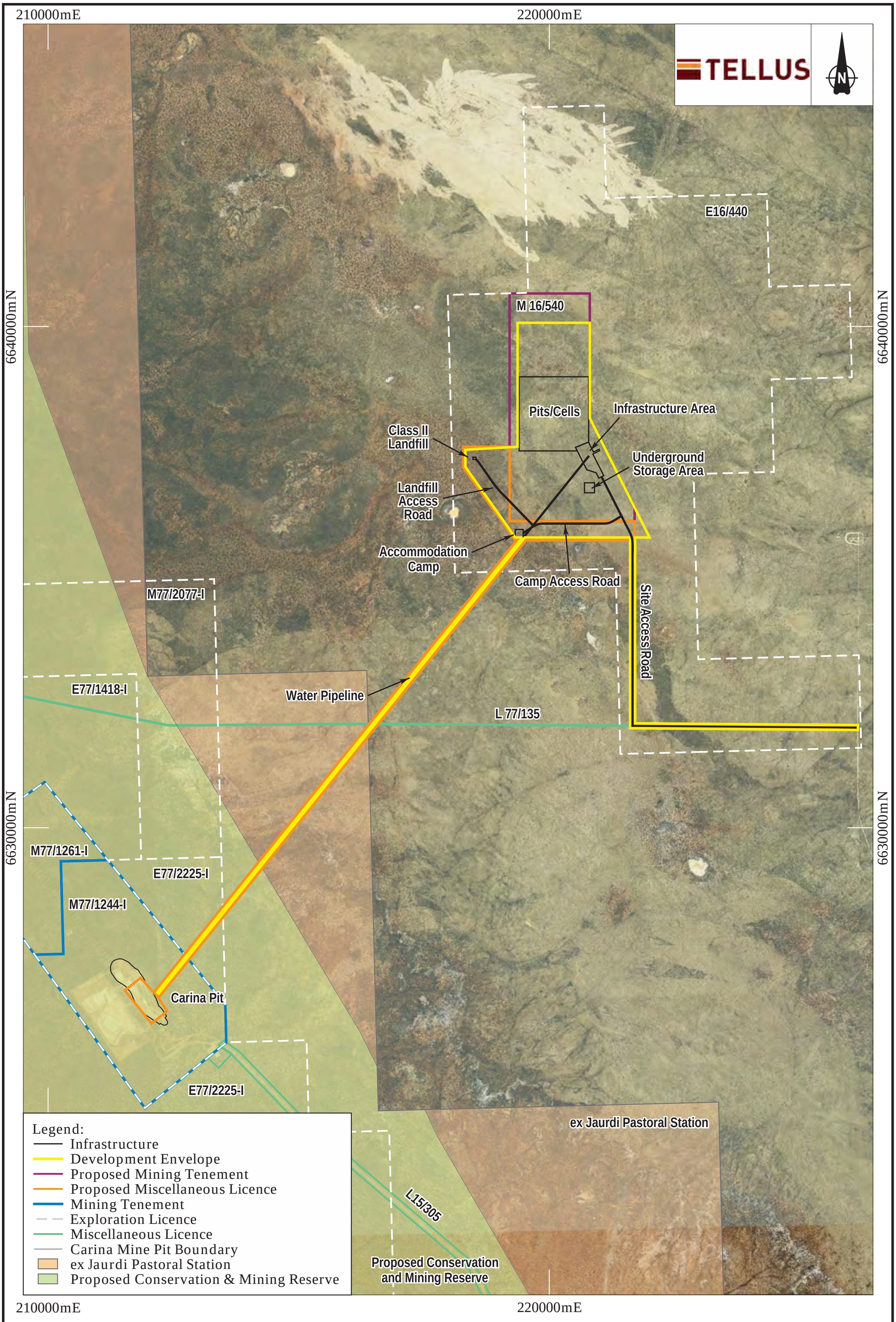
There are some waste types that may be placed in a cell without a roof, as the materials being placed are not immediately leachable, such as some contaminated soils and contaminated railway sleepers. Any such cell construction would be designed with a drainage sump to enable pumping-out of any direct precipitation whilst the cell is open. In addition, any potential stormwater surface flows would be diverted away from the cells by bund walls or levee banks.

5.1.5 Key Proposal characteristics

In accordance with *Environmental Assessment Guideline for Defining the Key Characteristics of a Proposal* (EAG1) (EPA, 2012), the key characteristics of the Proposal are defined in Table 5-1.

Table 5-1 Key Proposal characteristics

Summary of the Proposal		
Proposal title	Sandy RidgeFacility.	
Proponent name	Tellus Holdings Ltd.	
Short description	The Proposal is to develop a kaolin open cut and use the voids resulting from mining for the secure storage, recovery and permanent isolation of hazardous, intractable waste and low level radioactive waste using an international best practice storage and isolation safety case. The Proposal is located approximately 75 km north-east of Koolyanobbing, WA (Figure 1-1).	
PHYSICAL ELEMENTS		
Element	**Location**	**Proposed Extent Authorised**
Pits/Cells	Figure 1-3	Clearing no more than 202.3 ha within 1004.2 ha proposed development envelope.
Mine infrastructure	Figure 1-3	Clearing no more than 17.2 ha within 1004.2 ha proposed development envelope.
Accommodation camp	Figure 1-3	Clearing no more than 2.5 ha within 1004.2 ha proposed development envelope.
Class II landfill	Figure 1-3	Clearing no more than 0.25 ha within 1004.2 ha proposed development envelope.
Future technology park	Figure 1-3	Clearing no more than 4 ha within 1004.2 ha proposed development envelope.
Access roads	Figure 1-4	Clearing no more than 22.2 ha within 1004.2 ha proposed development envelope.
Water pipeline	Figure 5-1	Clearing no more than 27.6 ha within 1004.2 ha proposed development envelope.
Total disturbed area		Clearing a maximum of 276.05 ha within 1004.2 ha proposed development envelope.
OPERATIONAL ELEMENTS		
Element	**Location**	**Proposed Extent Authorised**
Ore Processing	Kaolin Plant, Figure 1-3, coordinates: 220800mE, 6637520mN	Kaolin plant design capacity per annum 40,000 t. Maximum amount disposed 1,000,000 t over a 25-year period
Class IV and Class V waste disposal	Pits/Cells, Figure 1-3 coordinates: 219920mE, 6638195mN	Disposal of no more than 100,000 tpa. Average amount per annum 66,000 t. Maximum amount disposed 2,500,000 t over a 25-year period.
Class II Landfill for waste generated on the site	Class II Landfill, Figure 1-3 coordinates: 218507mE, 6637370mN	Disposal of no more than 500 tpa.
Water use	Water source shown in Figure 5-1 coordinates: 220770mE, 6637430mN	0.18 gigalitres per annum sourced from water tanks onsite that are supplied via a water pipeline from the Mineral Resources Carina Iron Ore Mine.



0 1.5km

Scale 1:100,000
MGA94 (Zone 51)

CAD Ref: g2294_PER_05_01.dgn
Date: November 2016 | Rev: J | A4

Aurora environmental

Author: C. Dorrington | AE Ref: THO2014-003
Drawn: CAD Resources ~ www.cadresources.com.au
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Sandy Ridge Facility

Water pipeline route

Public Environmental Review

Figure:

5-1

5.2 Land use, ownership and tenure, zoning

5.2.1 Current land use

The proposed development envelope is on unallocated Crown land managed by the WA Government, with no current land use or occupation. The proponent holds an exploration licence (E16/440) over 5930 ha of land which has been explored since 2013. The proposed development envelope covers 1004.2 ha (17%) of the exploration lease (refer to Figure 5-2).

5.2.2 Ownership and tenure

The proposed development envelope is located on Crown Land. As the mining and waste disposal aspects would occur simultaneously on the same land, the proponent would require co-existing tenure for each of its mining and non-mining activities.

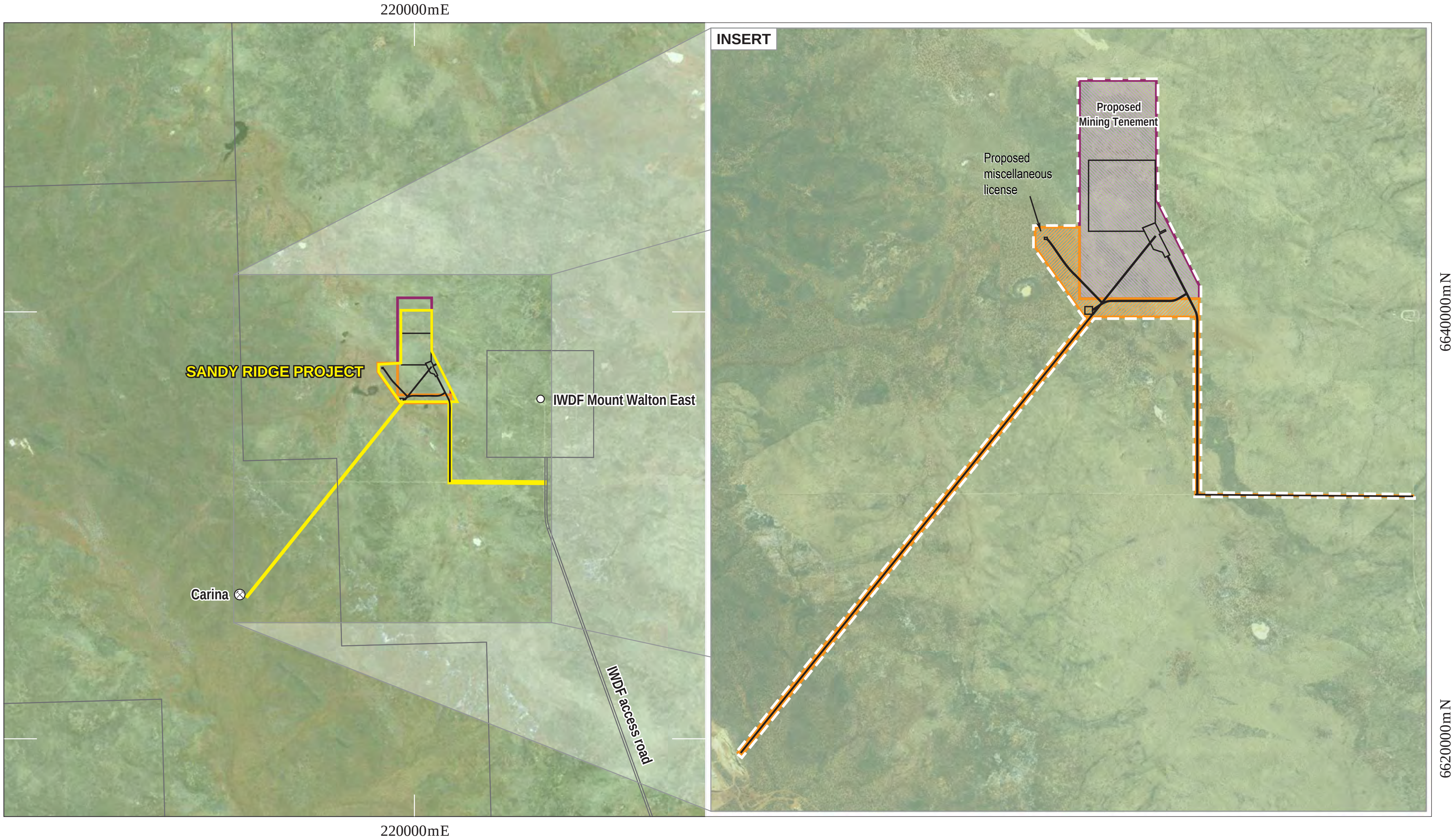
For the purposes of mining activities, would access the land through a mining lease (M16/540) and conduct other mining related activities under miscellaneous licences issued under the *Mining Act 1978* (refer to Figure 5-2). The proponent would also apply for a general-purpose lease for supporting activities.

To implement the waste disposal aspect of the Proposal, the proponent would be applying for a Crown Lease or Reserve over the proposed development envelope. The lease or reserve term would need to align with the Proposal lifecycle so is expected to be for a term of at least 45 years. Crown easements would be also applied for over linear infrastructure and the proponent would have the right to operate the water pipeline and access roads within these easements. The proponent is continuing discussions with Department of Lands and DMP with a view of achieving an in-principle agreement on the terms of the lease (or reserve) and the financial provisions when the land would be reverted to Crown managed land, most likely in the form of a Managed Reserve.

As Department of Lands is a DMA for the proposal under the EP Act*,* it is precluded from executing a lease until a Ministerial Statement pursuant to Section 45 of the EP Act is issued allowing the proposal to proceed. An indicative lease area is shown on Figure 5-2. A range of other tenure related approvals, e.g. section 165 order, compulsory acquisition steps and easement matters would also be addressed through further consultation with the DMP and Department of Lands.

5.2.3 Zoning

The Proposal's footprint stretches across two shires, namely the Coolgardie Shire and the Yilgarn Shire. The proponent has had discussions with the Yilgarn Shire who advised there would be no approval required from them, as the only infrastructure within that shire is a water pump station and pipeline. Land that occurs within the Coolgardie shire is zoned 'rural/mining' under the Shire of Coolgardie's Town Planning Scheme No. 4 (TPS4) (refer to Figure 5-2). This zoning is appropriate for the Proposal to be developed, and no scheme amendment is required (pers comm. J O'Brien, Shire of Coolgardie, 16 November 2015). Planning approval for the Proposal through the Shire of Coolgardie would be applied for prior to commencement of construction.



Legend:
- Infrastructure
- Development Envelope
- Proposed Mining Tenement
- Proposed Miscellaneous Licence
- Indicative Reserve Area
- Scheme Zoning - Rural / Mining Area

Notes
- Scheme Zoning supplied by DoP (2015)

TELLUS

N

0 5km

Scale 1:250,000
MGA94 (Zone 51)
CAD Ref: g2294_PER_05_02.dgn
Date: Nov 2016 | Rev: B | A4

Author: C. Dorrington | AE Ref: THO2014-003
Drawn: CAD Resources ~ www.cadresources.com.au
Tel: (08) 9246 3242 ~ Fax: (08) 9246 3202

Sandy Ridge Facility

Landuse, tenure and zoning

Public Environmental Review

Figure:

5-2

5.3 Proposal lifecycle

The proponent is seeking approval and an operating licence for the Proposal for a 25-year period. Following the cessation of mining and waste disposal, rehabilitation and institutional control would follow for a period of time. The typical Proposal life cycle has several key milestones as described below and presented in Figure 5-3:

- **Year 1**: at the completion of year one, the initial mine pit would have been excavated, with ore stockpiled ready for processing and up to 50,000 t of waste placed in the cell. How much waste is placed in the cell may vary due to the initial ramp-up of the business. Once the waste cell is full, the cap is completed and subsidence monitoring of the cell commences.
- **Year 11**: subsidence monitoring finishes on the first cell. Topsoil is respread and seeded, and vegetation established. Vegetation monitoring commences. Other cells completed during the previous decade continue to be monitored for subsidence.
- **Year 21**: vegetation monitoring finishes on the first cell, which is considered rehabilitated. Other cells completed during the previous two decades continue to be monitored for subsidence and vegetation growth.
- **Year 25**: at the completion of year 25, up to 7,250,000 t of ore may have been processed, and up to 2,500,000 t of hazardous, intractable and LLW may have been stored. Unless the proponent wishes to continue operations and an extension of the approval and licence is granted), mining and waste storage would cease. In accordance with the Waste Facility Decommissioning and Closure Plan (WFDCP), the cells would have been backfilled and capped, with various stages of rehabilitation and subsidence monitoring in progress.
- **Year 35**: subsidence monitoring on all cells is completed.
- **Year 45**: relinquishment of tenements under the *Mining Act 1978*. All mining related infrastructure has been decommissioned and surfaces revegetated in accordance with the Mine Closure Plan (MCP). Vegetation monitoring on all cells is completed. The Facility is rehabilitated and infrastructure decommissioned. Transfer of the management of the Facility to the WA Government along with financial provision for the management of the Facility during the institutional control period (ICP).
- **End of ICP**: the state of WA controls the Facility for the ICP (as described in Section 5.13).

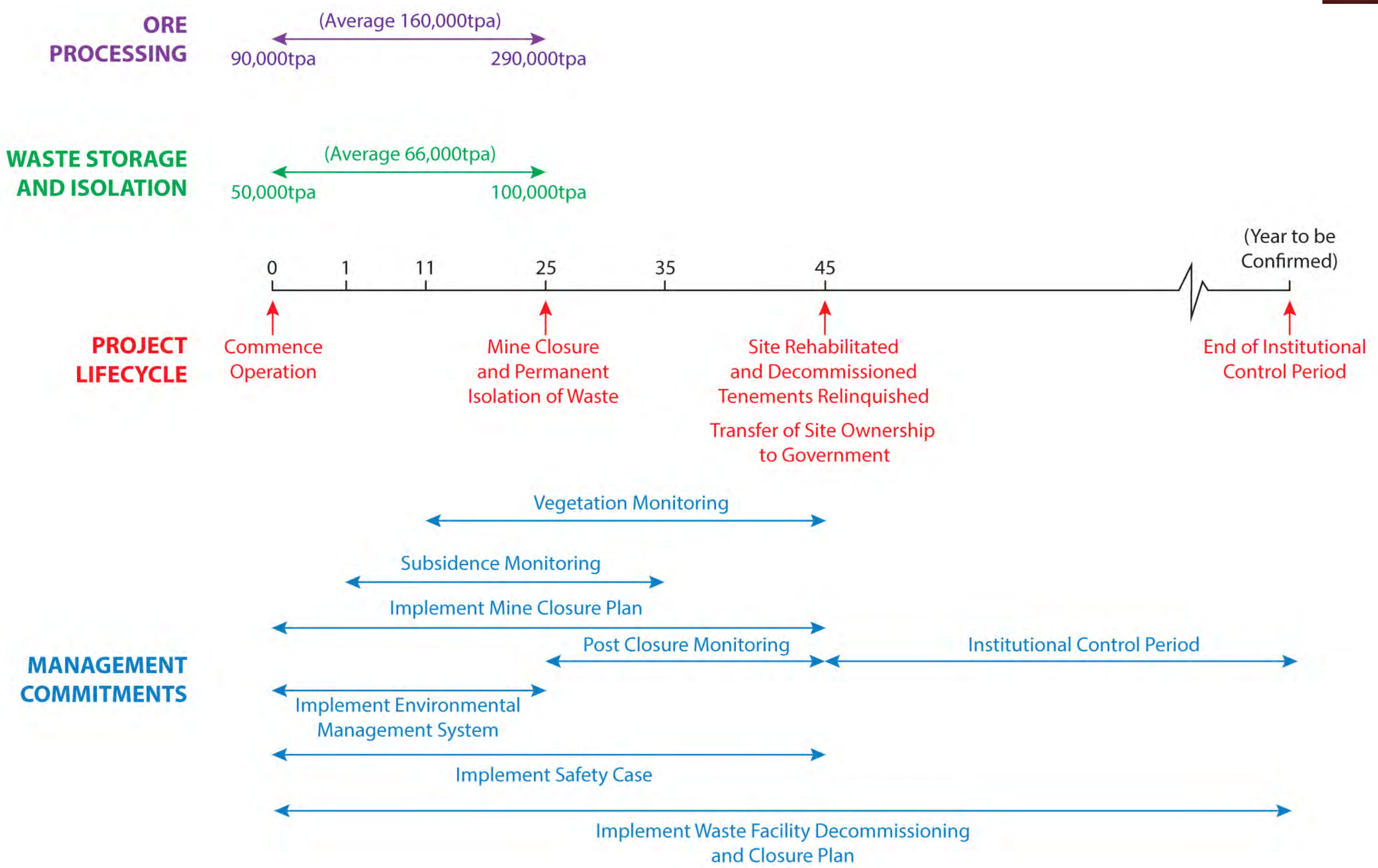


Figure 5-3 Proposed Sandy Ridge Facility lifecycle

5.4 Mining operations

5.4.1 Mineral resource

Exploration drilling has identified a JORC Inferred Mineral Resource of 17.6 million tonnes of kaolinised granite, with 9.5 million tonnes classified as ceramic grade and 8.1 million tonnes classified as paint grade. A 17.6 million tonne resource is likely to provide sufficient ore for at least a 25-year mine life.

5.4.2 Enabling and construction phase

Enabling works would include construction and commissioning of infrastructure. Infrastructure to be constructed and used for the mining operation includes:

- A kaolin processing plant.
- A kaolin ore stockpile area (run of mine [ROM] pad).
- A finished product (kaolin) storage building.
- A laboratory.
- Mining contractor offices and laydown yard including repair and maintenance facilities for earthmoving and plant equipment, saline water ponds, reverse osmosis plant, and an explosive magazine.

Waste related infrastructure to be constructed includes:

- Relocatable waste cell roof canopy and rail system.
- Container hardstand.
- Waste inspection area.
- Radioactive waste warehouse and packaging building.
- A waste laboratory.
- A waste solidification and stabilisation Facility comprising of waste storage, consumables storage and blending and mixing equipment. This is anticipated to be similar in size and layout to a small concrete batching plant.
- Truck and machinery wash-down pad, wash-down water system (including treatment and storage), front gate office, secure site fencing and gatehouse incorporating a computerised weighbridge.

In addition to the construction and commissioning of infrastructure the following activities would be undertaken:

- Construction of the site access roads and internal haul roads.
- Upgrade of the IWDF access road and intersection at Great Eastern Highway.
- Construction of a mobile and permanent accommodation camp.
- Construction of the water pipeline and associated pump station at the Carina Mine pit.
- Construction of administration building and carpark (including offices, first aid, training centre, communications, lunch room, and ablutions).
- Excavation of a trench at the Class II putrescible landfill location and erection of a fence around the landfill.
- Installation of sewage treatment systems.
- Installation of water tanks for raw and potable water.
- Installation of diesel storage tanks, piping reticulation and bowser.
- Installation of drying process fuel storage tanks.
- Installation of switchboards and generators.
- Removal and stockpiling of vegetation and topsoil from infrastructure area and construction of all infrastructure.
- Continued collection of weather data.
- Baseline studies as required by the MCP.
- Construction and commencement of plots for final capping design optimisation and revegetation trials.
- Continued monitoring of groundwater bores.
- Erection of a fence around infrastructure area and pits.

5.4.3 Operations phase

Mining would be carried out in campaigns on a frequency commensurate with the volume of wastes to be isolated. The frequency of mining campaigns is likely to commence at one every year, but the actual frequency is dependent on the depth of mining in each area, the demand for kaolin products and the timing of waste deliveries.

Mining campaigns could be as frequent as twice per year but are typically expected to occur at a rate of one every 12 to 18 months. Depending on the depth of the mine pit, a single waste cell would hold approximately 30,000 to 75,000 tonnes of waste material.

Sequence of pits

Pits would be constructed in sequence along a common alignment whenever possible, before moving to an adjacent alignment and returning in the opposite direction (refer to Figure 5-4).

Figure 5-4 Conceptual layout of mine pits at year 6

Current mine planning is for approximately 25 pits to be constructed. Each mine pit and waste cell would be nominally 120 m long, 60 m wide and 23 m deep (depending on local stratigraphy with a maximum depth of 30 m).

The cell would be covered by a roof canopy, most likely consisting of a steel lattice frame with a fabric covering that would be approximately 65 m wide and 120 m long. This allows the roof canopy to be relocated from one pit to the next on temporary rail tracks. The purpose of the roof is to prevent rainfall from entering the waste cell during the waste storage and isolation operation (refer to Figure 5-5).

There are some waste types which may be placed in a cell without a roof as the materials being placed are not immediately leachable. Any such cell construction would be designed with a drainage sump to enable pumping out of any direct precipitation whilst the cell is open.

Figure 5-5 Conceptual view of pit being mined and pit with roof canopy

A cross section of a typical mine pit is shown in Figure 5-6. Based on exploration drilling results the average overburden (sandy clay, laterite gravel and silcrete) thickness is 6 m. Beneath the overburden, the kaolinised granite (i.e. the mineral resource) is on average 17 m thick (6 m to 23 m depth).

Beneath the kaolin zone is a saprock zone (kaolinite, including some incompletely weathered granite). Below the saprock zone (23.5 m to 28.5 m) is unweathered granite (beyond 28.5 m, typically at 30 m). Note that the transitions between geological units are gradational and identification of boundaries is very subjective.

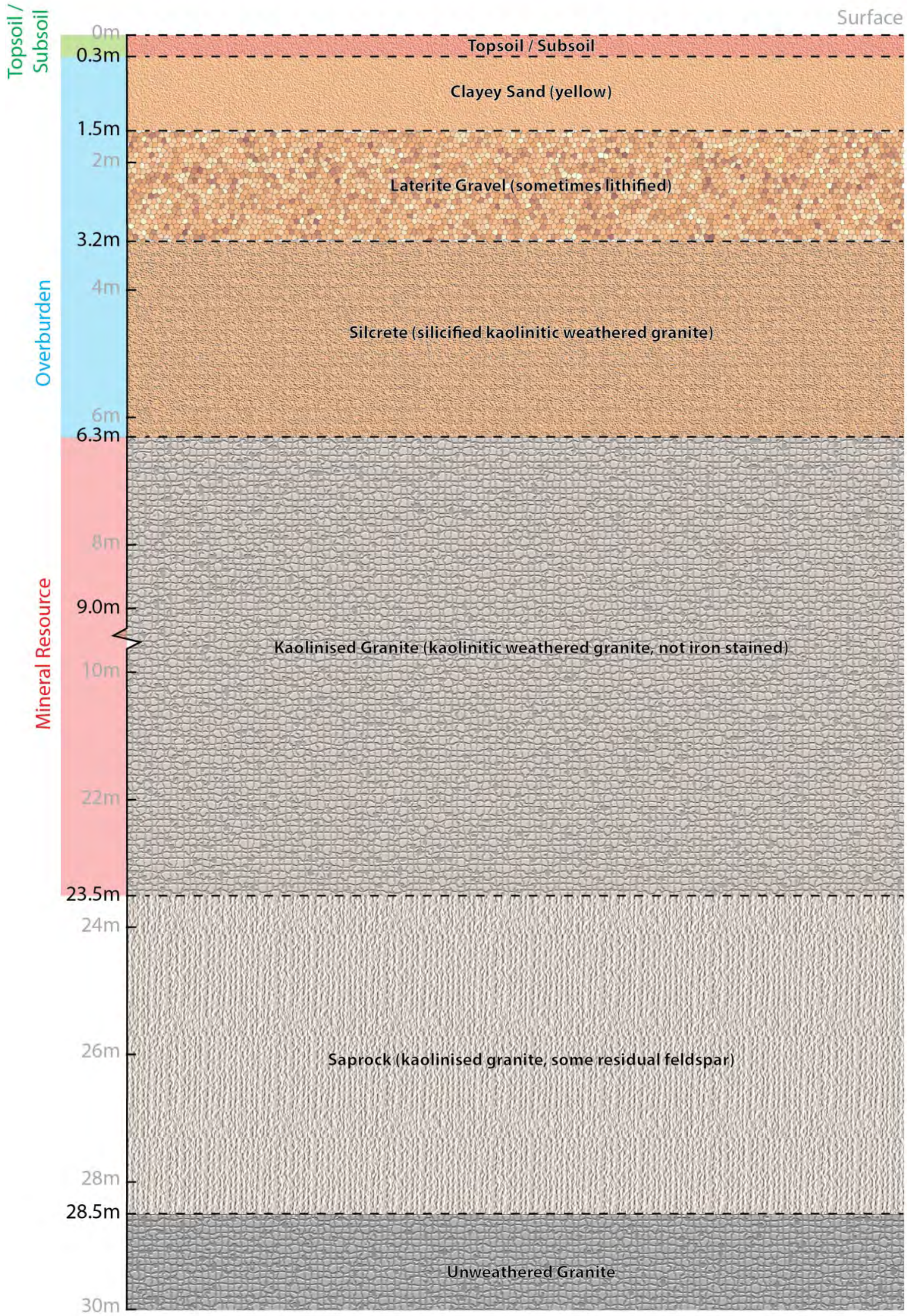


Figure 5-6 Cross section of a typical mine pit

Mining method

The principal mining method would be open cut to extract overburden and kaolin ore. The surface area of each kaolin pit would be cleared of vegetation. Cleared vegetation would be stockpiled and re-used in rehabilitation. The cell would then be opened by excavation of the topsoil, subsurface soil and laterite. Following this, there would be carefully controlled blasting using explosives or continuous mining of the hard, dense silcrete layer that overlays the kaolin, and then removal by excavator and truck.

The kaolin would then be recovered by conventional earthmoving equipment. Based on drilling results, the kaolin ore is very dry at approximately 10% moisture, and is free-digging. The kaolin overburden and ore mining plant fleet is likely to consist of a front-end loader, excavator and articulated dump trucks. The dump trucks would deposit the kaolin in stockpiles adjacent to each pit or the kaolin process plant. Overburden would be stockpiled adjacent to the cells in readiness for backfilling (refer to Figure 5-7).

Figure 5-7 Stockpiles adjacent to pits/cells

Separate stockpiles of different grades of kaolin ore would be located adjacent to the kaolin processing plant or each pit.

Excavation to the pit base

The elevation of the base of the pits would vary depending on the location of the mineral resource and the elevation of the top of the saprock. Mine-planning activity would ensure that at least 5 m of kaolinised granite remains in situ between the bottom of the pit and above the top of the unweathered granite.

This would be achieved through mine planning and grade control drilling. The location of each drill hole would be surveyed so that any hole penetrations within the mining pit areas would be known, and any locations where 'over-drilling' below the pit floor elevation has taken place would be carefully backfilled with compacted kaolinitic material. This process would ensure that the drilling activities do not provide preferential pathways in the unweathered granite if in the unlikely event a contaminated plume was ever generated from cells.

Transition from mine pit into waste cell

During mining, the excavation is termed a 'pit', once it is completed and ready for waste storage and isolation activities, it is termed a 'cell'.

In a typical cycle, one new mining pit would be excavated with the mining activities being scheduled to finish just prior to the previous pit (now a waste cell) being completely filled (refer to Figure 5-8). This would minimise the time that a completely mined pit would remain open to the weather. All surfaces within the pit would be graded to manage any precipitation which would run-off to a sump. The sump would be maintained in a dry state by a diesel powered portable pump, discharging to a pond at surface level.

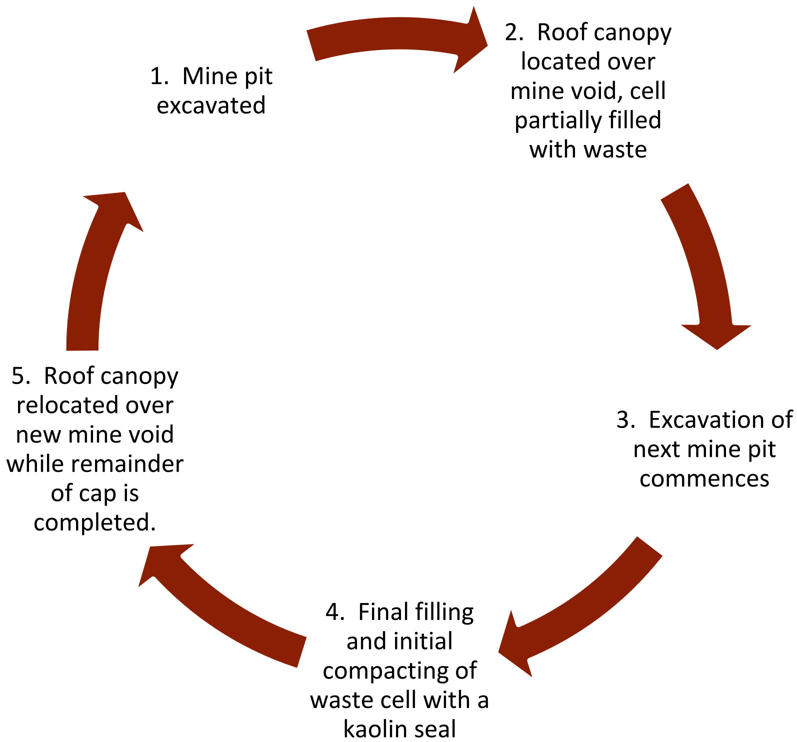


Figure 5-8 Normal sequence of mining and waste isolation

As soon as the last waste placement has taken place in a cell, the final filling and compacting of the waste cell cap would commence. Upon completion of the first 0.3 m of the lower compacted kaolin seal (grading to a run-off sump and pump), the portable roof canopy would be relocated over the newly excavated mine pit, which then becomes a waste cell.

The cycle then repeats as required. Should the kaolin production and waste disposal activities increase in scale due to market demand, the frequency of this cycle would simply increase.

5.4.4 Kaolin process description

A wet mineral processing circuit, as described further below, would be implemented to refine the kaolin product from the ore. A typical kaolin plant process flow diagram is provided in Figure 5-9. ROM feed material is recovered from the ore stockpile by a front-end loader and placed into a hopper feeding a trommel.

Material is screened and any oversize would be stockpiled for use in backfilling cells. Water is added at this point to produce a slurry which then undergoes a process of washing and hydro-cycloning to reject all quartz sand particles and recover the fine (<45 micron) kaolin clay particles. Varying portions of coarser kaolin particles are rejected in the hydro-cyclone stage to control the product properties depending upon the grade of product being produced at that time. The refined kaolin slurry is dewatered by filter press for drying in a gas-fired kiln before being packaged in bulk-bags or paper sacks on pallets. Some kaolin products may be further dried and pulverised into a dry powder before bagging.

Bagged product would be stored onsite pending quality assurance checks and to facilitate optimal transport arrangement. The on-site storage also provides buffer capacity between production and dispatch in the event of interruptions to either activity.

Forklifts would handle the bags from the filling stations in the plant, and for loading of stored bags onto trucks or into sea containers.

Waste streams from the kaolin processing plant consist of ROM oversize, waste quartz sand and de-watered coarse kaolin and very fine sand. All of these materials are used for backfill in the waste cell. The washed quartz sand is stockpiled on a drainage pad to recover and recycle process water and to ensure that the sand's moisture content is optimal for compaction. Some sand and screen oversize would be used for maintaining internal haul roads. To meet waste storage scheduling requirements some of these materials would need to be stockpiled close to the active waste cell for some portion of the year.

The only chemical which might be required for mineral processing is a small quantity of sodium hydroxide, to counter the natural acidity of the kaolin ore. Only fresh water is used in the circuit. The fuel for the dryer is likely to be Liquefied Petroleum Gas (LPG), as this is clean burning and would not produce soot or sulphur oxides which might affect the quality of the kaolin.

Imported bentonite clay may be added in small quantities to improve some end-use properties of the kaolin.

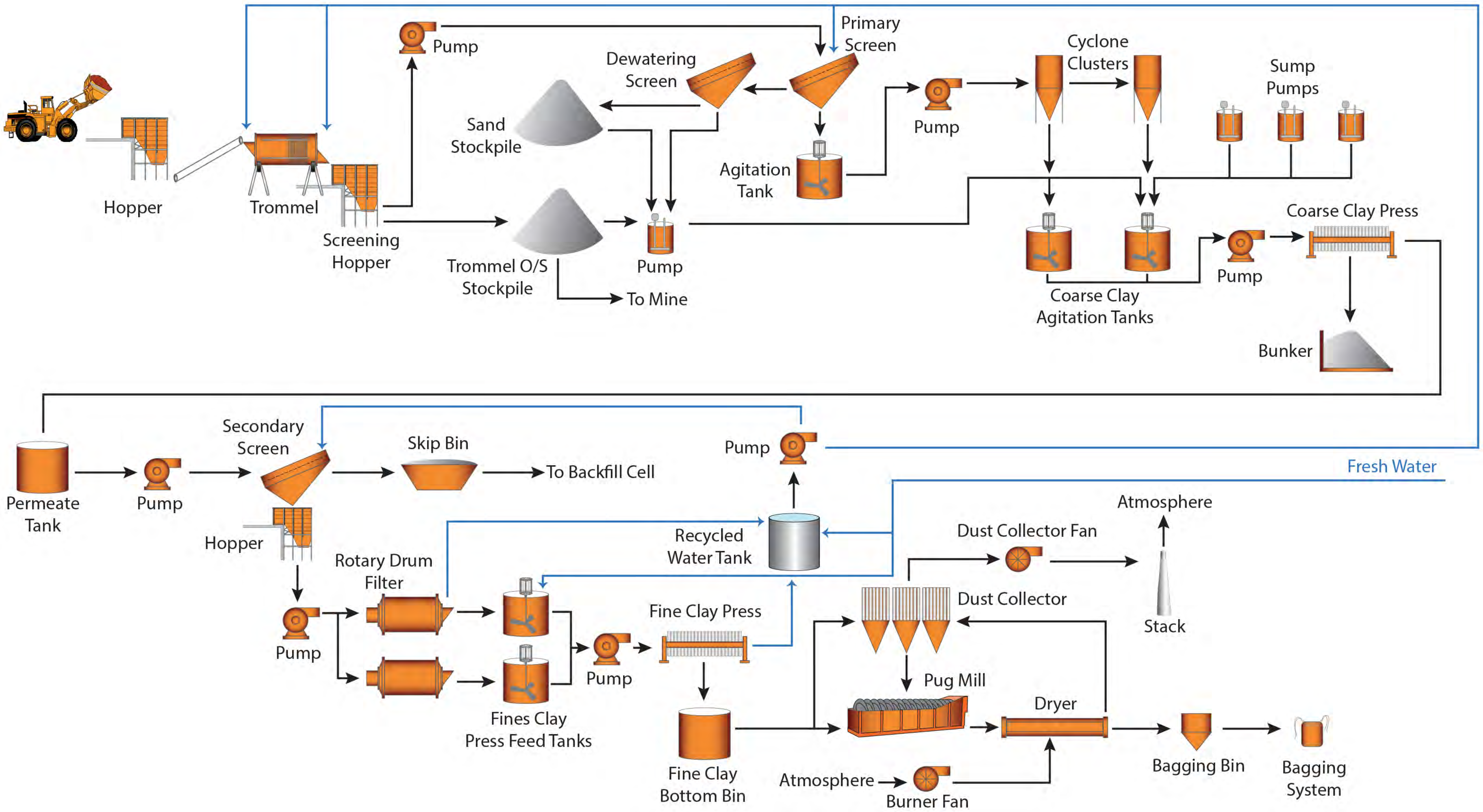


Figure 5-9 Conceptual process flow diagram

5.4.5 Transport of kaolin products from Sandy Ridge

Kaolin products would be transported from Sandy Ridge to markets both domestically and internationally. International exports are likely to depart in sea-container lots via Fremantle Port. The route departing the site would commence along the IWDF access road to the intersection with Great Eastern Highway.

Transport options are still being evaluated, but trucking is the most likely mode of transport. Export kaolin trucks then continue west along Great Eastern Highway to the outskirts of Perth. The route within Perth and to the port for full containers would depend upon which company is selected to provide intermediate warehousing and container services. If not already packed into containers at Sandy Ridge, transported bagged kaolin is packed into containers for export through the Fremantle Inner Harbour container terminals.

The total distance of the journey from Sandy Ridge to Fremantle Port is approximately 750 km. It is proposed an average of eight trucks would carry kaolin per week, and based on 50 weeks of truck movements, 400 trips per year would operate along the route.

5.5 Waste operations

What is hazardous waste?

Hazardous waste in Australia is regulated by the states and territories, which variously describe these waste types as controlled, trackable, prescribed, listed or regulated wastes. Hazardous waste is waste that is a management problem by virtue of its toxicity or chemical or physical characteristics which make it difficult to dispose of or treat safely and which is not suitable for disposal in a Class I, II, III or IV landfill, but is suitable in a geological repository (Class V) like the proposed Sandy Ridge Facility.

Overview

The Facilities' primary objective is to provide customers with a licensed Facility that safely allows for the storage, treatment, recovery and permanent isolation of bulk hazardous and intractable chemical waste materials. Some of these materials may be classified as dangerous or hazardous goods, such as those listed wastes under Schedule 1 of the National Environment Protection (Movement of Controlled Waste between States and Territories) or National Environment Protection (Movement of Controlled Waste between States and Territories) Measure 1998 (NEPM) 75.

The Facility may receive Naturally Occurring Radioactive Material (NORM) up to a low level radioactive waste level (LLW) of activity arising mainly from the mining, oil and gas and agricultural fertiliser, smelting industry. The proponent will be applying for a Licence (Controlled Action) to accept NORM up to a LLW level of activity and non-nuclear LLW such as medical isotopes, smoke detectors and sealed industrial sources. For planning purposes, the proponent is assuming a LLW volume of approximately 1%.

Wastes would be accepted from within WA, other Australian states and territories and from Australia's Exclusive Economic Zone.

Australian's are one of the world's highest emitters of hazardous waste on a per capita basis. Most Australian industries and households produce hazardous waste (refer to Figure 5-10 below).

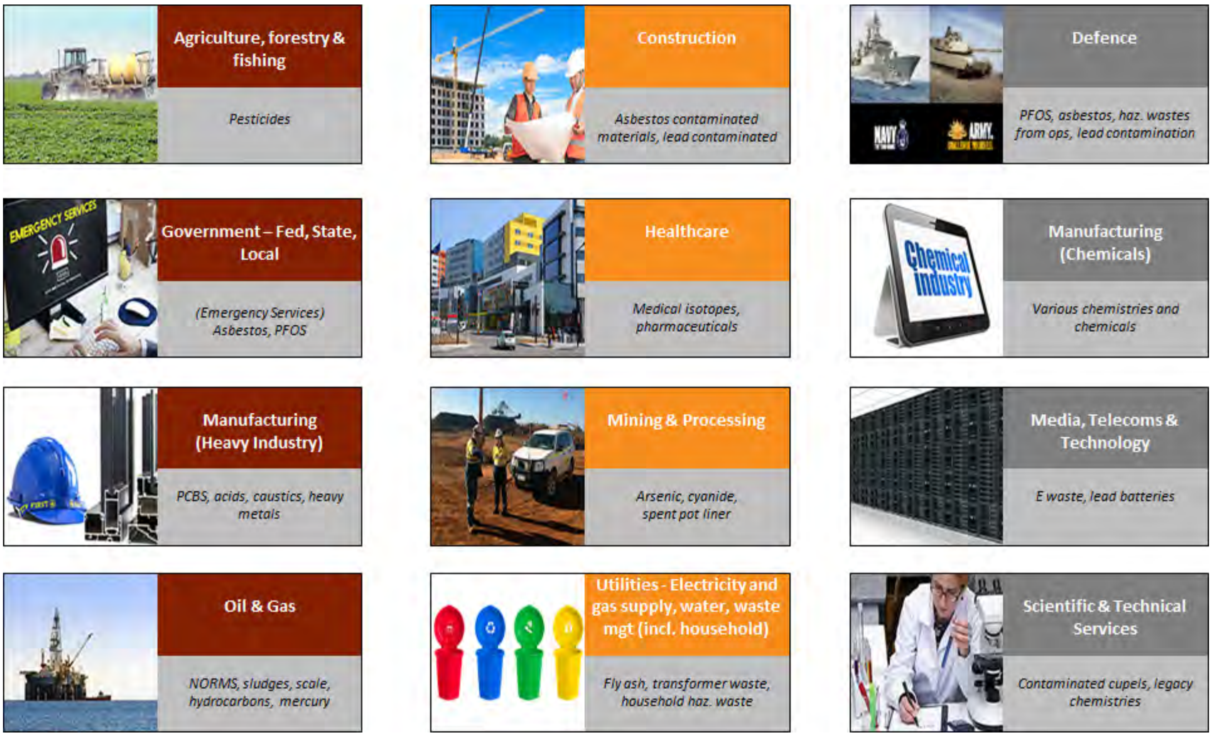


Figure 5-10 Examples of the main household and industry sectors that produce waste

The illustration below (see Figure 5-11) are examples of industrial chemicals uses in Australia.

Figure 5-11 Common industrial chemical uses in Australia that produce wastes accepted for the Proposal

5.5.1 Waste not accepted

Wastes not accepted at the Facility would include:

- Infectious or clinical materials (excluding pharmaceuticals).
- Uncertified waste (waste of unknown composition, or which does not pass the proponent's strict WAC).
- Biodegradable wastes – plant matter which are subject to material biological decomposition (putrescible waste), including vegetable matter (food waste like grease trap and garden waste) and organic materials suitable for Class II or Class III landfill.
- Biodegradable wastes – animal matter – effluent and residues (abattoir effluent, poultry and fish processing wastes), suitable for Class II or Class III landfill.

- Sewage sludge and residues including nightsoil and septic tank sludge.
- Free Liquids – liquid waste is generally excluded, unless it is solidified or packaged in sufficient absorbent material.
- Gases – dangerous goods of Class 2.
- Explosive, flammable, oxidising, corrosive waste – generally excluded, unless it can be safely stabilised and solidified.
- Nuclear waste as defined in the *Nuclear Waste Storage and Transportation (Prohibition) Act 1999* (depleted uranium, enriched uranium, LEU, HEU, Uranium-233 or plutonium). Does not include natural uranium and thorium.
- Radiation waste that may expose members of the public, workers or the environment to dose levels above the dose constraint limits set by the proponent for the operation. This level is typically one per cent level lower than set by the regulators. For example, the proponent has set a limit of 0.3 milli sievert (mSv)/a as dose constrained, which is well below the 1 mSv/a per annum guideline set by ARPANSA. To put this in context, the dose constrained limit equals three chest X-rays per year. One CT cat scan alone is 7 mSv, which is 23 times higher than the exposure dose constraint set by the proponent and seven times higher than the dose limits recommended by ARPANSA.
- Intermediate level and High level radioactive waste (HLW).

As stated above, nuclear waste storage or disposal services would not be provided at the proposed Sandy Ridge Facility. The Propsal has not been nominated as a potential National Radioactive Waste Management Facility. No such nomination is planned and no such nomination would be accepted should it be made by any other party.

5.5.2 Naturally occurring radioactive material

The Facility would be a world's best practice Facility for the storage (retrievable) and permanent isolation (non-retrievable) of chemical waste. However, some wastes also contain levels of naturally occurring radioactive material.

Almost everything in nature has some small amount of natural radioactivity and processing concentrates it. At Sandy Ridge the acceptance criteria identify NORM up to Low Level Waste (LLW) activity content[14] and other LLW such as medical isotopes, smoke detectors, sealed gauges as suitable for storage and disposal in accordance with the safety case (see Table 5-2).

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[2] *Classification of Radioactive Waste – RPS20, ARPANSA*

Table 5-2 NORM and LLR wastes accepted on site (surface) and below ground in waste cells

Radioactive wastes[2] (✓ = accepted, × = not accepted)	Accepted on site (surface storage)	Accepted below ground in waste cells
Naturally Occurring Radioactive Material (NORM) ***up to LLW activity levels*** *such as oil and gas industry scale*	✓	✓
Low level Waste (LLW) *such as smoke detectors, exit signs, industrial gauges and medical isotopes*	✓	✓
Intermediate level (ILW) and high level waste (ILW) *such as reprocessed spent nuclear fuel and components with high levels of radioactivity*	×	×
Nuclear waste *from power generation and defense use*	×	×

As stated above, nuclear waste storage or disposal services would not be provided at the proposed Sandy Ridge Facility. The Sandy Ridge Project has not been nominated as a potential National Radioactive Waste Management Facility. No such nomination is planned and no such nomination would be accepted should it be made by any other party.

What is NORM?

According to the Australian Federal Government's ARPANSA 2008 Management of NORM Report (Publication 15), NORM is abundant in the environment.

NORM is widespread in sands, clays, soils and rocks, and many ores and minerals, commodities, products, by-products, recycled residues, and devices used by humans. Although the concentration of NORM in most natural substances is low, any operation in which material is extracted from the earth and processed can potentially concentrate NORM in product, by-product or waste (residue) streams. Examples of NORM are listed in Table 5-3.

How is NORM managed in Australia?

According to ARPANSA, the most common ways of dealing with NORM residues are storage in stockpiles and/or tailings dams, utilisation in landfill, road-fill and building materials, and disposal by near-surface burial. The choice of method should be based on the results of an environmental impact assessment. Any disposal of radioactive waste must be approved by the relevant regulator.

The Facility is being developed as a best practice Facility for the permanent isolation of chemical waste. Some wastes also contain very low levels of naturally occurring radioactive material. Wastes containing NORM that would be accepted include from the power, electronics, ceramics, mining, metals and minerals processing, oil and gas, water and agricultural fertiliser industries.

Table 5-3 Examples of NORM

NORM location	Examples of the industry and materials containing NORM
Sands, clays, soils and rocks, and many ores and minerals	• Aluminium industry – bauxite. • Fertiliser industry – phosphate rock. • Paint, paper and plastics industry – mineral sands titanium bearing minerals (ilmenite, leucoxene and rutile). • Electronics industry – rare earth bearing minerals (monazite and xenotime). • Ceramics industry, refractory materials in the steel industry, the foundry industry and abrasive materials industry – mineral sands zirconium bearing mineral (zircon). • Metals and mineral processing industry – ores containing tin, tantalum, niobium, iron and some copper and gold deposits. • Power generation industry – coal (accumulation of impurities in the fly and bottom ash). • Energy industry – oil and gas up, mid and downstream processing, geothermal energy (scaling in pipes and equipment). • Many of the clays, rocks and ores listed above contain low levels of uranium and thorium impurities that accumulate during processing.
Commodities	• Water treatment and purification industry – Residues resulting from water treatment include flocculation sediments, filter sludge, other sand and sludge, spent ion exchange resins and reverse osmosis cartridges from desalination plants. • Building industry – building materials such as fly ash is used as a concrete extender or in lightweight building blocks; bottom ash is sometimes used as a concrete extender. Phosphogypsum is used in plasterboard, some types of granite rock used on kitchen benches and building materials. • Fertiliser industry – phosphate fertiliser.
Products	Ceramic pigments and glazes (often found in tiled bathrooms, hospitals, swimming pools spread very thin).
By-products	Phosphogypsum (by product from phosphate fertiliser industry), has the same chemical properties as natural gypsum used in fertilizer, plaster, blackboard chalk and wallboards.
Residues with potential for future use	• Fly ash from coal burning (electricity generation). • Red mud from alumina production. • Slags from mineral processing.
Devices used by humans	• Welding rods (thorium-conducts heat efficiently). • Gas mantles (thorium). • Electronic components. • Scrap metal recycling. • Magnesium-thorium alloy in jet engines.

NORM waste acceptance criteria

NORM waste acceptance criteria are derived from the generic levels given in the National Health and Medical Research Council, Code of practice for the near-surface disposal of radioactive waste in Australia (1992) for Category C waste and are such that it safeguards individual dose limits and/or dose constraints (less than 1mSv) would be achieved, and incorporates the parent radionuclide (refer to Table 5-4 for NORM acceptance levels).

Table 5-4 NORM acceptance values

Radioisotope		Bq/g allowed to meet dose constrain
Uranium-238	U-238	500
Plutonium-239	Pu-239	10000
americium 241	Am-241	10000
Thorium-232	Th-232	500
Radium-226	Ra-226	500

Radioactive waste classification

The ARPANSA Radiation Protection Series No. 20 - Classification of Radioactive Waste (2010) sets out non-prescriptive, best practice guidance for classifying radioactive waste in Australia and is based on IAEA General Safety Guide Classification of Radioactive Waste (No. GSG-1) published in 2009. The Safety Guide is qualitative in nature with the intention being that users would have appropriate flexibility to classify their waste in accordance with internationally accepted methods and terminology.

The Australian classification scheme for disposal of radioactive waste is based on the safety of disposal pathways; taking into account the radioactivity level and the time it would take for the radioactivity to decay (half-life). As such, it does not include quantitative values of allowable activity content for each significant radionuclide. Radioactive waste classification within Australia is described in Figure 5-12.

Radioactive waste generated in Australia generally falls within the VSLW, VLLW, and LLW or ILW classifications. Australia does not generate any electricity from nuclear power and therefore currently does not generate any used fuel that would be classified as HLW (ANSTO, 2011).

Approval to accept Intermediate or High Level Waste at the Facility is not being sought. As shown in Figure 5-12, approval to permanently isolate exempt waste to LLW is sought.

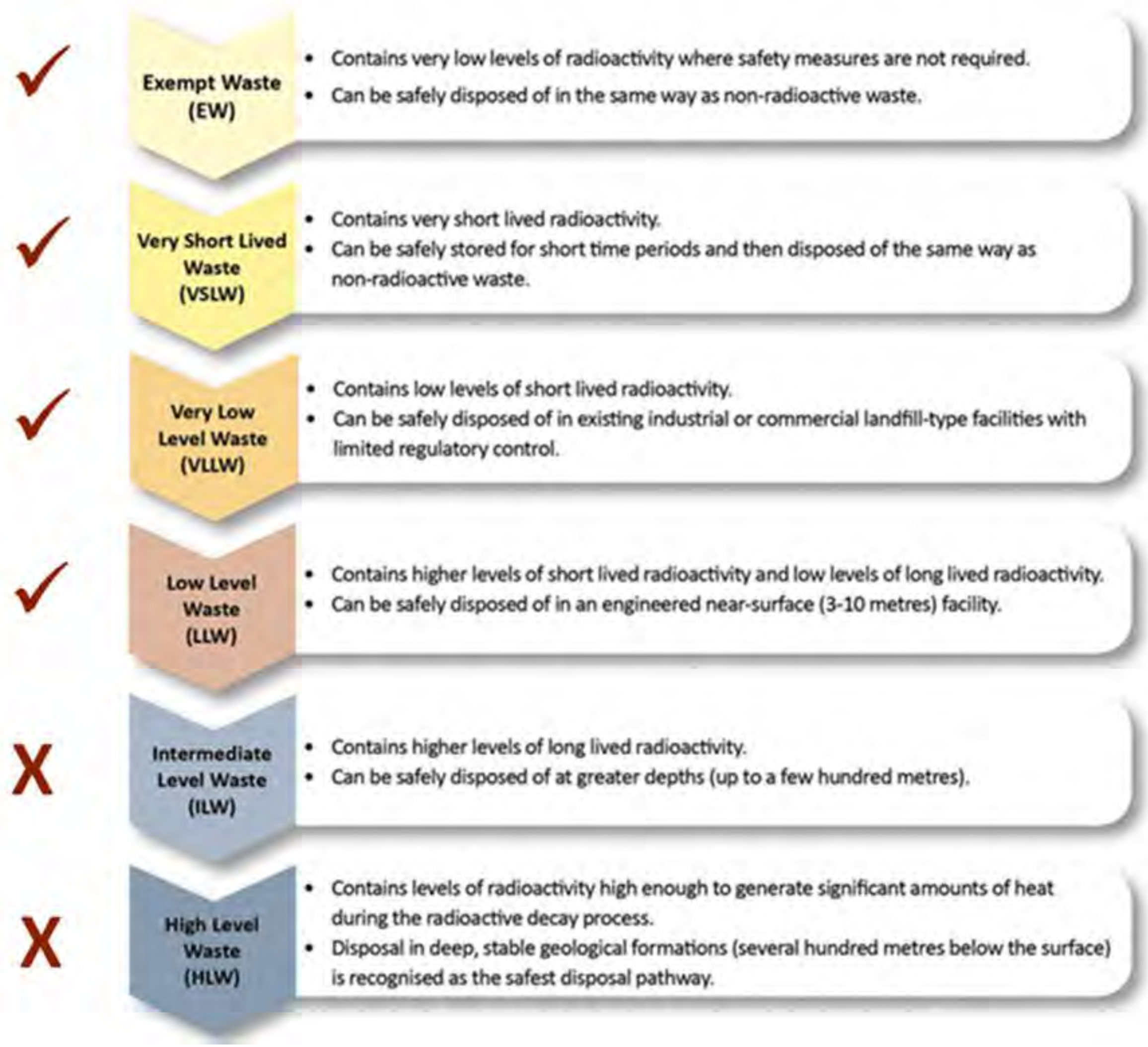


Figure 5-12 Radioactive waste classification and acceptance

Non-nuclear low level radioactive waste

Acceptance criteria for radioactive waste that is being developed for the Facility is described in the WAC (refer to Appendix A.24). The radionuclide concentration limits are set taking into account the actual siting, design and planning of the Facility (e.g. natural geological barrier, arid climate, remoteness, engineered multi layered shielding and barriers, duration of institutional control, site specific management plans and operating procedures) and exposure dose constraints to ensure no person is exposed above the dose limit (as defined in Schedule I of the Radiation Safety (General) Regulations 1983).

Likely radioactive wastes to be disposed of in the cells within specific shafts include radioactive wastes that are generally generated by; medical research and industry, operation of research facilities (e.g. laboratory coats, overshoes, gloves) (see Table 5-4). The proponent would apply for a Licence (Controlled Action) to also accept non-nuclear LLW such as those listed in Table 5-5.

Table 5-5 Examples of the industry and material containing LLW

LLW location	Examples of the industry and materials devices used by humans containing LLW (non-nuclear low level radioactive waste)
Households and industry	• Smoke detectors.
Medical research and industry	• Medical isotopes generated from disease research, diagnosis and treatment (cancer, blood disorders, etc.). • Medical radiography (medical X-Ray), used by dentists and doctors for organ, muscle or bone scans for research, diagnosis and treatment. • Radioisotopes are also widely used in scientific research, e.g. tracing the flow of contaminants in biological systems, determining metabolic processes. • Waste from hospitals, research and university laboratories, also includes waste related to maintenance (clothes, tools, gloves, filters, etc.).
Industry	• Industrial radiography (industrial X-Ray), check the integrity of welds e.g. test aeroplane jet engine turbines for structural integrity) • Sealed industrial gauges (density, moisture and other types of measurement gauges), used to measure levels of liquid inside containers, or to measure the thickness of materials.
Examples	• Americium 241 soil moisture / density gauges, smoke detectors. • Caesium 137 industrial gauges (slurry density, bin level). • Cobalt 60 radiation sterilisation (medical consumables, food etc.). • Iridium 192 industrial radiography, radiotherapy. • Manganese 54 environmental and industrial tracer studies. • Phosphorus 32 biological research. • Strontium 90 thickness gauges (paper & plastic sheet production). • Technetium 99m nuclear medicine diagnostic tests (organ scans).
Rate of use	• According to Australian Nuclear Science and Technology Organisation (ANSTO), on average, one in every two Australians can expect at some stage in his or her life to undergo a nuclear medicine procedure that uses a radioisotope for diagnostic or therapeutic purposes.

Sealed sources

Drawing upon international experience, sealed sources need to meet the <3,700 Becquerel per gram and < 30 years half–life criteria. When a source has a half-life longer than 30 years it can be accepted for disposal if the average value of mass activity of long lived emitters in the waste package is less than 370 Bq/g at the end of the Institutional Control Period (refer to Table 5-5 for examples).

It should be noted that these waste concentration limits can be revised to be applicable to a specific site or design of a disposal facility, if a strong case can be developed. In revising any criteria for a specific site, the safety performance assessment should use data or parameters based upon the local conditions at that particular site. The preliminary safety assessments conducted with RESRAD Modelling indicate that NORM acceptance criteria up to a factor 100 higher than those given in the NHMRC (1992) will still achieve the dose constrain levels.

Table 5-6 summarises the Waste Acceptance Criteria (WAC) proposed for the disposal of sealed sources. The activity of the radionuclides present in the radioactive waste packages would be limited in such a way that the radiological impact of the site is within the dose constraint limits under foreseeable circumstances.

Table 5-6 Generic concentration limits for sealed sources LLW for 100 year Institutional Control Period

LLW	Concentration limit (Bq/kg)	Concentration limit (Bq)[15]
	100 years	100 years ICP
Tritium	1.00E+11	2.00E+13
Carbon-14	5.00E+08	1.00E+11
Radium-226	5.00E+06	1.00E+09
Alpha (α) emitting radionuclides (Am-241, U-238, PU-239)	1.00E+08	2.00E+10
Beta (B) /gamma (γ)emitters with half-lives > 5y	1.00E+09	2.00E+11
Beta (B) /gamma (γ)emitters with half-lives ≤ 5y	no limit	no limit

Sources at activity concentration levels above those specified in Table 5-7 would not be accepted for permanent isolation without re-assessing the safety case and seeking approval from the relevant regulatory bodies.

[15] [4] *Assumes a bulk density of 1 kg/L. The concentration of a radionuclide in the waste package as presented for disposal is calculated by averaging the activity of the source over the weight of the whole conditioned package. For example, the activity of sealed sources, which have been conditioned by being embedded in a solid matrix, can be averaged over the weight of the solid waste matrix. However, to reduce the risks from any future inadvertent intrusion, only one sealed source should be incorporated in a single conditioned package. An industrial gauge source in its approved housing would most likely meet the requirements for disposal if embedded in concrete. In practice, a limit on the maximum activity per package for beta/gamma emitting radionuclides with half-lives of 5 years or less, including cobalt-60, would be imposed by occupational and transport considerations. ARPANSA (2010) Technical Report No. 152).*

Table 5-7 Limits for common sources based on NHMRC near surface code (1992)

Radioisotope	Symbol	Half-life	Decay	Concentration limit (Bq)*
				100 years ICP
Americium-241	Am-	432.17 y	α	2.00E+10
Barium-133	Ba-133	10.74 years	E	no limit
Caesium-137	Cs-	30.07 years	γ	2.00E+11
Californium-252	Cf-252	2.6 years	α	2.00E+10
Carbon-14	C-14	5 715 years	β	2.00E+11
Chlorine-36	Cl-36	301,000	β	2.00E+11
Chromium-51	Cr-51	2.7 days	E	no limit
Cobalt 57	Co-57	271.8 days	E	no limit
Cobalt-60	Co-60	5.27 years	γ	no limit
Gold-198	Au-198	2.7 days	β	no limit
Hydrogen-3 (tritium)	H-3	12.32 years	β	2.00E+11
Indium-111	In-111	2.80 days	E	no limit
Iodine-129	I-129	15.7 million years	β	2.00E+10
Iridium-192	Ir-192	73.8 days	γ	2.00E+10
Krypton-85	Kr-85	10.5 years	β	2.00E+11
Iron-55	Fe-55	2.74years	E	no limit
Lead-210	Pb-210	22.6 years	β	2.00E+11
Manganese-54	Mn-54	312.1 days	E	no limit
Molybdenum-99	Mo-99	66 hours	β	no limit
Nickel-63	Ni-63	96 Years	β	2.00E+11
Polonium-210	Po-210	138 days	α	2.00E+10
Radium-226	Ra-226	1,600 years	α	1.00E+09
Selenium-75	Se-75	120 days	γ	no limit
Sodium-22	Na-22	2.6 years	γ	no limit
Strontium-90	Sr-90	28.8 years	β	2.00E+11
Technetium-99m	Tc-99m	6.01 days	γ	no limit
Thallium-204	Tl-204	3.78 years	β	no limit
Thulium-170	Tm-170	129 days	β	no limit
Ytterbium-169	Yb-169	32 days	E	no limit
Zinc-65	Zn-65	243.87 days	E	no limit

*(alpha (α), Beta (β), Gamma (γ) or Electro capturing (EC))

5.5.3 Waste packaging

Typical waste packaging comprises multiple packaging layers that would be utilised during the product lifecycle that include some or all of the following steps:

- Transport, storage, recovery and permanent isolation.
- Typically, a minimum of two containment layers and often three e.g. plastic lined steel drums on a pallet, strapped together, wrapped or hazardous waste rated (double layered) one tonne bulker bags.
- Pallets placed in sealed 20 or 40-foot shipping containers.

The waste will be transported in containers that are suitable for that type of waste. Examples of the types of containers used in packaging and transport are illustrated in Figure 5-13.

Figure 5-13 Acceptable transport containers

The original IWDF *Waste Acceptance Guidelines* 2011 provide clear criteria for the packaging of waste for delivery to the Mount Walton East site, which is presented below. The proponent has considered the IWDF packaging requirements to be consistent with industry best practices; therefore, waste packaging delivered to the proposed Facility must fulfil the following criteria:

- Not have a total measured weight of more than the Safe Working Load.
- Be capable of being disposed of with the waste.
- Be filled so as to contain no significant voids.
- Be free of ruptures at the point of delivery.
- Be free of external contamination at the point of delivery.
- Not significantly deteriorate during the duration of storage, transport and handling when in contact with the waste.
- Remain intact during normal transport and handling procedures.
- Be strong enough to be walked on if required.
- Be clearly labelled with the waste owner's name and identification number and material description/name on opposite sides of the waste package.
- Allow no leakage during normal transport and handling operations.
- Be capable of containing all the waste whatever the orientation of the package.

5.5.4 Waste storage

Overview

Storing similar materials together would achieve safe storage and also creates opportunities for the future long-term, storage, treatment and potential recovery of valuable materials or the permanent isolation of waste, as illustrated in Plate 5-2. For planning purposes, the proponent is assuming the development would start at <50,000 tpa in year 1, average 66,000 tpa over 25 years, but would have licenced capacity of 100,000 tonnes per annum of Class IV and V hazardous and intractable wastes. This is to accommodate one-off, campaign -style emergency service infrastructure requirements during a man-made or natural disaster, when significant volumes of materials need to be rapidly removed from communities, or to allow one-off campaign-style transfer of significant mine dumps or tailing ponds containing waste resources from a large industrial customer.Typically, waste received during steady state operations would be temporarily stored on the surface before being placed in a cell for storage (retrievable) or permanent isolation (disposal).

To support future recovery or re-use opportunities for certain waste types, e.g. aluminium spent pot line waste, the proponent is planning a future technology park. This area would focus on research and development and provide space for other research institutions to complete research institutions and development on aspects of the Proposal.

Plate 5-2 Process from creating the kaolin mine and filling a cell with waste materials and creating recovery opportunities

Pre–delivery assessment

A key element of the Proposal is to ensure that wastes are carefully vetted for suitability before the holder is advised that waste can be despatched to the Facility. This approach ensures that:

- Only materials that can be safety handled are delivered.
- The waste customer is aware of the appropriate packaging and transport standards that need to be met for acceptance of the waste.
- Staff are prepared for all waste deliveries and can immediately assess delivered waste to ensure that it is suitable.

The assessment process commences when a waste owner makes contact with a request to send waste to Sandy Ridge. The waste owner would be requested to complete a pro forma (see Appendix A.16) which would provide details on:

- Origin of waste (indicate name of waste-producing facility).
- Identify/describe intractable or hazardous waste constituents.
- Classification and coding under the NEPM.
- Volume and weight of package(s).
- Description and quantification of waste form (solid, sludge, liquid or gas) and applicable material safety data sheets (if available).
- A comprehensive chemical analysis of representative samples performed by a National Association of Testing Authorities certified laboratory.
- Description of previous treatment/conditioning.
- Radiation dose rate on the surface of any packaging.
- Presence of alpha emitters if any.
- Concentration of radioactivity as Becquerels per kilogram (Bq/kg) or Becquerels per cubic metre (Bq/m^3) and/or total radioactivity.
- Description of package and container.
- Any specific additional information advice, especially procedures and warnings related to accidental damage to the container.
- Transport mode and request for transport contractor approval.
- Requested date for delivery (if approved by the proponent).

The information provided would be reviewed against the proponent's outline WAC contained within (Appendix A.24). If the waste meets the WAC, a Dispatch Confirmation Notice would be issued to the waste owner to agree that the waste can be transferred to Sandy Ridge.

Along with the Dispatch Confirmation Notice, notification of the expected packaging and transport standards that the waste owner must comply with would be issued and whether or not the proposed transport contractor is approved by the proponent. These standards would be in line with best practice which is currently defined in the following documents:

- Packaging of waste for transport to the Facility must be in accordance with the *Australian Code for the Transport of Dangerous Goods by Road and Rail* (Australian Dangerous Goods Code; Commonwealth of Australia, 2016, edition 7.4) for all dangerous goods, with the exception of radioactive material.
- All radioactive materials must be transported in accordance with the *Code for the Safe Transport of Radioactive Material* (ARPANSA, 2014b) and the Radiation Safety (Transport of Radioactive Substances) Regulations 2002 (WA) or applicable legislation in each state/territory through which the waste is transported.
- Transport arrangements would conform to the Environmental Protection (Controlled Waste) Regulations 2004 and equivalent legislation in other states and territories and the NEPM (NEPC, 1998a).

The customer's pro forma and the Dispatch Confirmation Notice would be logged in an Electronic Tracking System (TETS). A flow diagram of the conceptual initial contact phase is presented in Figure 5-14.

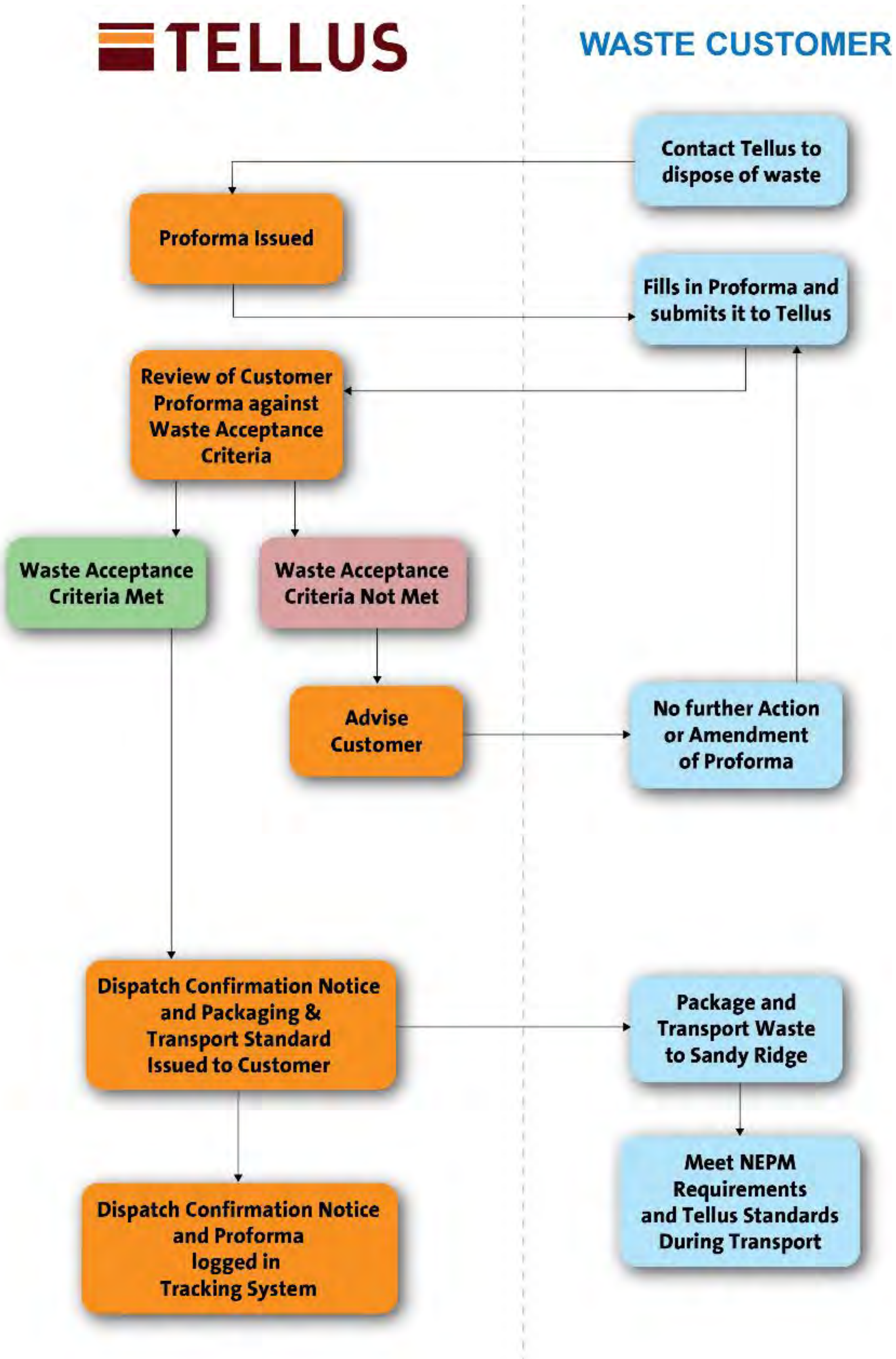


Figure 5-14 Conceptual initial contact phase

Procedures for waste acceptance

The procedures for accepting waste deliveries at Sandy Ridge are underpinned by the following key documents attached to Appendix A.24:

- Waste Acceptance Policy.
- Waste Acceptance Criteria (WAC).
- Waste Acceptance Procedure (WAP).
- Waste Zoning Guide (WZG).

The overall process is shown in Figure 5-15 and described in more detail below.

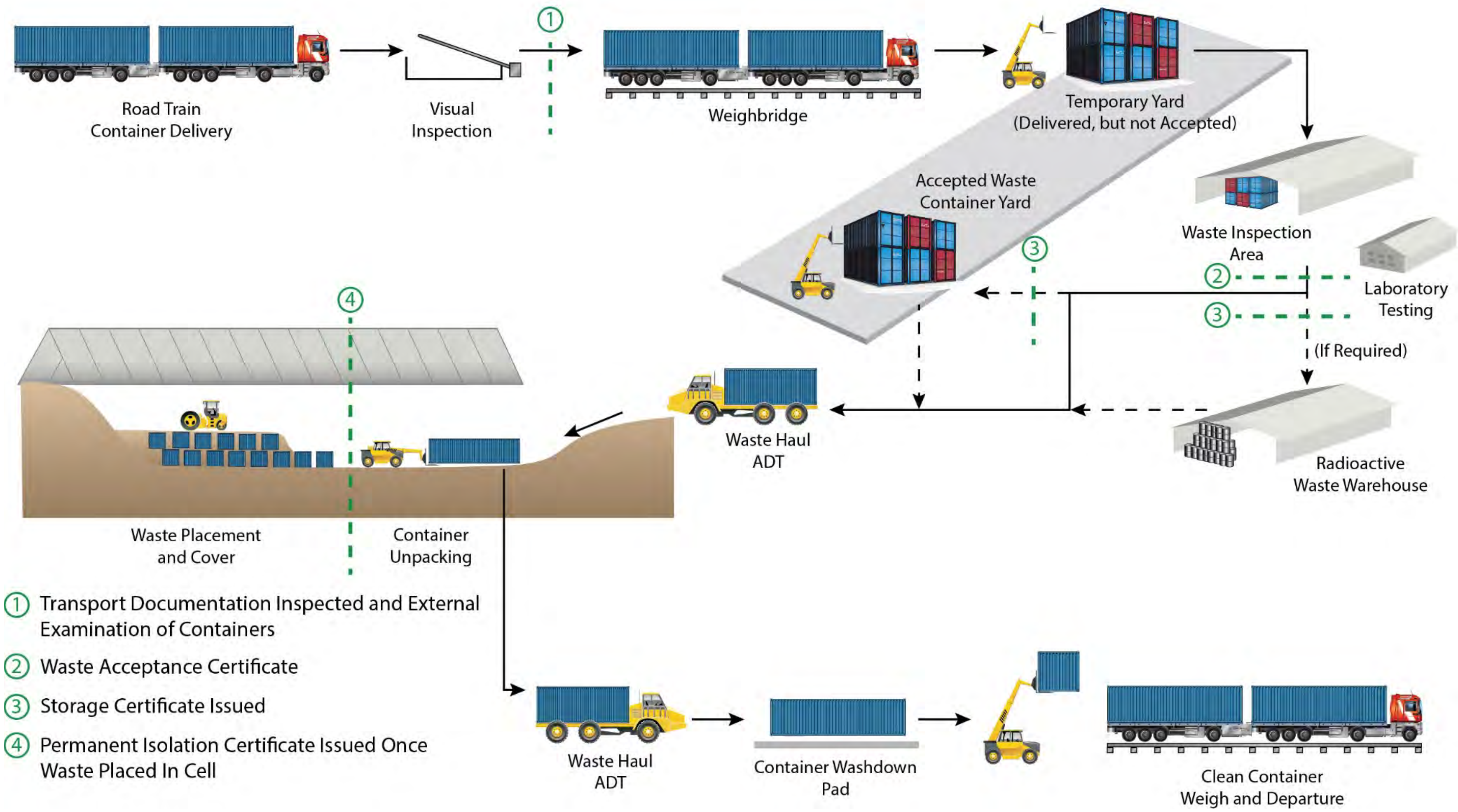


Figure 5-15 Waste materials process flow diagram

Waste Acceptance Policy

The proponent's WAC established for the proposed Facility, is to determine waste types which can and cannot be accepted to achieve safe operation and environmental protection in the longer term at our facilities. The facility has been designed and is in a dry, 70 million year old, thick, stable host geological environment (clay bed) which can store and dispose of the majority of the NEPM 75 hazardous and intractable wastes types subject to them meeting strict WAC. These criteria have been developed following internationally recognised best practice and set out waste characteristics which would and would NOT be suitable for storage or disposal in a geological repository.

The table below describes the hazardous and intractable wastes accepted on site (surface) and below ground in waste cells.

Table 5-8 Hazardous wastes accepted on site (surface) and below ground in waste cells

Hazardous and Intractable Wastes (NEPM 75)	Accepted on site (surface storage)[2]	Accepted below ground in waste cells[2]
Hazardous and intractable wastes (NEPM 75) subject to meeting the characteristics criteria below (examples of acceptable wastes on next slides)	✓	✓
• Liquid and sludges	✓	×[1]
• Explosive wastes	✓	×[1]
• Flammable liquids or solids	✓	×[1]
• Self-combusting wastes or wastes that can generate a gas-air mixture which is toxic or explosive	✓	×[1]
• Highly corrosive or oxidizing	✓	×
• Gases	×	×
• **Clinical waste** *such as infectious hospital waste and body parts*	×	×
• **Municipal Solid waste** *such as putrescible household and commercial waste*	×	×
• Putrescible wastes *which rot such as household rubbish*	×	×
• Uncertified waste *which can not be identified or has not undergone characterisation testing*	×	×
• Reacts with the repository geology *such as dissolving it or producing a gas*	×	×

[1]*Normally excluded unless modified before disposal or during disposal so the operational or post closure safety of the waste cell and facility is not compromised*

[2] ✓ = accepted, × = not accepted. ×[1]= normally excluded but possibly suitable[3]

[3] Classification of Radioactive Waste – ARPANSA RPS20

Example of waste types and volumes that could potentially be accepted

Table 5-9 describes the top 10 main wastes using the simpler NEPM 15 descriptions and the more detailed NEPM 75 descriptions that are likely to be accepted at Sandy Ridge. For planning purposes, the proponent, is assuming the top 10 waste type could account for approximately 90 % of the waste volume.

Table 5-9 Top 10 (<90%) of waste types likely to be accepted at the proposed Sandy Ridge Facility

NEPM 15	Description	NEPM 75	Description
N	Soil / sludge	N205	Residues from industrial waste treatment/disposal operations
N	Soil / sludge	N120	Soils with controlled waste
N	Soil / sludge	N150	Fly ash, excl. coal fired Power Stations
N	Soil / sludge	N220	Soils with asbestos
J	Oils	J120	Waste oil and hydrocarbons mixtures
D	Inorganic chemicals	D220	Lead compounds
C	Alkalis	C100	Basic solutions or bases in solid form
D	Inorganic chemicals	D110	Inorganic fluorine compounds excluding calcium fluoride (SPL)
D	Inorganic chemicals	D120	Mercury compounds
D	Inorganic chemicals	D230	Zinc compounds

[2] *Classification of Radioactive Waste – ARPANSA RPS20*

The figure below describes the potential volume and type of waste by NEPM 75 code that may be accepted at Sandy Ridge. The top 10 main wastes that the proponent is using for planning purposes, account for the majority of the waste volume.

Figure 5-16 also illustrates that for planning purposes, the facility is mostly a chemical hazardous waste facility (99%), but is also applying to accept NORM up to LLR and LLR (1% volume).

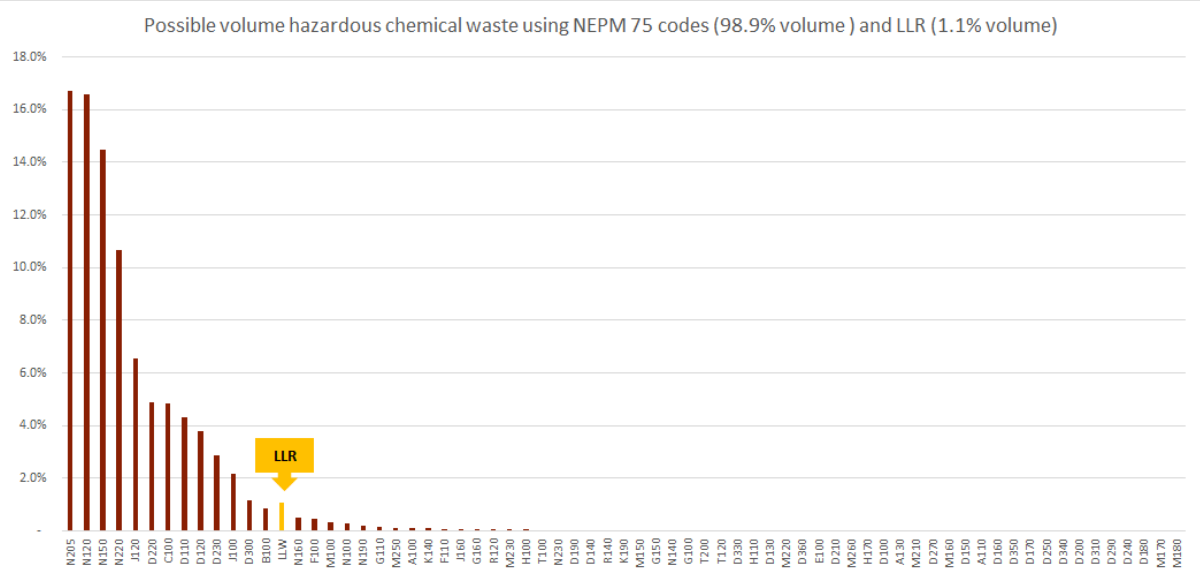


Figure 5-16-Potential volume and type of waste by NEPM code that may be accepted at Sandy Ridge

The aim of the Waste Acceptance Policy is to set a policy framework for the proposed Sandy Ridge Facility. The Waste Acceptance Policy is the Tier One document within the proponent's waste acceptance hierarchy.

This document is intended initially for use by regulators responsible for assessing the facility and issuing licences for the operation of the proposed Facility, and for the formation of procedures to control the process by which waste producers and the proponent's staff would determine if the waste streams may be suitable for storage or permanent isolation.

The document would also be of interest to other stakeholders who wish to understand the approach being followed by the proponent's for waste acceptance, including the safe storage and permanent isolation of wastes.

Waste Acceptance Criteria

The objective of the Sandy Ridge WAC is to establish and explain to regulators, customers and other stakeholders:

- The criteria that would be applied for the exclusion of certain types of wastes.
- The criteria that would be applied to the acceptance of certain types of wastes.
- The requirement for suitable packaging and the criteria that would be applied for packaging acceptance.

Waste Acceptance Procedure

Having established the overarching waste exclusion criteria to be applied at the proposed Facility via the WAC, a gated WAP, using specified test methods and criteria values would be applied to determine if a waste can be accepted.

In addition to considering the specific characteristics of the waste, consideration is also given to how the wastes would perform in the conditions of storage and permanent isolation. This assessment would be performed by a suitably qualified person who has the necessary skill in determining such matters.

Wastes would need to pass through each waste acceptance “criteria gate” to be accepted for in cell storage or permanent isolation.

Waste Acceptance Procedure – Step 1 front gate and weighbridge

On entering the site, trucks would be weighed on a weighbridge and their waste documentation/Dispatch Confirmation Notice would be reviewed by personnel. The exterior of the truck and containers would be inspected at this point. In the event of LLW deliveries, external surface levels of radioactivity would be measured.

If the documentation is not present or is incomplete, the proponent would be unable to confirm that its packaging and transport standards have been met, and the truck would either be turned away from the Facility or directed to the hardstand (‘temporary yard’ on Figure 5-15) while any uncertainties or discrepancies are resolved. If the documentation meets packaging and transport standards the truck would proceed to the hardstand and/or Waste Inspection Area.

Waste Acceptance Procedure – Step 2 hardstand and waste inspection area

Trucks would drive from the weighbridge to a hardstand (‘temporary yard’ in Figure 5-15) where the waste would be considered delivered, but not accepted. Shipping containers would be removed from the truck and externally inspected in accordance with operational procedures, and may remain unopened on the hardstand for a period of time to suit the current activities at the site.

The truck would pick up empty shipping containers and can leave the Facility after being inspected for cleanliness and weighed.

From the hard-stand the following steps would occur:

1. The shipping container would be moved across to the Waste Inspection Area, where the container would dock with the side of the building and one end would be opened into the building.
2. An internal inspection inside the shipping container would be conducted to check for damaged/leaking waste packages (this may require removal of some packages) and a selection of waste packages would be removed and taken to the Waste Inspection Area for sampling. The waste package would be audited against the customer’s pro forma to confirm the volume and type of waste delivered is as described in the customer’s documentation. The outcome of the review of documentation would be:
    a. If the documentation is incomplete or does not match the waste that has arrived, the package would be held pending liaison with the waste customer.

   b. If documentation is complete, the waste packages would be inspected for damage and leaks. If the packaging is damaged significantly the pallet would be held whilst a solution is agreed to with the waste customer. Any damaged or leaking waste package would be made safe as soon as possible to minimise worker or environment exposure to the waste. The waste package would be 'made safe' in accordance with the methodology outlined in the Operating Strategy (Appendix A.16).

3. The samples would be tested (as described in the Operating Strategy) and confirmed that waste matches documentation.
4. The removed waste packages would be repacked and the shipping container closed, and transferred back to the hardstand ('accepted waste container yard' in Figure 5-15).
5. The shipping container remains on the hardstand until it is scheduled to be moved into the waste cell.

Each container would be tracked and logged in the TETS through each handling stage so that its location is known and can be communicated to the regulator or customer if requested.

For bulk materials, the load would be inspected and sampled in the truck before being unloaded into a bulk storage building, vessel, tank, hopper, covered bunker or hardstand area. The frequency of inspection and sampling of waste packages would be adjusted over time as confidence increases in the consistency and reliability of deliveries from any particular customer.

Waste Acceptance Procedure – Step 3 compliance testing

When waste has been deemed acceptable on the basis of a basic characterisation it shall subsequently be subject to compliance testing to determine if it complies with the results of the basic characterisation and the relevant acceptance criteria as laid down in the WAC.

The function of compliance testing is to periodically check regularly arising waste streams are compliant with the WAC. The check has to show that the waste meets the limits of acceptance for the identified critical parameters.

Waste Acceptance Procedure – Step 4 onsite verification

Each load of waste delivered to Sandy Ridge shall be visually inspected before and after unloading, and the required documentation shall be checked. The waste may be accepted at the Facility, if it is the same as that which has been subjected to basic characterisation and compliance testing. If this is not the case, the waste must not be accepted. Upon delivery, samples would be taken periodically. The samples taken would be kept after acceptance of the waste for a period that would be determined by the proponent.

A gated WAP using specified test methods and criteria values would be applied to determine if a waste can be accepted. Detailed explanations of each gate, its associated criteria and an applicable test method(s) required to be used to confirm acceptance, are presented in the WAP (Appendix A.24).

Waste zoning guide

To prevent dangerous interaction, dangerous goods should be kept apart (segregated) from all other goods with which they are not compatible. Segregation can be achieved by storing and handling incompatible goods in separate areas or by the use of physical barriers or distances within the same area.

Systems and procedures would be developed and enforced, and personnel involved in the storage and handling of dangerous goods would be trained and supervised to ensure segregation is maintained at all times. Therefore, arrangements need to be made for the safe storage of these wastes.

Useful guidance for segregating incompatible dangerous goods is provided in *Australian/New Zealand Standard AS/NZS 3833 The Storage and Handling of Mixed Classes of Dangerous Goods in Packages and Intermediate Bulk Containers* which is referenced in the code of practice[16] which, in turn, supports the National Standard. The proponent would adopt the segregation protocols presented in AS/NZS 3833 for all waste materials that are stored on site prior to in cell permanent isolation.

Further information on chemical and LLW zoning is attached in the WZG in Appendix A.24.

Waste treatment or conditioning

Some wastes delivered to the Facility may require treatment or conditioning in order to meet the WAC (Appendix A.24) for placement into a cell. In general, the proponent is not aiming to become a waste treatment contractor or service provider. However, there are presently gaps in the service offerings of the established waste management service companies and some waste treatment processes are best applied immediately prior to placement in the cell.

All waste treatment processes which would be carried out at the Facility have not yet been identified. The proponent currently has test work commissioned with European specialists in the area of non-solid waste solidification and stabilisation. The aim of this work is to confirm the performance of various cement blends with a range of liquid and paste waste types, which would guide the design of the blending and mixing plant. The likely processes that may be implemented at the Facility are described below. A Works Approval would be obtained under Part V of the EP Act prior to the construction of pre-treatment plants. The proponent would ensure that the pre-treatment processes do not result in unacceptable emissions or discharges to the environment.

- **Oily sludge -** Hydrocarbon sludge containing NORM and/or heavy metals cannot always be recovered or safely disposed of using existing treatment processes such as biodegradation, oxidisation, stabilisation or incineration. The proponent is currently investigating methodologies for the stabilisation and solidification of such sludges using pozzolanic materials and cement based additives.

[16] *Page 29 The National Code of Practice for the Storage and Handling of Workplace Dangerous Goods NOHSC:2017(2001)*

Oily sludges would be delivered in either intermediate bulk containers inside sea containers, or as bulk liquids in a tanker truck, with the former being more likely. Oily sludges would be stored until such time as they are ready to be placed in the cell. The oily sludge would then be mixed with controlled measures of binding and stabilising materials such as high carbon fly ash and Portland cement, to produce a cement-like slurry which would either be placed directly into the waste cell, or poured into moulds where it would set. The direct placement slurry would be allowed to set in-place in the cell, and moulded blocks would be placed into the cell in the same manner as other packaged wastes.

- **Non–oily liquid and sludge -** Other wastes in either liquid or sludge form would ideally be reduced in volume, filtered or dried before delivery to Sandy Ridge, preferably by an existing waste management contractor. In the event of some liquid wastes not being able to be treated or only being partially treated (to a sludge), solidification and stabilisation treatment would be provided for these wastes using absorbent materials such as clays and pozzolanic materials such as fly ash and cement. Solidification and stabilisation would typically take place with both materials being added to a mixing device.

  In the event of drums of waste being delivered where a liquid has separated in transport from a paste, absorbent material would need to be added into the drum or container to absorb the released liquid before the waste can be placed in a cell**.**

- **Radioactive waste (sealed sources)** - Sealed sources would be received at site and stored in the Radioactive Waste Warehouse, in the form which they were transported. Prior to placement in a shaft, the sealed source would undergo the proponent's identification and quality assurance and quality control processes before being placed in a concrete filled steel drum.

- **Radioactive waste (NORM and other) -** Material containing NORM may require conditioning or treatment to achieve a physical form suitable for placement in a cell (refer to 'Oily sludge' and 'Non-oily liquid and sludge' above).

  NORM or radioisotope contaminated solid materials may require any voids to be filled with kaolinitic material or cement grout either prior to placement or once in the cell. Examples of such materials could include piping, process machinery, demolition rubble and personal protective equipment (PPE)**.**

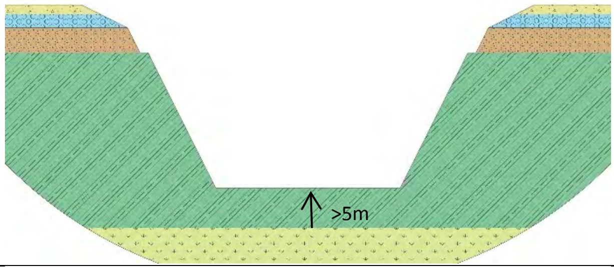
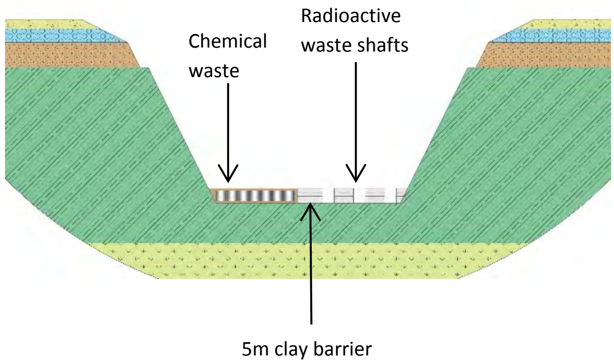
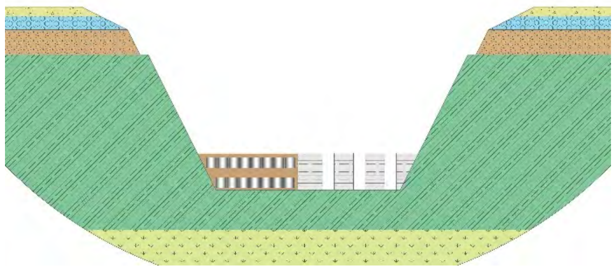
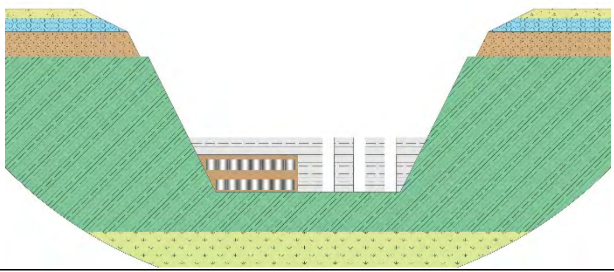
Waste placement

Waste packages would be contained within the kaolin mine void. The base and walls of the void would comprise kaolin clays which are naturally impermeable to water. The natural kaolin would effectively act as a liner as this material is present in a significant thickness and is more impermeable in the long-term than a synthetic liner (e.g. high-density polyethylene [HDPE], geomembrane or concrete), which would break down and disintegrate over geological time (i.e. 10,000 years).

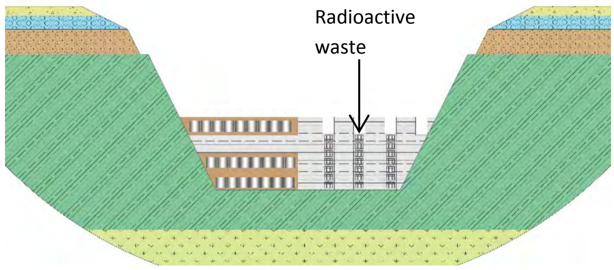
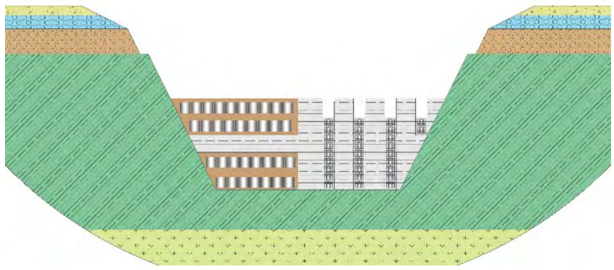
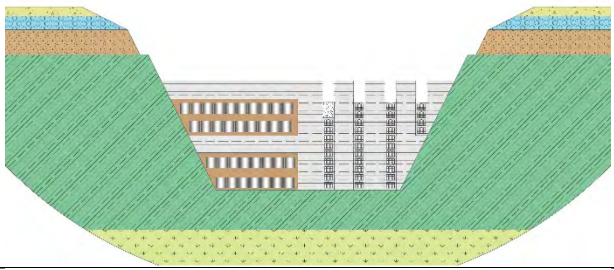
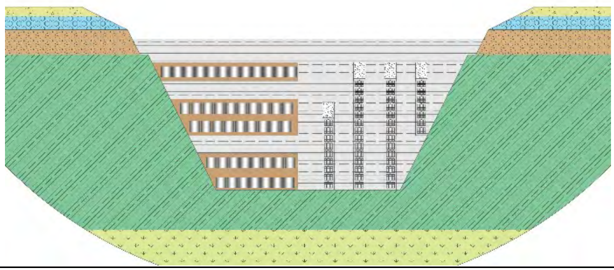
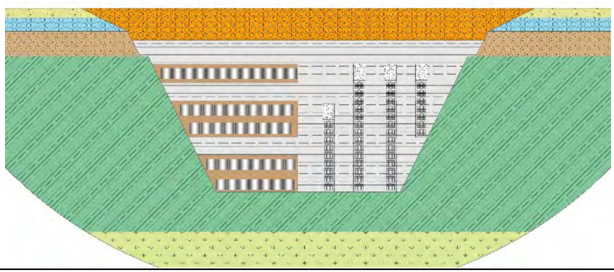
The waste cells would be filled in layers with multiple sections in each layer containing wastes of similar characteristics. All space between waste packages would be backfilled and compacted to minimise air or void space. If this approach is not taken it may result in settlement. Each layer would be compacted, until approximately 7 m below the ground surface, where a thick capping layer of low permeability clay (referred to as a 'seal') would be installed to prevent water ingress into the cell. Following this, more compacted backfill and a clay domed cap would be situated on the top of the cell, to shed any landing rainfall.

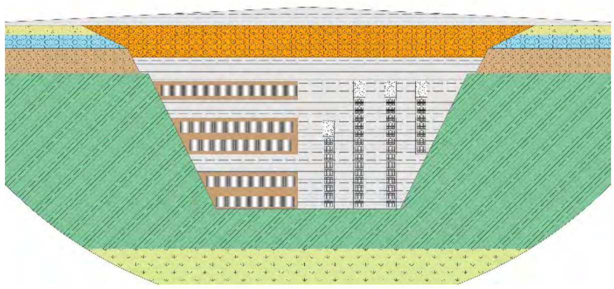
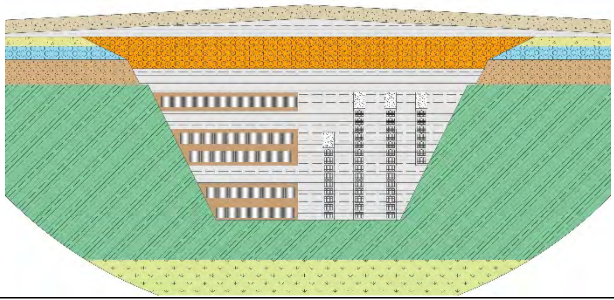
Figure 5-16 illustrates how co-disposed chemical and radioactive wastes would be contained within the cells. The conceptual design of the cells has been independently reviewed by Eden Nuclear and Environment of the United Kingdom (Appendix A.21). The review concluded "that the design of the Facility is excellent and that the proposed multibarrier system offers very good prospects of excellent long-term performance that would be comparable or in excess of that for many other LLW isolation facilities in other countries. This is facilitated by the favourable hydrological and hydrogeological environment". Recommendations were made for further investigations with respect to the outline safety case and activity concentrations of LLW. These recommendations would be addressed during detailed design of the Facility.

The encapsulation of wastes within each cell is subject to rigorous engineering design and compaction testing to ensure the properties of the constructed cell is a close analogue of the existing geological and hydrogeological conditions at the site, which naturally excludes water from the kaolinitic soils located beneath the silcrete layer. A feature survey of the cell would be conducted to confirm the cell is constructed in accordance with the engineering design.

The bottom of the mine void would be a minimum of 5 m above the unweathered/fresh granite bedrock.	
A base layer of waste is placed on one side of the floor of the mine void. Wastes of different types are segregated by internal compacted kaolin walls which are 5 m wide. The height of each waste layer and barrier wall is the equivalent of the height of a waste package, typically 0.9 m. Waste packages are placed tightly next to each other in a row. Granular material is backfilled between and around the waste packages to fill any air spaces. The shafts for radioactive waste are constructed approximately 3 m apart from each other and with a 5 m barrier between the shafts and the chemical waste layer.	
A thin (300 mm minimum) layer of compacted granular material is placed over the chemical waste layer. Compaction testing would be carried out in accordance with *AS1289.5.8.1*[17] to confirm material is compacted to the density required by the engineering design. The next layer of chemical waste packages is placed on the kaolin compacted layer along with the 5 m wide kaolin separation barrier. The shafts for radioactive waste will continue to be constructed.	
A 3 m thick capping layer of kaolin is compacted onto the second waste layer. The shafts for radioactive waste continue to be constructed.	

[17] *Australian Standard for testing soils for engineering.*

The next layer of waste packages is tightly placed on the thick capping layer and backfilled with granular material to exclude air pockets and voids. The separation barrier is maintained in the middle of the cell. The radioactive waste is lowered into the shafts. Between each radioactive waste package, a 200 mm layer of kaolin is compacted into place.	
A thin (300 mm minimum) layer of compacted granular material is placed over the chemical waste layer. Compaction testing would be carried out in accordance with *AS1289.5.8.1* to confirm material is compacted to the density required by the engineering design. The next layer of chemical waste packages is placed on the kaolin compacted layer along with the 5 m wide kaolin separation barrier. Radioactive waste continues to be lowered into the shafts. Between each radioactive waste package, a 200 mm layer of kaolin is compacted into place.	
A 3 m thick capping layer of kaolin is compacted onto the fourth waste layer. Radioactive waste continues to be lowered into the shafts. Between each radioactive waste package, a 200 mm layer of kaolin is compacted into place.	
A fifth layer of waste is placed in the cell. Concrete lids are fitted into each radioactive shaft. A 3 m thick kaolin cap is placed on the waste packages and concrete lids and is keyed into the surrounding clay.	
A 4 m thick layer of compacted crushed silcrete and laterite material, with some kaolinised granite or clayey sand is placed between the kaolin cap and the natural ground surface.	

The compacted kaolin clay dome cap is placed over the cell. The final capping layer is formed of compacted kaolinised granite material (permeability approximately 6.0 x 10^{-8} m/s (Douglas Partners, 2015)) and placed in the form of a dome, so as to shed stormwater from the structure into perimeter V drains, which flow to a sump. The cap would have a 1:20 gradient and be an approximate thickness of 2 m in the middle, thinning as it slopes to integrate into the landscape. Subsidence monitoring of the cap would commence.	
Subsoil and topsoil is replaced on the cap after the cessation of subsidence monitoring.	

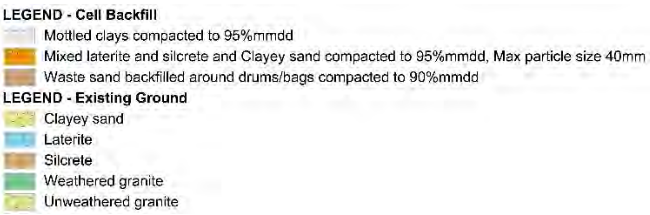


Figure 5-17 Cell containment of chemical and radioactive wastes

The protection of water quality has been considered throughout the cell design, which specifically incorporates the following features to avoid water entering the cell (and therefore leaching contaminants from the waste packages) and to prevent the accumulation of moisture in the unlikely event that small quantities enter the cell from generating leachate from the waste packages.

- No liquids would be placed in the cell.
- A roof canopy over the cell prevents rainfall directly into the cell while it is open.
- The roof canopy is guttered to collect and dispose of collected rainwater.
- Operational bunding around each cell prevents the entry of surface water flow while the cell is open (such flows only occur in extreme rainfall events).
- The absence of a highly impermeable HDPE or concrete seal allows natural and gradual venting of any minor quantities of gases (should they be produced) without pressure damage to a man-made liner or cap system.

- Wastes are stored below ground level (and well below silcrete level) which reduces the likelihood of erosion ever exposing waste.
- The natural topsoil/subsurface soil, thick clay domed cap and the compacted clay layer at approximately 4-7 m depth minimises water ingress and erosion. Based on modelling results, net recharge to the topsoil/subsoil is 1.4 mm per year. Vertical flow below the cap is 0.8 mm per year, into the compacted silcrete and laterite backfill to the compacted kaolinised granite seal/layer. Below this layer the rate of water movement is 0.008 mm per year. These vertical fluxes are extremely low, illustrating that water ingress into the cell is negligible.

Cell planning and inventory assessment – storage of like with like

Shipping containers would be stored on the hardstand until that waste type is ready to be placed in the cell in accordance with the cell scheduler. Bulk materials would also be stored until required in the cell.

The cell scheduler is an electronic planning and inventory assessment tool to effectively manage space within the cell and to ensure the entire batch of a certain type of waste (e.g. arsenic), can be placed in a designated location within the cell that is ready to receive the waste. The cell scheduler would be integrated with the TETS so that each waste package is tracked and its location and depth within the cell logged with a survey coordinate.

The TETS would track each waste package from the point where it is accepted on-site until it is placed in the cell. An example of the Cell Scheduler and tracking system integration is shown in Table 5-9 while Figure 5-15 illustrates how different waste types could be physically separated within the waste cell.

Table 5-10 Example of cell scheduler for tracking of waste from sorting to placement and storage of 'like with like'

Scheduled date for placement	Scheduled time for placement	Shipping container No	Package ID (number from tracking system)	Contents	Cell for storage/isolation	Layer and Section in Cell	Actual date of placement	Actual time for placement	RFID/barcode	Surveyor	Survey coordinates of boundaries of stored waste (MGA94)	Elevation (mAHD) of waste	Date of isolation
10 Oct 2017	9 am	1	D2009-001-001	Arsenic trioxide	2017 – Cell 2	Layer 2 – Section M	10 Oct 2017	9.20 am	D2009-001-001	DH	220,001 6638000	472	10 Jan 2018
	9 am	1	D2006-003-002	Arsenic trioxide	2017 – Cell 2	Layer 2 – Section M	10 Oct 2017	9.30 am	D2006-003-002	DH	220,001 6638000	472	10 Jan 2018
	9 am	1	D4009-129-003	Cyanide	2017 – Cell 2	Layer 2 – Section M	10 Oct 2017	9.40 am	D4009-129-003	DH	220,001 6638000	472	10 Jan 2018
21 Oct 2018	10.30 am	2	X3456-222-001	Solidified pesticides	2018 – Cell 1	Layer 3 – Section G	21 Oct 2018	10.30 am	X3456-222-001	AS	220,001 6,639,000	480	21 Nov 2018
	10.30 am	2	F4567-204-002	Solidified pesticides	2018 – Cell 1	Layer 3 – Section G	21 Oct 2018	10.45 am	F4567-204-002	AS	220,001 6,639,000	480	21 Nov 2018
	10.30 am	2	G3450-765-003	Solidified pesticides	2018 – Cell 1	Layer 3 – Section G	21 Oct 2018	10.55 am	G3450-765-003	AS	220,001 6,639,000	480	21 Nov 2018
	10.30 am	2	H4367-765-004	Solidified pesticides	2008 – Cell 1	Layer 3 – Section G	21 Oct 2018	11.30 am	H4367-765-004	AS	220,001 6,639,000	480	21 Nov 2018

Figure 5-18 Placement of wastes within the waste cell and a roof canopy covers the cell

When the cell scheduler indicates that a particular container is scheduled for placement, it would be loaded onto a waste haul articulated dump truck (ADT) and driven into the cell. The shipping container would be removed from the waste haul ADT and placed on the floor of the cell adjacent to the designated disposal and isolation area.

The shipping container would be opened and the pallets of waste packages removed in accordance with the Outline Operating Strategy (Appendix A.16).

There are situations where an entire sea-container would be placed in a cell. In this case, holes are cut into the roof, grout or concrete is poured in place (to remove airspace) and the filled container is then buried with its contained waste.

Bulk material in a form suitable for placement would be transported from the surface storage area to the cell by an ADT when required and placed directly into a cell.

Prior to unpacking shipping containers into the cell, the roof canopy would be in place. The roof runs on rails and would cover the full length of an active waste cell. The purpose of the roof canopy is to exclude water from the cell until it is capped, to avoid the generation of leachate within the cell and avoid any potential structural impacts that may affect the integrity of the cell walls. There are some waste types which may be placed in a cell without a roof as the materials being placed are not immediately leachable, such as some contaminated soils and contaminated railway sleepers. Any such cell construction would be designed with a drainage sump to enable pumping-out of any direct precipitation whilst the cell is open.

VLLW and LLW would be managed separately from other wastes and would have a dedicated shaft constructed within the cell. Handling of VLLW and LLW would be in accordance with the Radioactive Waste Management Plan (Appendix A.14). Equipment and larger objects may be filled with kaolinitic material or cement grout/concrete either prior to placement in the cell, or in situ. In general, (though dependent upon activity and isotope presence), NORM would not be placed in shafts; rather, they would be placed in a designated area of the cell. Shaft placement would normally be reserved for higher activity LLW.

Survey coordinates of each placed waste package or area of bulk waste placement would be recorded. Each section of the cell would be surveyed and depths of stored waste updated in the TETS. Once the waste customer's shipping container or bulk materials have been placed in the cell, a Placement Certificate would be issued to the waste customer.

Backfilling of cell

Chemical waste

Once the base layer of waste packages is in place, granular material would be backfilled to completely fill any voids between the waste packages. This would be done to minimise the risk of subsidence or settlement of the covering material, creating a solid structure with no voids. Additional granular backfill would be placed on top of the completed layer of waste packages, sufficient to allow the safe movement of vehicles without damage to the waste packages below. Additional layers of waste would be stored then backfilled and compacted in the same manner (refer to Figure 5-19). Compaction testing would be carried out in accordance with *AS 1289.5.8.1–2007 Methods of testing soils for engineering purposes – Soil Compaction and density tests – Determination of field density and field moisture content of a soil using a nuclear surface moisture density gauge – Direct transmission mode.*

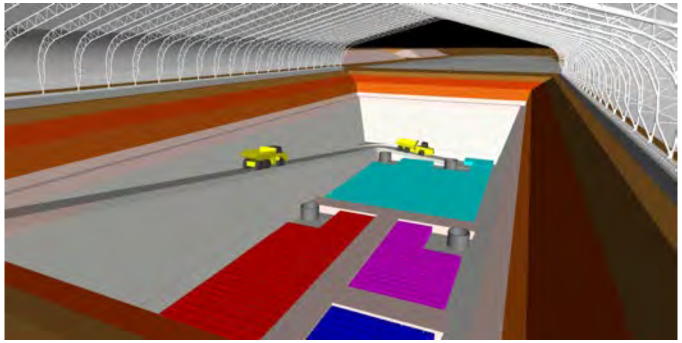
Following the placement of the final waste layer, capping layers are used to fill the remaining void and cover the completed waste cell. This would occur at approximately 7 metres below the ground surface. These serve to provide a barrier:

- Between the waste materials and the surface.
- To prevent water infiltration.
- To prevent erosion.

When available, waste kaolin from the kaolin refining circuit would be used as the seal (first capping layer). This material has a compacted permeability of approximately 3.0 x 10^{-8} m/s (Douglas Partners, 2015) and would be 3 m thick. In the event waste refined kaolin is unavailable, overburden and low grade kaolinised granite would be used for this layer. Compacted kaolinised granite material has a permeability of approximately 6.0 x 10^{-8} m/s (Douglas Partners, 2015) and would be 3 m thick.

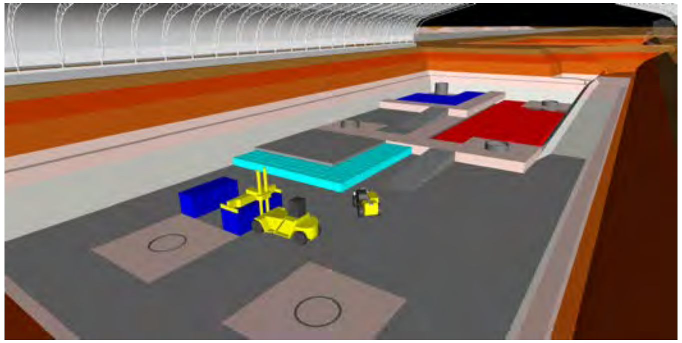
The remaining thickness of backfill up to the surrounding natural ground level is filled with compacted crushed silcrete and laterite material, with some kaolinised granite or clayey sand material used if additional volume is required. This layer would be typically 4 m thick (refer to Figure 5-19). The roof canopy is moved to the next cell after the second complete lift (600 mm) of the capping layer is placed over the waste. Prior to removing the roof an internal temporary sump would be created in a portion of the cell and on top of the first 300 mm cap so that any stormwater can be contained and pumped from the cell.

Figure 5-19 Backfill stages



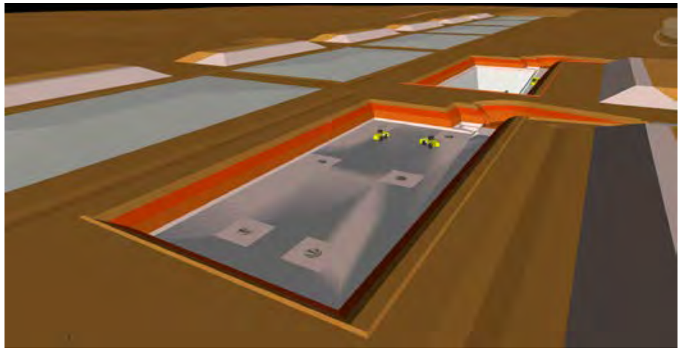
Base layer of waste cell

Waste packages would be segregated, so those with similar characteristics are stored together as illustrated by the different colours. Each section of waste packages would be separated horizontally and vertically by compacted, highly impermeable kaolinitic material.



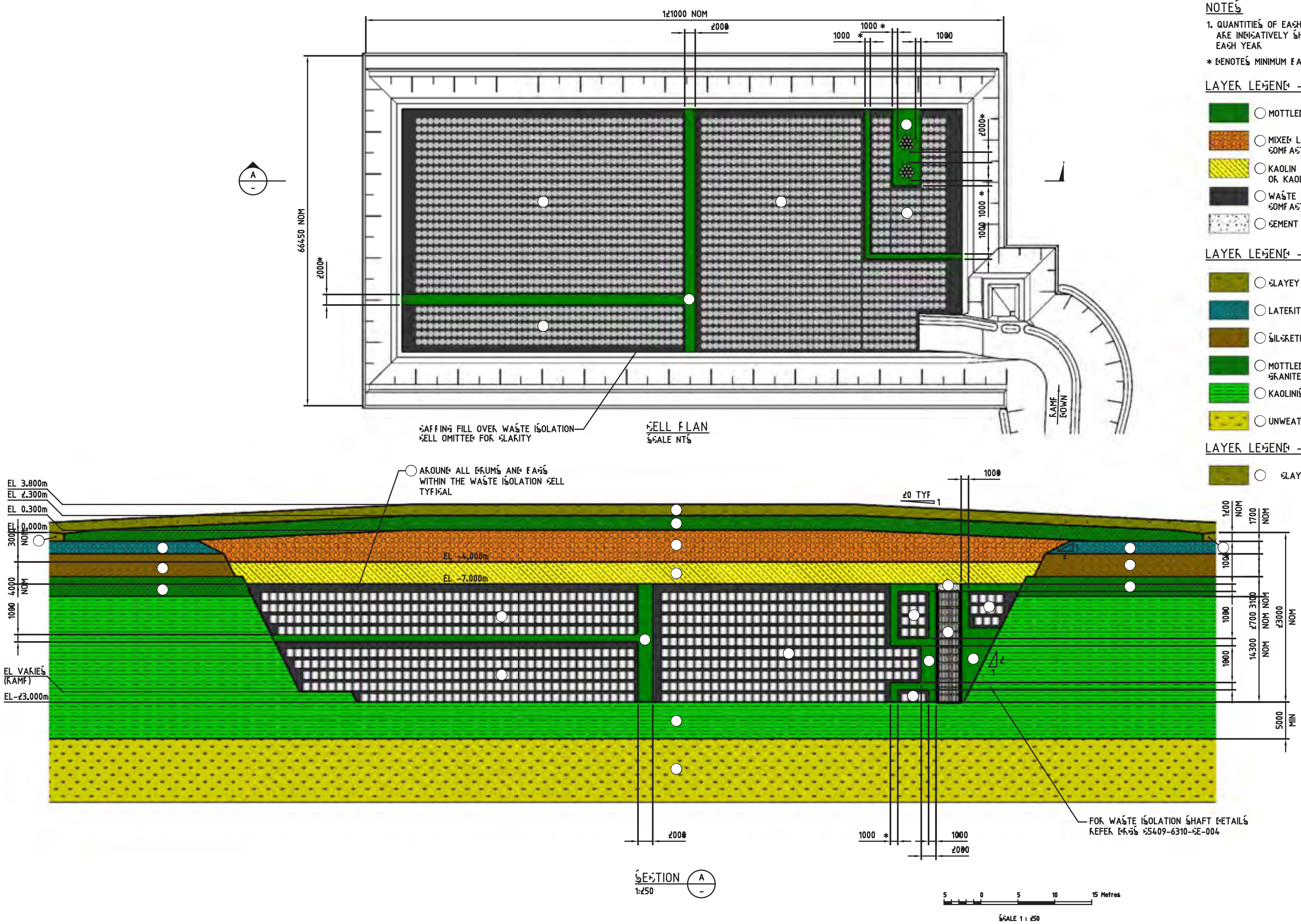
Layers of waste

Additional layers of waste would be stored then backfilled and compacted in the same manner as the base layer. Each layer of waste packages is separated vertically by compacted, granular material. Different waste types are separated both horizontally and vertically by compacted kaolinitic material. The number of waste layers in a cell depends on the waste package form and the depth to the base of the kaolinised granite material.



Capping layers

Following the placement of the final waste layer, capping layers are used to fill the remaining void and cover the completed waste cell. An approximately 3 m thick layer of low permeability waste kaolin or kaolinised granite material (seal) would be placed in multiple lifts on the waste layer. This would be topped with another 4 m thick layer of silcrete and laterite material. The cell is now ready for its clay dome. The overall conceptual cell profile is shown in Figure 5-17.



NOTES

1. QUANTITIES OF EACH TYPE OF WASTE AND NUMBER OF SHAFTS ARE INDICATIVELY SHOWN AND WILL VARY WITH WASTE MARKET EACH YEAR

* DENOTES MINIMUM BARRIER OF SEPARATION REQUIRED

LAYER LEGEND – CELL BACKFILL

- MOTTLED CLAYS COMPACTED TO 95%MMDD
- MIXED LATERITE AND SILCRETE AND KAOLINISED GRANITE COMPACTED TO 95%MMDD, MAX. PARTICLE SIZE 40mm
- KAOLIN WASTE COMPACTED TO 90%MMDD OR KAOLINISED GRANITE COMPACTED TO 95%MMDD
- WASTE SAND BACKFILLED AROUND DRUMS/BAGS COMPACTED TO 90%MMDD
- CEMENT STABILISED COMPACTED KAOLINISED GRANITE

LAYER LEGEND – EXISTING GROUND

- CLAYEY SAND
- LATERITE
- SILCRETE
- MOTTLED CLAYS (IRON STAINED KAOLINISED GRANITE)
- KAOLINISED GRANITE
- UNWEATHERED GRANITE

LAYER LEGEND – SURFACE REHABILITATION

- CLAYEY SAND

ACCEPTED WASTE STREAMS	
A	SHAFT WASTE (REFER DRG 6310-CE-004)
B	NORM WASTE
C	CHEMICAL WASTE TYPE 1
D	CHEMICAL WASTE TYPE 2
E	CHEMICAL WASTE TYPE 3
F	CHEMICAL WASTE TYPE 4

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NOT FOR CONSTRUCTION

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CAD Ref: g2294_PER_05_15.dgn
Date: Nov 2016 | Rev: B | A4

Aurora environmental

Author: C. Dorrington | AE Ref: THO2014-003
Drawn: CAD Resources ~ www.cadresources.com.au
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Sandy Ridge Facility
Conceptual cell profile
Public Environmental Review

Figure: 5-20

LLW shaft packing

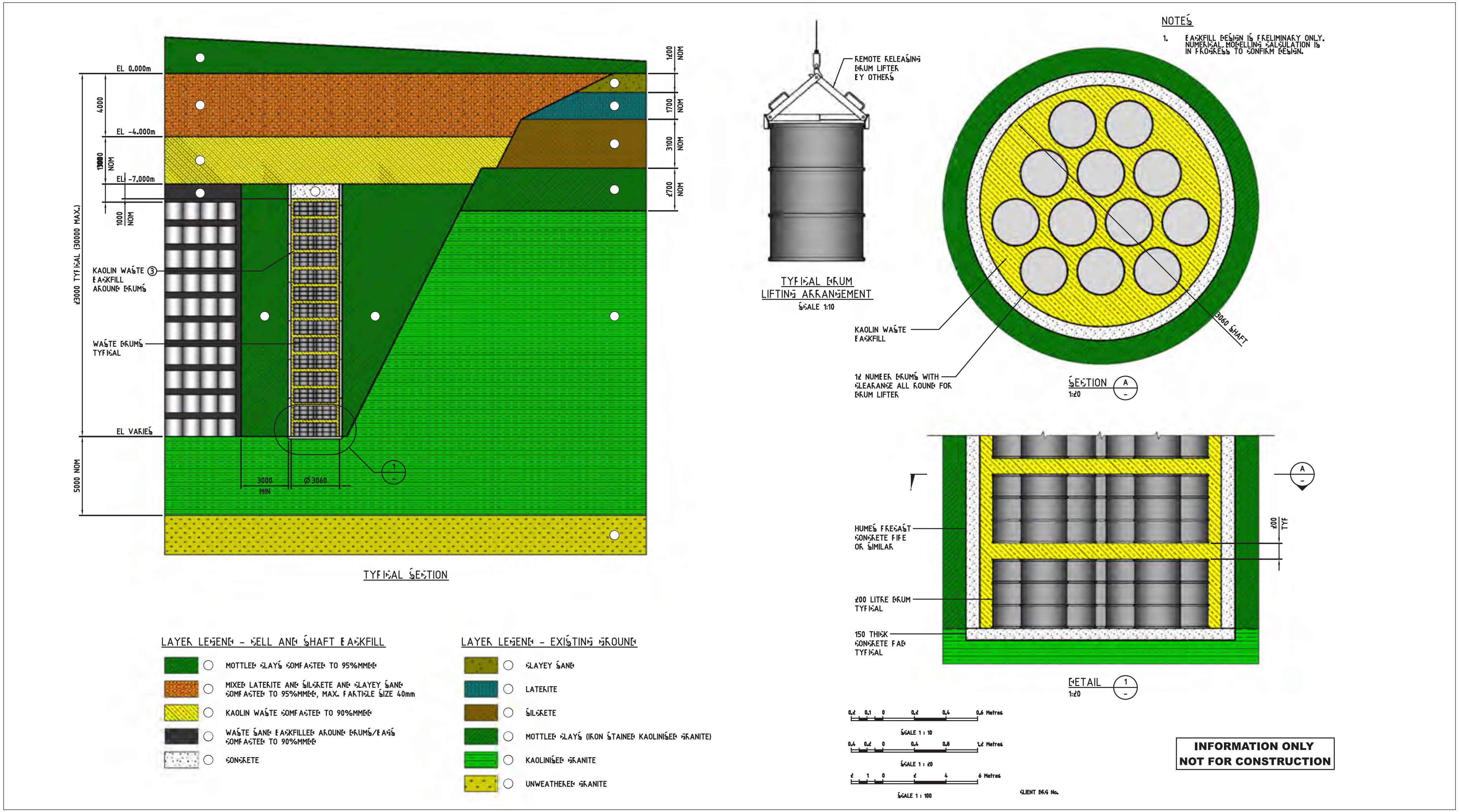
It is preferable that LLW of higher activity are not combined with chemical waste storage; therefore, vertical shafts would be constructed within the cell from prefabricated concrete or steel liners surrounded by natural materials to provide shielding (refer to Figure 5-21).

Figure 5-21 Radioactive waste storage (shaft in cell)

A number of shafts would be constructed within a cell using pre-formed cylindrical shaft segments. As the cell is progressively filled in waste layers to approximately 7 m below the ground surface, more pre-formed segments are stacked upon each other to create a shaft. A buffer of compacted kaolinised granite is placed around each segment to provide further isolation from chemical waste at the same level (refer to Figure 5-22).

Radioactive waste can be placed into the shaft at any time, but it is expected that the placement of chemical waste and pre-fabricated shaft segments surrounding the shafts would progress to several metres of depth before radioactive waste placement occurs, so as to provide vertical physical separation between the radioactive waste and workers on the active surface.

Radioactive waste packages would be lowered into the shaft and then backfilled with kaolinitic material to fill void spaces. Higher activity wastes may be backfilled with concrete slurry. A substantial pre-fabricated lid would be emplaced as a temporary cap on top of placed radioactive waste in the shaft to prevent un-authorised access or incidental exposure. When the shaft is filled with waste to the base of cap level (approximately 7 m below ground level), and permanent lid would be put in place and the structure covered by the cell cap materials as described previously.



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Sandy Ridge Facility

Conceptual design of low level radioactive waste isolation cell

Public Environmental Review

Figure: **5-22**

Non-shaft stored LLW

NORM at sufficiently low radioactivity may be placed in the same manner as chemical wastes in the open area of the waste cell. Whenever possible, the cell layout would have all shaft storage of radioactive materials at one end of the cell, with the adjacent space used for NORM, and chemical wastes in the rest of the cell.

Cell dome capping

The final capping layer is formed of compacted kaolin which has a low permeability (permeability approximately 6.0 x 10^{-8} m/s [Douglas Partners, 2015]) and placed in the form of a shallow dome, so as to shed stormwater from the structure into perimeter V drains, which flow to a sump.

The domed cap would be monitored for subsidence for a period of 10 years in accordance with the WFDCP (Appendix A.17). Following the monitoring period, topsoil would be respread and seeded. Vegetation monitoring would be conducted for 10 years.

5.6 Outline safety case

The Sandy Ridge outline safety case is both a written presentation and an operational requirement dealing with the technical, management and operational information regarding the hazards and risks of operation and how they are managed and mitigated. It considers the transport, construction, operation and closure of the Facility drawing on best practice examples from around the world which are internationally recognised as suitable to host a geological repository.

The proposed Facility would only accept wastes if they meet strict waste acceptance criteria and would store compatible 'like with like' wastes to ensure operational safety and create opportunities for the future recovery and reuse of valuable materials.

The outline safety case (Appendix A.15) is underpinned by the dry arid desert environment and the multi-barrier system, which provides long term containment and isolation.

5.6.1 Environmental suitability for an arid near surface geological repository

The environmental suitability of the Facility is presented in Table 5-11.

Table 5-11 Evidence supporting the proponents near surface geological repository over the lifecycle of the facility

Characteristic	Sandy Ridge – ClayVault
Type	• Near surface geological repository.
Can the hazardous waste be safely isolated from the biosphere for the long term?	• Waste can be safely isolated over the long term (hundreds of thousands to millions of years).
Recycling opportunities and contribution to the Circular Economy	• Hazardous waste should be seen as a valuable resource. • 'Like with like' waste materials would be stored together securely and safely until a way is found for the waste to re-enter the circular economy. The next generation may have a better recovery technology toolbox and can recover the materials in an economically viable way. • Permanent isolation of waste material if no further use is identified.
Does the site require ongoing monitoring after closure?	• No, the system is 'passively safe'. However, an appropriate insurance and assurance package would be in place over the 100 year closure and monitoring period to verify this. • Clay beds do not corrode or decay. • Clay beds have a self-healing characteristics (clay plasticity).
Liability	• There is no ongoing potential liability as there is a permanent isolation of the waste in the geological barrier.
Geology and stability (seismic, tectonic, volcanic activity)	In the proposed development envelope: • Kaolin clay bed is approximately 260 million years' old. • Geological stable thick, flat, extensive kaolin clay bed. • The rate of movement and the location is within a seismically quiet portion of a stable shield and is very unlikely to cause any significant tectonic activity (uplift, subsidence, or fracturing) in any timeframe relevant to the Proposal. • There has not been any igneous activity in the region for over 1,000 million years. There is no reason to expect that there would be any sub-surface or surface volcanic activity within this part of the stable craton for at least 50 million years. • It is in an area with the lowest hazard rating for earthquakes in Australia. This means there is a very low risk of earthquakes affecting the structural stability of the waste cells.

Characteristic	Sandy Ridge – ClayVault
Safety barrier types (multi barrier safety case)	• Engineered barriers. • Natural geological barrier (extensive kaolin clay bed). • If man-made engineered systems fail, then the 'fail safe' stable extensive geology would isolate the waste from the biosphere. • The multi-barrier safety case is increasingly recognised as a cost effective and preferred method of permanently isolating difficult to manage wastes. • The geological barrier provides isolation of wastes from the environment over the very long term (tens of thousands or millions of years), something a man-made barrier cannot achieve and creates significant additional opportunities for the future recovery and recycling of valuable materials from the waste which can re-enter the circular economy.
Liner dimensions	• Kaolin bed and overlying silcrete layer is the liner and is laterally extensive. • ~ 160 km long. • ~20 km wide and flat. • Clay bed ~7 to 24m thick (average 14 m). • ~ 40 m deep. • No credible risk of water ingress or contamination leaving the site.
Permeability (Perm.) of the geology (indicator regarding the risk of seepage)	• In situ kaolin has very low permeability. • When the thickness and permeability of the clay are combined, there is no credible risk of water ingress or contamination leaving the site (seepage). • The combination of a virtually flat plateau, cemented surface layers, and semi-arid conditions creates the stable geomorphology of the area.
Climate	• Semi-arid – low erosion and water ingress risk.
Groundwater contamination risk?	In the proposed development envelope: • A thick impermeable silcrete layer above clay bed (15 million years ago when climate became arid).

Characteristic	Sandy Ridge – ClayVault
	• The hydrogeological investigation confirmed that there are no regional aquifers present. • Clay bed has been dry for millions of years. • No credible scenario for groundwater contamination. • Not subject to flooding, nor is it predicted to be in the future. • Very low risk of encountering cyclones. • Low rainfall – averages just over 250 mm of rainfall per annum and evaporation is greater than 2,000 mm per annum. This means very little rainfall occurs across the proposed development envelope and generally water would evaporate before it infiltrates the ground surface. • The silcrete layer, which is a hard surface, ensures that even very large rainfall events are contained within the top few metres of the ground. Once rainfall does enter the soil profile, it is quickly evaporated before the water can infiltrate. • There are no defined surface watercourses or water bodies in the proposed development envelope. It is located close to the top of a watershed which means that catchment areas for surface water flows are small.
Other features	• Very low rates of erosion. • Lack of commercial mineral deposits. • It is an area of extremely low population (non-permanent camp approximately 52 km away). • No potential for medium to high value agriculture. • The site has no special environmental features. • No special cultural or historical significance has been identified through a completed heritage study and consultation with stakeholder's familiar with the area. • There is little credible risk to human health or the environment from suitably conditioned and packaged wastes that might be stored and isolated at the Sandy Ridge Facility. • Wastes would be accepted from within WA, from other states and territories, and from Australia's Exclusive Economic Zone.

Provided the storage or isolation cells are capped to prevent any vertical surface water or groundwater infiltration into the cell, the characteristics listed above essentially eliminate the possibility that contaminants contained in waste materials could migrate outside of the cell and affect sensitive environmental receptors.

Even in the highly unlikely event that water did enter a cell, the highly impermeable clays surrounding the cell would prevent migration of contaminants over more than a few metres from the cell walls. As a consequence, virtually any chemically contaminated waste could be accepted at the site (NEPM 75), provided:

- Wastes placed in the cell are dry non-compactable solids which are non-reactive (stabilised).
- They are placed in a manner that ensures that no voids are left.
- The cells are securely capped to prevent the intrusion of surface water.

5.7 Onsite Class II landfill

A putrescible landfill (Class II) would be constructed to service the accommodation camp and offices. Only wastes generated at the Facility would be disposed of in this landfill. Wastes may include; food scraps, plant materials and inert materials (e.g. cardboard, bricks, concrete). The landfill would comprise a series of single trenches (opened as required) that are 60 m long, 3 m wide and 3 m deep.

5.8 Site access and traffic management

Site access roads have been preliminarily designed to suit a maximum of a 36.5 m long road train configuration. An existing unsealed access road would be utilised to access Sandy Ridge and new unsealed access roads would be created. The existing road is the IWDF access road, which is not a gazetted road but is a private road managed by the Department of Finance. Upgrade works required for the IWDF access road include:

- Construction of an intersection with slip-lanes at the IWDF access road and Great Eastern Highway.
- Re-forming and re-surfacing of IWDF access road.

The use of and any alterations to the IWDF access road would require the permission of the Department of Finance (Building Maintenance and Works) whom manages the road on behalf of the State.

The Great Eastern Highway intersection upgrade requires Main Roads WA approval prior to construction works.

New unsealed access roads would connect the upgraded existing IWDF access road alignment to the proposed development envelope, infrastructure area, accommodation camp and the Class II landfill.

5.9 Ancillary infrastructure

5.9.1 Introduction

Infrastructure to support the mining and waste repository operation is summarised below and shown in Figure 5-23.

- Accommodation camp to be located approximately 1.6 km south-east of the infrastructure area, with a capacity to house up to 40 people. Includes camp carpark and access roads.
- Putrescible landfill (Class II) for disposal of camp and office waste.
- Sewage treatment systems (BioMAX® systems or equivalent), would be installed at both the accommodation village and at the infrastructure site.
- Administration and gatehouse building and carpark, including (offices, first aid, training centre, communications, lunch room, and ablutions).
- Potable water treatment facilities (reverse osmosis plant).
- Water tanks including raw saline water, potable water and firefighting water systems.
- Kaolin drying fuel storage facility (most likely LPG).
- Diesel storage tank, piping reticulation and bowser for refuelling of trucks and mobile plant
- Switchboard and generators (see Section 5.9.3 below).
- Access roads, gate and perimeter fence.
- Water supply pump station (at Carina Iron Ore Mine) and pipeline.

5.9.2 Water supply

This section addresses matters in relation to the water source and viability of the source for the Proposal. Specifically, water demand and the agreements in place to secure the water source are discussed. The viability of using the Carina Iron Ore Mine as a water source is also presented.

Water demand and agreements in place to secure the water source

The Facility requires water for the following components of the Proposal; for potable use at the accommodation village and administration building and amenities, for use in the laboratory, for use in kaolin processing, for vehicle washdown and for firefighting. Non-potable water (RO reject and raw saline water) would be used for dust suppression and compacting of waste cell backfill and capping.

The proponent would apply for a Licence to Take Water from the Department of Water following completion of the environmental impact assessment (i.e. Part IV) process. It is anticipated that an agreement would be made with Mineral Resources for access to the Carina Pit water via overlapping tenure following the Part IV environmental impact assessment process. The operations at the Carina

Pit would be nearing their end around the time that construction of Sandy Ridge would commence. It is unlikely that the two operations would conflict, and discussions held with Mineral Resources representatives indicated that the mine cell is proposed to be left as a cell lake at mine closure.

The water within the pit is held within fractured rock and Mineral Resources' licence (GWL 169652) allows for abstraction of 1.6 GL per annum. Significantly less water is proposed to be extracted (estimated at 0.18 GL per annum) than Mineral Resources is currently abstracting.

Viability of using Carina Iron Ore Mine as a water source for 25 years

The Carina Mine currently has an excess of water from dewatering which is disposed of in evaporation ponds. By the time Sandy Ridge is in construction or operations, the Carina Pit would be closed and is planned to be partly backfilled and left to flood naturally. The salinity of the water is close to seawater at approximately 33,000 mg/L Total Dissolved Solids (TDS) which is less saline (in concentration) than other locations assessed by Rockwater (2015). The pH of the Carina Mine water is currently close to neutral.

It is anticipated that a maximum of 495 kL/day or 0.18 GL of water would be required for operations per annum from Carina Pit. Rockwater Pty Ltd (Rockwater) (2015) completed an assessment of suitable water supplies in the vicinity of Sandy Ridge. As there is a distinct lack of water within the proposed development envelope, Rockwater identified the Carina Iron Ore Mine as the best source of water. Mineral Resources' Carina Iron Ore Mine is located approximately 13 km to the south-west of the site on Mining Lease M77/1244–1 (refer to Figure 5-1).

When compared to the 2014 dewatering rate of 2,250 kL/day, is a 78% reduction in volume. At the abstraction rate of 495 kL/day, the water level is likely to reduce from 379 m AHD to 357 m AHD.

The water balance calculated by Rockwater (2015) at the water level contour of 350 mAHD shows that rainfall (332 kL/day) and groundwater inflows (707 kL/day) combined, with evaporative losses (411 kL/day) subtracted, equate to a water surplus of 628 kL/day. If 495 kL/day is abstracted for the Facility, this leaves a residual surplus of 133 kL/day.

Therefore, water would rise, albeit slowly, and the abstraction would be sustainable. There is also water stored at deeper depths, as shown by Polaris Metals/Mineral Resources whom have dewatered to 315 mAHD, suggesting 42 m of water could be available over the 25 year period, if it was needed.

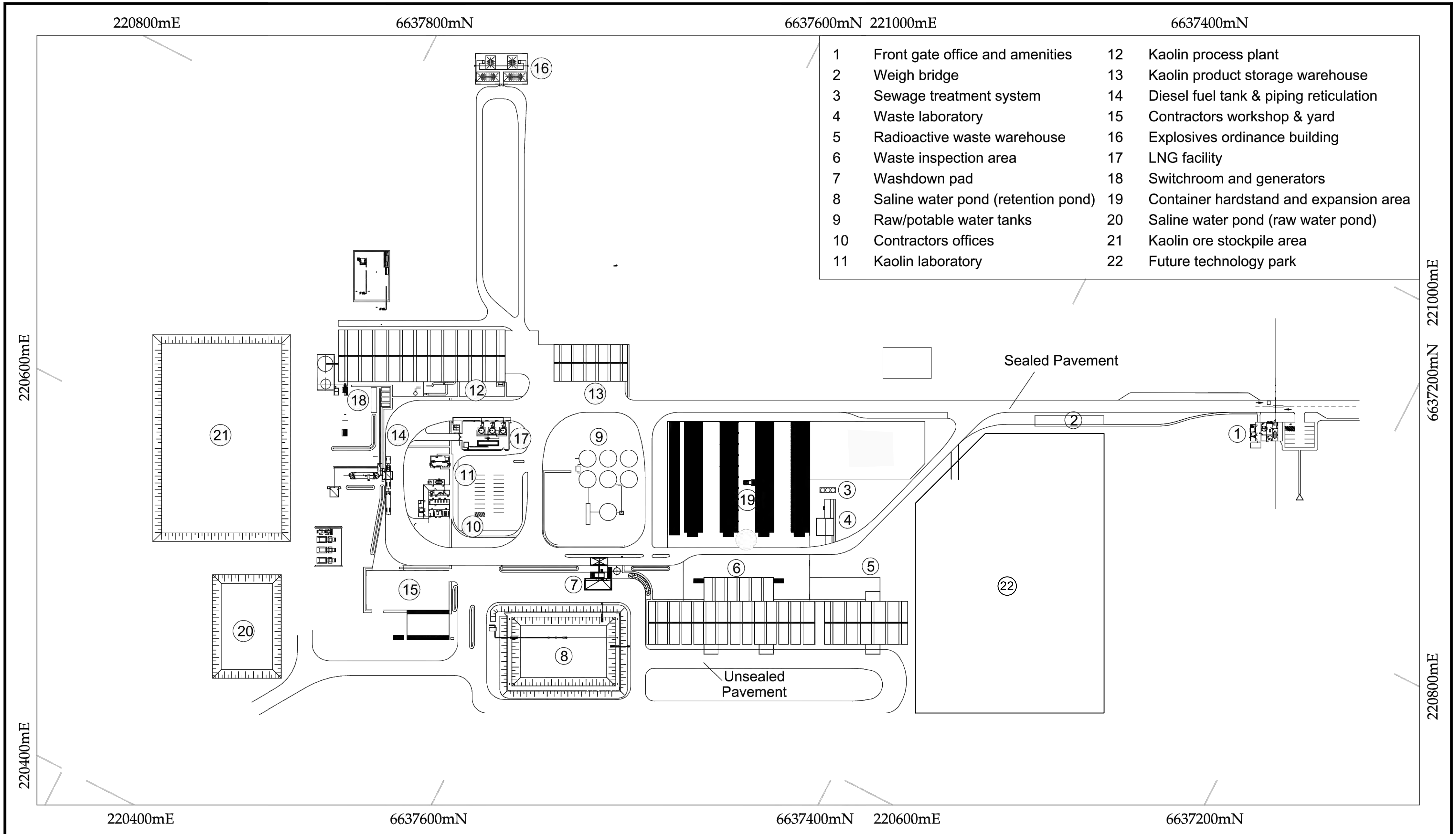
To transport water from the Carina Pit to the water tanks within the proposed development envelope, a floating pump would be placed within the Carina Pit and a pump station (including water tank, pumps, genset and small diesel tank) would be constructed adjacent to a 12 km long dedicated water pipeline (refer to Figure 5-1).

A floating pump, suitable for full time saline water exposure, would pump the raw water from the Carina Pit into the pump station which would pump water into the pipeline and into water storage tanks within the proposed development envelope. Saline water delivered to Sandy Ridge would be treated in a RO plant to produce fresh water for potable use in:

- The accommodation camp.
- Administration building.
- Amenities.
- The laboratory.
- Kaolin processing.
- Vehicle washdown.
- Firefighting.

RO reject and raw saline water are used for dust suppression and compacting of waste cell backfill and capping.

It is anticipated that an agreement would be made with Mineral Resources to enable the grant of tenure to the proponent that would allow access to the Carina Pit water. The proponent would also apply for a Licence to Take Water under the *Rights in Water and Irrigation Act 1914* after the Ministerial Statement and Commonwealth approvals are granted.



Notes:
- Design Supplied by Onyx Projects

TELLUS

0 60m
Scale 1:3,000
MGA94 (Zone 51)
CAD Ref: g2294_PER_05_04.dgn
Date: Nov 2016 | Rev: G | A4

Author: C. Dorrington | AE Ref: THO2014-003
Drawn: CAD Resources ~ www.cadresources.com.au
Tel: (08) 9246 3242 ~ Fax: (08) 9246 3202

Sandy Ridge Facility
Infrastructure area conceptual layout
Public Environmental Review

Figure:
5-23

5.9.3 Energy supply

Power supplies are required for the kaolin processing plant and associated support infrastructure and at the accommodation camp. Infrastructure may be powered by diesel, dual-fuel and/or solar generators located at the site. The anticipated average electrical demand required is 1.5 megawatts.

Fuel supplies are needed to power the generators, kaolin dryers and mobile plant. Gas and diesel storage tanks would be located in the main infrastructure area, with mobile energy suppliers topping up fuel onsite on a regular basis. Diesel day tanks would be located at the camp and the water supply pump station.

5.9.4 Site security

The *Code of Practice for the Security of Radioactive Sources* (ARPANSA, 2007) would be complied with. The code sets out the security requirements to be implemented in order to decrease the likelihood of unauthorised access to or acquisition of radioactive sources by persons with malicious intent.

In the absence of direction from ARPANSA on security screening requirements for staff working with radioactive materials, the Maritime Security Identification Card system would be adopted as a minimum standard.

5.10 Opening hours, workforce and accommodation

The Proposal would normally be open for waste deliveries four days a week, for 52 weeks a year. This would provide waste customers with flexibility in scheduling waste deliveries. Deliveries and waste operations may occur on the remaining three days of the week if required due to:

- Delays due to inclement weather (particularly affecting the access roads).
- Short term peaks in waste supply.
- On-site activity delays e.g., re-positioning of infrastructure (e.g. cell roof) or equipment breakdown.

It is anticipated the proposal would require a construction workforce of up to 90 people and an operational workforce of 25 to 35 people.

During the construction phase employees and contractors would be housed at a temporary accommodation camp onsite until the permanent camp is built. An accommodation camp with a capacity to house up to 40 people would be constructed and would include; kitchen, dining room, wet mess, bedroom modules, laundry modules, recreation and exercise facilities.

During the operations phase, where possible, local people would be employed to run the Facility to provide employment opportunities to the local community. Approximately five people would be based in Perth and Sydney in administrative roles. Working hours would be 12-hour day shifts Monday to Thursday and two people working 12-hour day shifts on Thursday to Monday for maintenance purposes.

5.11 Closure and decommissioning

Closure, rehabilitation and decommissioning would proceed in accordance with the MCP (provided in Appendix A.19) and the WFDCP (provided in Appendix A.17).

The phases of management for closure of the Facility are illustrated in Figure 5-24.

Years 0 to 25: Operations Phase	•Tellus Holdings Ltd manage the waste facility. •Complete backfill, cap cells, replace topsoil and establish vegetation. •Undertake subsidence, radiation, vegetation and groundwater monitoring.
Years 26 to 45: Post Closure Management Period	•Tellus Holdings Ltd manage the waste facility. •Manage any subsidence of caps, and infill plant vegetation. •Undertake subsidence, radiation, vegetation and groundwater monitoring. •Final duration to be negotiated; dependent on satisfactory monitoring results
Years 46 to 125 (or end date as negotiated with regulator): Institutional Control Period	•State Government manage the waste facility and restrict public access. •Undertake radiation and groundwater monitoring.

Figure 5-24 Phases of closure

Elements of the Proposal that are covered in the decommissioning and closure phase are listed in Table 5-11.

Table 5-12 Elements of the Proposal and location of information regarding decommissioning and closure

Physical elements	MCP	WFDCP
Class V/Class IV cell closure	×	✓
Front gate office and amenity building	×	✓
Water pipeline	×	✓
Roof canopy	×	✓
Technology and recovery park	×	✓
Radioactive waste warehouse	×	✓
Accommodation camp	✓	×
Class II landfill	✓	×
Internal roads	✓	×
Waste inspection area	✓	×
Container hardstand	✓	×
Weighbridge	✓	×
ROM pad	✓	×
Diesel fuel tank, piping reticulation and bowser	✓	×
Waste laboratory	✓	×
Kaolin laboratory	✓	×
Kaolin processing plant	✓	×
Washdown pad and washdown treatment and storage system	✓	×
Water tanks	✓	×
Contractors offices, laydown yard and maintenance workshop	✓	×
Kaolin products storage warehouse	✓	×
Saline water ponds	✓	×
Explosive ordinance building	✓	×
Sewage treatment systems	✓	×
LNG facility	✓	×
Switch room and generators	✓	×

The regulator of a Class V Waste Facility in WA (currently DER) has no published closure requirements for Class V landfill sites, but based on consultation with DER, closure requirements would centre on the post-closure monitoring and management of potential emissions and discharges. The proponent would also discuss the closure objectives with the ICP Government Manager (see below for more detail).

The objectives of closure are:

1. Structurally stable, non-eroding disposal and isolation cells.
2. No emissions or discharges from the cells following capping.
3. Establish vegetation on the cell caps.

To demonstrate that closures objectives have been met, the proponent would need to meet the completion criteria and provide evidence to regulators as stipulated.

During mine closure and decommissioning, groundwater and vegetation establishment would be monitored as outlined in Appendix A.19.

The radiation monitoring programs would follow a conventional format for each of the types of hazards described.

The aim of the monitoring program is to:

- Demonstrate regulatory compliance.
- Assessment of the efficiency of work practices and engineering controls in preventing and limiting employee and public exposure to radiation.
- Provide data to enable knowledgeable radiation protection decision-making.

The general procedures are:

- To conduct area gamma and airborne activity surveys to define general baseline radiation levels before the Proposal is started.
- To conduct area gamma and airborne activity surveys before finalising the preliminary earthworks phase to confirm that sufficient material has been removed and to confirm no spread of contamination to neighbouring areas.
- To comprehensively monitor people who work in the areas by:
  - Individual gamma monitoring to determine external γ-radiation.
  - Random personal dust sampling to determine airborne radioactivity.
- To conduct assessments of doses received by employees and the critical group.
- To ensure action levels are not exceeded.
- To investigate and correct any situation that results in an action level being exceeded.
- To adopt practical preventive measures at all times to limit the exposure of all persons.

The purpose of the Environmental program is to ensure that radiological impact on the local environment and to members of the public is minimal. This program is usually accomplished by area monitoring (dust and water monitoring, and area γ-surveys).

5.12 Environmental monitoring program

The environmental monitoring program is adapted based on on-going interpretation of results and risk assessments before permanent disposal and waste acceptance. The following environmental radiation monitoring program (Table 5-12) would be followed as a minimum to ensure that the operations have no detrimental effect on the environment.

Table 5-13 Environmental monitoring schedule summary

Monitoring type	Type of monitoring	Type of radiation	Pre-operational	Baseline (operational)
Dust monitoring	Environmental high volume dust samples	LLA	1/year from six representative locations.	2/year from representative locations.
Radon	Track etch	Radon decay product (RnDP)	1/year from three locations.	2/year for first three years of operation – then as per determined risk.
Area γ-monitoring	Pre-disposal background gamma levels	γ-survey	Pre-clearance survey before cell is mined.	Pre-disposal (mined out area), after disposal and after final capping.
	Boundary gamma surveys	γ-survey	Once off.	Annually.
	Equipment contamination clearance	α, β, γ-survey	Once off.	As required before equipment that might be contaminated leave site.
Waste storage	Radiation store	γ-survey	-	2/year.
	Stockpiles	γ-survey	-	2/year.

5.12.1 Dust monitoring

Samples are deposited upon a pre-weighed (25.5 cm x 20.5 cm) glass-fibre filter paper with an effective sampling area of 382.5 cm^2 (22.5 cm x 17.0 cm). Upon completion of sampling, the filter paper is re-weighed to determine the mass of dust collected. The sub-samples are stored for a period of not less than seven days to allow short lived radioactive products to decay, and are then presented to the α-spectrometer to determine the long-lived α-emitting activity. The mean α-activity from the sub-samples is integrated over the total active area to determine total collected long-lived α-activity.

5.12.2 Environmental area γ- monitoring program

Environmental area γ- monitoring program would consist of:

- Site boundary monitoring surveys.
- γ- monitoring to determine background levels.
- Clearance survey.

The environmental gamma survey would be done at a height of 1 m from the ground. Keeping the monitor and audio indicator in the on position allows for the identification and monitoring of smaller areas with elevated gamma radiation levels. A grid of approximately 15 m x 15 m is recommended.

- All monitoring locations are recorded using a Global Positioning System (GPS) receiver.
- Area γ- monitoring of the site boundary would be undertaken as part of the pre operational and operational baseline program. The monitoring locations would be recorded with the GPS coordinates and compared to the pre-development monitoring results.
- A survey would be undertaken once mining has been completed and before disposal to confirm the background levels in the cell. The survey results with the GPS coordinates would be recorded.
- A clearance survey of each cell would be undertaken after completion of earthworks and capping to confirm area above cell is at background levels. Results and GPS coordinates would be recorded.

5.12.3 Occupational monitoring program

The purpose of the occupational monitoring program is to ensure that radiation exposures of the workforce remain below the statutory annual limit (20 mSv) and as low as reasonable achievable. Occupational radiation monitoring is carried out on a cross section of the employees. Results of area surveys and time and motion studies are also used to estimate potential doses for employees. The personal monitoring to be conducted would include:

- Personal dust samplers and analysis for gross α activity.
- Personal γ- monitoring with personal electronic dosimeters (Canary).

- Work Area γ- monitoring to demarcate areas based on exposure risk.

5.12.4 Personal dust monitoring

Personal dust sampling would be conducted in accordance with *AS 3640:2004 Workplace Atmospheres -Method for Sampling and Gravimetric Determination of Inhalable Dust, 2004.* Samples would be analysed for LLA. The International Commission on Radiolocial Protection (ICRP) recommends that a default Measurement of Aerosol Size Distribution (AMAD) of 5 µm is used for occupational exposures whilst for environmental exposures the default AMAD is taken to be 1 µm (ICRP, 1994).

Sampling sizes for the baseline program would be in accordance with the *Occupational Exposure Sampling Strategy Manual* (National Institute for Occupational Safety, 1977) to ensure that there is 90% confidence that at least one individual from the highest 10% exposure group is contained in the sample.

5.12.5 Personal γ-Radiation monitoring

Personal γ monitoring would be conducted to confirm the individual dose is kept below the action levels. This would be done with personal electronic dosimeters or Thermoluminescent Dosimeter (TLD) badges.

5.12.6 Area γ- Monitoring

Work areas would be classified based on the potential annual radiation exposure in excess of the natural background and would be demarcated accordingly. The average level of natural background gamma radiation would be determined in the pre-operational surveys.

5.13 Institutional control period

Institutional control is defined by the *Code of practice for the near-surface disposal of radioactive waste in Australia* (NHMRC, 1992) as the control of a former waste disposal site by the appropriate authority in order to restrict access to and use of the site, and to ensure an on-going knowledge that the site has been used for the disposal and permanent isolation of radioactive waste.

The ICP, as defined by NHMRC (1992) is:

> *The period following closure of the disposal facility where public access to, or alternative use of, the site shall be restricted for a predetermined period of time. The ICP shall be established before the commencement of disposal of operations (i.e. disposal of radioactive waste) and should not be less than 100 years.*

The appropriate authority to determine the ICP for Sandy Ridge is the Radiological Council of WA. As per NHMRC (1992) the Radiological Council of WA may vary the ICP according to the usage of the facility.

5.13.1 International standards for institutional control periods

Other near-surface geological sites around the world have ICP ranging between 100 and 300 years (Nuclear Energy Agency [NEA], 1999). A summary of ICPs applied to similar facilities overseas is provided in Table 5-13.

Table 5-14 Institutional control periods at near surface facilities

Country	Near surface geological facilities	Institutional Control Period
Australia	IWDF Mount Walton East	100 years
Czech Republic	Dukovany, Richard and Bratrstvi Facilities	200–300 years
France	L'Aube and La Manche Facilities	300 years
Hungary	Puspokszilagy Facility	100 years
Japan	Rokkasho No 1 and Rokkasho No 2 Facilities	300 years
South Africa	Vaalputs Facility	300 years
Spain	El Cabril Centralised Waste Disposal Facility	300 years
United Kingdom	National Low Level Waste Repository	100 years

Sources: NEA (1999), Empresa Nacional de Residuos Radiactivos (ENRESA) (2009), LLW Repository Ltd (2011), South African Nuclear Energy Corporation (no date)

5.13.2 Appropriate authority for institutional control

As the proponent is a private company and does not own the land, at an agreed milestone in the ICP, responsibility for the Proposal may be transferred to the WA Government. The site would then be managed by a government agency determined by the WA Government. This agency would then be recognised as the appropriate authority for institutional control. As part of the transfer of responsibility from the proponent to the WA Government, the proponent would also provide ample funding through an escrowed fund arrangement to cover management costs likely to be incurred by Government.

Government is the only practical option to be the appropriate authority for institutional control given:

- The nature of the wastes is such that they must be contained securely for geological time.
- The length of the ICP.
- The land in question is a Crown land.
- The Government exists in perpetuity, whereas it is feasible or even likely that at some future date, the proponent may no longer exist.

The Government therefore is in the best position to restrict access to and use of the site, and to ensure on-going knowledge is retained in state archives for future populations to access if and when required.

5.13.3 Financial provision during institutional control period

Financial provisioning information for closure of the Proposal has been provided by the proponent. Closure cost estimates are a part of the overall financial planning of the Proposal, and the final estimates would fall into the Bankable Feasibility Study. The costings provided are based on the size of areas within each domain to be closed (as defined during the pre-feasibility phase of the Proposal) and 2016 rates.

Rates account for; supply, labour, construction equipment and freight. The rate multiplied by the size of the area (quantity) provides a cost estimate. This cost estimate is then considered in terms of growth over the life of the Proposal (i.e. growth of the quantity) to account for any change to the size of areas to be closed.

The outcome is a total estimated direct cost for each domain and subtotal for elements within each domain. The proponent recognises the importance of updating the financial provisioning cost estimates with each revision of the MCP, to ensure closure is included in the proponent’s annual financial budgets.

The proponent would provide appropriate financial assurance for the expected closure costs of the Proposal. The proponent intends on this financial assurance being via appropriate contributions to the WA Mining Rehabilitation Fund, consistent with the DMP’s standard policy for mining projects in WA.

The proponent would agree to the final legal structure of the financial assurances to be put in place following detailed legal, tax and accounting advice and following consultation with relevant government agencies. Such a financial assurance package would also be considered on a holistic basis with other financial assurances to be provided for the Proposal (i.e. for an ICP).