

2.7 REAGENT AND PRODUCT MANAGEMENT

2.7.1 Introduction

The processing operations would use a number of reagents and the following subsections review the source and method of delivery, storage locations and quantities, specific safeguards and management measures which would ensure that environmental risks associated with each are minimised to the greatest extent possible.

2.7.2 Sulphur

The Applicant estimates that approximately 106 520t of sulphur would be required annually for the production of sulphuric acid (at maximum production rate). The material would be imported to Newcastle (ex Kazakhstan or Canada), unloaded by crane and delivered to a Newcastle storage facility capable of maintaining 1.5 x shipment size (10 000t), i.e. 15 000t.

As is discussed in more detail in Section 2.12.1, the preferred method of transportation from Newcastle to the DZP Site would be by rail (Option A), however, two additional options are being considered by the Applicant and have been assessed as part of the EIS.

- Option B: rail transport to Fletcher International Exports Rail Terminal at Dubbo, transfer to trucks and road transport to the DZP Site.
- Option C: road transport from Newcastle to the DZP Site.

The sulphur would be transported in open top covered containers (container pay loads would vary depending on the method of transport, i.e. road or rail – refer to Section 2.12.1). If delivered by rail to the DZP Site, the containers would be unloaded by forklift and either immediately loaded to trucks for delivery and tipping onto a dedicated stockpile with a 4 000t capacity (2 weeks supply) or stored temporarily in the Rail Container Laydown and Storage Area before being loaded to trucks and delivered to the stockpile at a later time. Empty containers would be stored within the Rail Container Laydown and Storage Area for back-loading to the train.

If delivered by road, the trucks would be marshalled on arrival and either directed to the Rail Container Laydown and Storage Area for replacement of a full for empty container or the Sulphur Stockpile for tipping. The Sulphur Stockpile would be regularly profiled by a front-end loader with the reagent loaded to the acid plant hopper on a regular cycle during acid production.

As illustrated by **Figure 2.11**, both the Sulphur Stockpile and Rail Container Laydown and Storage Area would be on bunded concrete pads isolated from surface drainage.

2.7.3 Sulphuric Acid

While sulphuric acid (H_2SO_4) (DG Class 8, PG II) could be purchased, the Applicant has determined internal production from the burning of elemental sulphur (refer to Section 2.6.3 for an overview of the chemical reaction) is feasible. Notably, this replaces the requirement for the

transportation of sulphuric acid (a Class 8 dangerous good) with sulphur (not classed as a dangerous good in Australia). Importing sulphur rather than sulphuric acid reduces the quantum of the freight task significantly because sulphuric acid is a heavy product to transport while sulphur is relatively light.

The sulphuric acid produced on site would be stored in two above ground 10 000m³ capacity mild steel tanks, sufficient to provide up to 15 days supply to the roasting circuit of the processing plant in the event of an extended acid plant shut down. Each tank would be vented in accordance with the required safety standard, with both tanks placed within the same bunded concrete pad as the Sulphur Stockpile.

In the event of an extensive unplanned acid plant outage, a very specific tanker (high grade stainless steel, ribbed with copper dams) would be required to bring the acid to site (most likely from an active sulphuric acid storage tank in Newcastle). On delivery to the DZP Site, it would be marshalled and directed to the sulphuric acid storage tanks then unloaded in accordance with the supplier's specifications.

2.7.4 Limestone

Limestone (CaCO₃) would be required to provide a neutralising agent for the acidic solid and liquid residue streams generated by the processing operations (refer to Section 2.6.3). The Applicant proposes to establish a limestone quarry at Geurie, however, until such time as this quarry is approved, developed and operating, supplies would be sourced from an existing limestone supply near Parkes. In either case, approximately 16 trucks per day (B-Doubles or rear-tipping semi-trailers) would deliver the limestone via the public road network, i.e.:

- Mitchell Highway – Newell Highway – Obley Road: if delivered from Geurie; or
- Newell Highway – Obley Road: if delivered from Parkes.

The trucks entering the DZP Site would be marshalled prior to entry to the processing plant area and then directed to a dedicated storage stockpile towards the southern end of the processing area. The limestone would be tipped onto the stockpile which would be 3m to 4m in height and regularly profiled with a front-end loader. The stockpile would be maintained on a crushed and compacted limestone base (bundled on three sides) (see **Figure 2.11**) with a 1° slope to a sump in the southeastern corner of the stockpile area. Limestone would be reclaimed from the stockpile by front-end loader and fed to the hopper of the limestone milling and slurring plant to produce the neutralising slurry to be added to the residues prior to disposal (refer to Section 2.6.3). Water accumulating in the sump would also be periodically pumped into this plant.

On-site storage would equate to approximately 2 weeks stock (7 500t) with an additional week stock to be held at the source.

2.7.5 Quick Lime

Quick lime (CaO) would be sourced from a manufacturing plant in Charbon, NSW, and transported to the DZP Site in bulk pneumatic tankers, or B-Double pressure pots, with a 40t payload. Approximately 17 tankers would be required per week to maintain supply.

The tankers would be marshalled on arrival on the DZP Site and directed to the lime silos into which the quick lime would be pneumatically conveyed. The silos would be purpose built on a bunded concrete pad and have a combined capacity of at least 1 000t (approximately 13 weeks supply).

2.7.6 Caustic Soda

Caustic soda sodium hydroxide (NaOH) (DG Class 8, PG II) would be delivered to the DZP Site in isotainers filled in Newcastle and loaded onto either a dedicated train or single drop deck semi-trailers (depending on the transport option undertaken – see Section 2.7.2).

If delivered by rail (64 isotainers per week / 18 per train delivery), the isotainers would be unloaded by forklift and either immediately loaded to trucks for delivery and emptying into bulk storage tanks or stored temporarily in the Rail Container Laydown and Storage Area before being loaded to trucks and delivered to the bulk storage tanks at a later time. Empty isotainers would be returned to the Rail Container Laydown and Storage Area for back-loading on the train.

If delivered by road, the trucks would be marshalled on arrival and either directed to the Rail Container Laydown and Storage Area for replacement of a full for empty container or to the bulk storage tanks directly for immediate emptying.

The storage tanks would be constructed on a bunded concrete pad and have a capacity equal to one week's supply (1 400t). In order to maintain ordered supply, a fleet of approximately 60 isotainers would be required with 20 at the source in Newcastle, 20 in transit and 20 at the DZP Site.

2.7.7 Soda Ash

Soda ash (Na_2CO_3), used for the regeneration of the solvent extraction organics used in zirconium separation, would either be delivered by rail in full container loads from Sydney to the Fletcher International Exports Pty Ltd Rail Terminal Dubbo, where the containers would be transferred to trucks for delivery to the DZP Site, or by road from Sydney. Approximately 33 containers (11 per train) would be delivered each week.

Containers would be unloaded from the rail cars using container forklifts, transferred to trucks and delivered to the DZP Site. From the DZP Site entrance, the trucks would be marshalled and directed to a Reagent Storage Area (a series of enclosed warehouse style facilities on bunded concrete pads) where the containers would be unstuffed using a 2-tonne forklift. On-site storage equivalent to 4 weeks supply (3 400t) would be maintained.

2.7.8 Hydrochloric Acid

Concentrated hydrochloric acid (HCl) (DG Class 8, PG II) would be delivered in isotainers (20 000L) filled in Newcastle and loaded, full for empty, onto either a dedicated train or single drop deck semi-trailers (depending on the transport option undertaken – see Section 2.7.2).

If delivered by rail (21 isotainers per week / 7 per train delivery), the isotainers would be unloaded by forklift and either immediately loaded to trucks for delivery and emptying / tipping into bulk storage tanks or stored temporarily in the Rail Container Laydown and Storage Area before being loaded to trucks and delivered to the bulk storage tanks at a later time. Empty isotainers would be returned to the Rail Container Laydown and Storage Area for back-loading on the train.

If delivered by road, the trucks would be marshalled on arrival and either directed to the Rail Container Laydown and Storage Area for replacement of a full for empty container or to the bulk storage tanks directly for immediate emptying.

The storage tanks would be constructed on a bunded concrete pad and have capacity equal to two weeks supply (1 600t). In order to maintain ordered supply, a fleet of approximately 21 isotainers would be required with 7 at the source in Newcastle, 7 in transit and 7 at the DZP Site.

2.7.9 Salt

Salt (sodium chloride – NaCl), a component of the zirconium strip liquor, would be delivered from Salt Lake, in northeastern Victoria, via the Newell Highway and Obley Road in rear-tipper semi-trailers or truck and dogs.

Approximately 44 trucks per week would deliver to the DZP Site with each marshalled and directed to the salt stockpile located along the western perimeter of the processing area. The trucks would tip directly to this stockpile, located on a bunded concrete pad, which would maintain a 3 500t capacity (2 weeks supply). A sump would be constructed to which runoff would be directed with a pump in the sump returning brine back to the stockpile.

The salt stockpile would be maintained by front-end loader.

2.7.10 Anhydrous Ammonia

Anhydrous ammonia (NH₃) (DG Class 2.3), used for precipitating the zirconium product, would be sourced from the manufacturer in Newcastle and transported to the DZP Site by road (approximately 10 trucks per week) or rail in specially designed tanks.

On entry to the DZP Site, the road tankers would be marshalled and directed to the Ammonia Storage Area where the ammonia would be pumped in to the storage vessels by compressor. The storage vessels would be maintained within an enclosed structure on a bunded concrete pad and maintain approximately 200t (5 days supply).

2.7.11 Aluminium Powder

Aluminium powder (DG Class 4.1, PG II) would be sourced from a manufacturer in Sydney. The powder would be shipped in 200L clamped drums, loaded into 20' containers (80 drums per container) (approximately 11.2t of aluminium powder) and delivered by road to the DZP Site (approximately 3 vehicles per week).

On entry to the DZP Site, the truck would be marshalled and directed to the dedicated storage facility where the container would be unstuffed. The storage facility would be enclosed and constructed on a bunded concrete pad. Approximately 65t of aluminium powder (2 weeks supply) would be maintained within the storage area.

2.7.12 Other

A number of other minor reagents would also be required and stored within the Reagent Storage Area (see Section 2.7.7). These would generally be delivered in bulk bags or boxes as full container loads to maintain a 2 to 4 week supply of these reagents and materials on the DZP Site. Between 40 and 45 trucks per week would be required to deliver these reagents (80 to 90 movements) with the trucks initially marshalled in the truck park-up area and then directed to the relevant location within the Reagent Storage Area where the containers would be unstuffed using a 2-tonne forklift.

2.7.13 Export Products

A number of products would be produced by the DZP, namely, zirconium hydroxide (ZOH), zirconium basic sulphate (ZBS), niobium pentoxide (Nb_2O_5), ferro niobium (FeNb), light rare earth concentrate (LRE) and heavy rare earth concentrate (HRE). Material Safety Data Sheets (MSDS) have been produced from these products and are included as **Appendix 11**. Annual production is anticipated to be 75 000t.

The zirconia, zirconium hydroxide, zirconium basic sulphate, niobium pentoxide and ferro-niobium, produced in solid form, would be discharged into storage silos. From the storage silos, the products would be bagged, via dedicated bagging plants, into 1-tonne bulk bags, each individually labelled and bar-coded, then stored in dedicated product sheds. The LRE and HRE products, produced in liquid form, would be stored in storage tanks prior to decanting into 1 000 litre bulk boxes. The product bulk boxes and boxes would be individually labelled and bar-coded prior to storage in dedicated storage sheds.

Individual customer orders would be made up on site, with dedicated product containers filled, as required. Once the order has been completed, the sealed container, along with its relevant product assays, would then be trucked to the DZP Rail Siding for loading (using forklifts) onto the return train to Newcastle. At Newcastle, the containers would be unloaded and delivered to the container port for onward shipment to the relevant customer.

2.8 WATER REQUIREMENTS, SUPPLY AND SECURITY

2.8.1 Water Requirements

Whilst improvements in water efficiency of the processing operations described in Section 2.6.3 are continuously being made, the Applicant has budgeted for worst-case water requirements, i.e. 4.05kL of water per tonne of ore processed. At maximum production, this would be equivalent to 4 050ML (4.05GL) per year.

Discussed in further detail in Section 6.1.4, the Applicant has identified water use as a potential constraint on the development and has made considerable efforts to reduce the total volume of water required by the processing operations. This has included the incorporation of two water softening and reverse osmosis (RO) plants within the processing operations. The Applicant is committed to continuing to identify and make modifications to the processing operations to either reduce the water requirements of processing (from 4.05kL/t) or improve the re-use / recycle capability of the plant.

The annual requirement for water to suppress dust on the Mine Haul Road has been estimated by multiplying the area to be watered (70 000m²) by the difference between annual average pan evaporation (1778.2mm) and mean annual rainfall (647.3mm), 79 170 000L (79.2ML). It is noted that this annual requirement could be reduced by at least 50% through the use of a chemical dust suppressant (39.6ML).

2.8.2 Water Supply and Security

As indicated by the proposed installation and management of a pipeline from the Macquarie River, the Applicant intends to provide for a significant proportion of this annual water requirement under licence(s) obtained in accordance with the *Water Sharing Plan for the Macquarie and Cudgegong Regulated Rivers Water Source* ("the WSP").

In recognition that the volume of water available for extraction under licence from the Macquarie River would vary each year (largely dependent on flows within the river), additional sources of water are currently being identified and a *Water Supply Strategy* for the Proposal developed. **Table 2.8** provides a summary of the identified water sources and approximate allocation entitlements to be obtained.

Table 2.8
Water Supply Strategy

Water Source	Target Allocation	% of Total Allocation
Macquarie River High Security	1 000ML	25%
Macquarie River General Security	5,000ML	25%
Macquarie River Alluvial Aquifer	1 000ML	25%
Fractured Rock Aquifer (Lachlan Fold Belt)	1 000ML	25%
Surface Water Harvest (MHRDC ¹)	109ML ²	Variable ³
Supplementary Water ⁴	1 000ML	-
<p>Note 1: Maximum harvestable right dam capacity (MHRDC)</p> <p>Note 2: Refer to SEEC (2013) – Section 6.2.2 (Part 4 of the <i>Specialist Consultant Studies Compendium</i>)</p> <p>Note 3: Variable depending on rainfall , i.e. may be more or less than the MHRDC</p> <p>Note 4: Only available during wet years</p>		

Mr Peter Hennessy of Peter Hennessy Water has provided a review of the availability of the entitlements as nominated in **Table 2.8**. The report of Hennessy Water, which can be viewed as **Appendix 7**, confirms that licence allocations within the surface and groundwater sources are available, and that there is sufficient tradable volumes of water within each groundwater source to provide for the total 4GL of water required each year.

The following provides an overview of each water source from which the annual requirement could be drawn.

Macquarie River Water

Water obtained under an entitlement provided by high or general security Water Access Licences (WALs) can be pumped from the Macquarie River, based on the allocation for each WAL type issued by the NOW through the course of each year. 100% allocation of high security WALs can be expected, although this is not absolutely guaranteed (during the 2007/2008 year, the allocation of high security licences available for extraction commenced at 40% before ultimately increasing to 100% over the year). High security WALs offer the greatest security of supply, however, there are only limited high security WALs available for purchase. The Applicant has to date sourced 812ML of high security WALs.

The annual allocation of general security WAL, as a proportion of the WAL entitlement, is far more subject to variability. In fact, when there are low flows in the Macquarie River, zero allocation may be provided, e.g. years 2006/2007 and 2009/2010. The lack of allocation during any given year could be partly overcome by utilising carry-over allocation from a previous year, hence the strategy for holding WALs in excess of the annual requirement for the proposed operations. Water trading would also allow the Applicant to obtain closer to the full WAL entitlement during years when the proportional allocation is low. The Applicant currently holds a WAL for 750ML of general security water, however, it is noted that on average 12 200ML of general security water was traded each year between 2001/2002 and 2012/2013. In addition, water may be 'parked' by utilising a third party's WAL to hold water additional to the entitlement of the Applicant's WALs, which could be carried over and then transferred to the Applicant's licence the following year.

'Supplementary Water' could also provide temporary top-up of water supply held within the DZP Site. Supplementary water is available when flow conditions in the river exceed critical parameters, e.g. a major rain event. Water can be harvested and placed within dams or a reservoir on the DZP Site outside of the nominated entitlement of the WAL. The ability to utilise supplementary water requires the availability of sizeable dams or a reservoir on the DZP Site. The Applicant proposes that, following final refinements to the processing operations and confirmation of water requirements, areas currently allocated to the LRSF could be used for the construction of an appropriately sized water reservoir. This would be the subject of a future application to modify the development consent following optimisation of the processing operations water efficiency and confirmation of local evaporation rates.

While an application for a water supply works and use approval would be made following receipt of development consent, the information contained within this EIS is sufficient to allow for an assessment as to the impact of the extraction and use of up to 4.05GL of water from the Macquarie River to be made.

Groundwater

As indicated above, the availability of surface water from the regulated Macquarie River would be subject to fluctuation and require annual trading to maximise the volume of water which the Applicant would be entitled to extract. The annual cost of such trades would also vary considerably with the cost per ML of water increasing during periods of low flow within the river (corresponding to low general security water allocation) and decreasing during periods of

high river flow (corresponding to higher general security water allocation). The availability of groundwater is not subject to such fluctuation with the nominated WAL entitlement available each year, in accordance with the rules of the relevant water sharing plan.

As nominated in **Table 2.8**, the Applicant proposes to obtain up to 1 000ML of groundwater from the Macquarie River alluvial aquifer, in accordance with the *Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources*, and 1 000ML from local fractured rock aquifers in accordance with the *Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources*. A desktop investigation completed by Environmental Earth Science Pty Ltd (EES) and provided as **Appendix 8** indicates that it is likely that at least 1 000ML of water could be drawn from groundwater annually. Additional groundwater could almost certainly be drawn from surrounding properties under agreement with the land owner. The Applicant plans on developing the groundwater resources from these aquifers on and surrounding the DZP Site over the ensuing 18 months to two years. Appropriate assessment of impacts on surrounding groundwater users and the aquifer itself would be completed as part of application(s) for water supply works and use approval(s) under the Water Management Act 2000., i.e. information on the impact of such extraction on other water users and the aquifers more generally is not provided as part of this EIS.

With careful planning and management of water supply sources, the Applicant should be able to minimise impacts on local groundwater users (centre pivot irrigators), e.g. by drawing less water from the Macquarie alluvial aquifer during summer cropping season.

Surface Water Harvesting

Current NSW legislation permits landholders to capture (harvest) and use a proportion of the total runoff from their land without requiring a licence. Two factors determine the harvestable right for a piece of land, namely:

- the property's geographical location (which determines the harvestable right multiplier value); and
- the size of the property, expressed in hectares.

A landowner's harvestable right permits construction of dams up to the harvestable right capacity without the requirement for these to be licensed, provided the dams are either "off-line" from natural watercourses or are positioned on first or second order streams only. Water captured within the harvestable rights dams may be used for any purpose, including mining-related purposes.

The Applicant owns or has options to purchase approximately 3 450ha of contiguous land on and surrounding the DZP Site. Reducing this area by 640ha (equivalent to the catchment removed by the construction and operation of various features of the DZP Site from which runoff would be prevented, i.e. LRSF, SRSF, open cut, WRE and Salt Encapsulations Cells), and applying a harvestable right multiplier of 0.065ML/ha¹³, this provides for a harvestable right dam capacity of 182ML. There are 64 existing farm dams within the DZP Site with a total estimated volume of approximately 82ML (SEEC, 2013). Therefore, an additional 100ML of storages could be constructed within the DZP Site without exceeding the harvestable right.

¹³ determined using maps obtained from NSW Office of Water at http://www.farmdamcalculator.dnr.nsw.gov.au/cgi-bin/ws_postcode.epl

Water collected in existing and new dams to be constructed on the DZP Site and land to be owned by the Applicant would be harvested and transferred to the Process Water Pond of the Processing Plant and DZP Site Administration Area to supplement water obtained from the Macquarie River or groundwater sources. The annual volume harvested would vary dependent on annual rainfall and the requirements of the proposed ongoing agricultural operations on the DZP Site and surrounding Applicant owned land (refer to Section 2.17.5). While likely to represent less than 5% of the total water requirement, the Applicant would maximise the harvest of surface water over the life of the Proposal.

2.9 RESIDUE MANAGEMENT

2.9.1 Introduction

At various stages in the processing operations, solid or liquid residues (waste by-products no longer containing economically extractable metals or REEs) would be generated and require disposal.

This subsection provides an overview of the proposed residues that would be generated, design of the RSF and the procedures that would be used during residue placement to ensure appropriate densities and compaction are achieved within the RSF. The Applicant engaged the following specialist consultancies to assist with the identification of residue volumes and characteristics and design of the facilities to manage these.

- TZ Minerals International Pty Ltd (TZMI) was commissioned by the Applicant to review and design the processing operations. As part of this design, TZMI have documented the form (liquid or solid), source, characteristics and volume of the various residue streams requiring disposal.
- D.E. Cooper & Associates Pty Ltd (DECA) prepared the *Dubbo Zirconia Project Solid and Liquid Residue Management Conceptual Design Report* (DECA, 2013) which outlines the design, construction methodology, post construction testing and operation of the RSF. DECA (2013) is appended to the EIS (**Appendix 6**) with reference made throughout the following subsections to the various concept drawings contained.

2.9.2 Solid Residue Management

2.9.2.1 Sources

Solid processing wastes are generated by the light and heavy REE processing operations, in decreasing order of magnitude, as follows.

- Filtration of the leach pulp during PLS separation and light REE recovery.
- Filtration of the impurities precipitated from the heavy REE containing liquid.
- Filtration during selective leaching of alkaline waste filtrates from the heavy REE compounds.
- Filtration during selective leaching of alkaline waste filtrates from the light REE compounds.

As noted in Section 2.6.3, a more detailed analysis of the processing operations can be made available by the Applicant on request by the relevant government agencies.

2.9.2.2 Solid Residue Characteristics and Volume

The solid residue produced by the combination of the various precipitated and filtered waste and limestone slurry would be fine with a P80¹⁴ of below 75µm and have the physical appearance of a damp fine sand or clay. The moisture content of the solid residue would be reduced to 35% with ANSTO (2012) reporting that the majority of the contained moisture appears to be chemically bonded with the finer particles. At maximum production (1Mtpa), approximately 2.0Mt of wet solid residue (at 35% moisture) would be generated each year reducing to 1.3Mt on drying. At a compacted in situ dry density of 1.3t/m³, the annual volume of the material requiring disposal annually would approximate 1Mm³.

The geotechnical properties of the solid residue, as tested by SGS (DECA, 2013) are as follows.

Atterberg Limits

- Liquid Limit (LL) (moisture content at which a soil changes from plastic to liquid behaviour) – 45%.
- Plastic Limit (PL) (moisture content where a thread breaks apart at a diameter of 3 mm) – 37%.
- Plasticity Index (PI) (a measure of the plasticity of a soil and measured as the difference between the liquid limit and the plastic limit) – 8.
- Linear Shrinkage (the decrease in length of a soil sample when oven-dried, starting with a moisture content of the sample at the liquid limit) – 3%.

Compaction Testing

- Maximum Dry Density (MDD) – 1.33t/m³.
- Optimum Moisture Content (OMC) – 33%

Triaxial Testing

- Cohesion – 6 kPa.
- Phi – 39 degrees.

Table 2.9 provides a summary of the chemical composition of the solid residue following analysis by the Specific Contaminant Concentration (SCC) and Toxicity Characteristics Leaching Procedure (TCLP) methods nominated in the *NSW Waste Classification Guidelines* produced by the Department of Environment and Climate Change (DECC, 2008).

¹⁴ P80 refers to particle size that is 80% finer than that quoted, i.e. 75µm.

Table 2.9
Solid Residue Chemical Composition

Element	Units	Composition	Units	Composition	Element	Units	Composition	Units	Composition
	SCC		TCLP			SCC		TCLP	
Ag	ppm	5	mg/L	<0.1	Na	%		mg/L	1 380
Al	%	4.60	mg/L	0.8	Nb	ppm	520	mg/L	<0.5
As	ppm	38	mg/L	<0.1	Nd	ppm	395	ppm	1.45
Ba	ppm	180	mg/L	0.1	Ni	ppm	4	mg/L	0.2
Be	ppm	39	mg/L	<0.1	P	%	0.030	mg/L	1.1
Ca	%	7.54	mg/L	1 200	Pb	ppm	145	mg/L	0.5
Cd	ppm	<2	mg/L	<0.1	Pr	ppm	125	ppm	0.35
Ce	ppm		mg/L	2.5	Rb	ppm	730	ppm	0.3
Cr	ppm	13	mg/L	<0.1	S	ppm	53 600	mg/L	533
Cu	ppm	11	mg/L	0.4	Se	ppm	9	mg/L	<0.1
Dy	ppm	80	ppm	0.14	Si	%	20.4	mg/L	4.5
Er	ppm	35	ppm	0.05	Sm	ppm	85	ppm	0.24
Eu	ppm	2.7	ppm	<0.02	Sn	ppm	25	mg/L	<0.1
F	%	0.26			Sr	ppm	45	mg/L	0.9
Fe	%		mg/L	<0.1	Ta	ppm	100	ppm	<0.5
Gd	ppm	80	ppm	0.25	Tb	ppm	12.5	ppm	0.02
Hf	ppm	150	ppm	<1	Th			mg/L	<0.1
Hg	ppm	<0.05			Ti	%	0.035	mg/L	<0.1
Ho	ppm		ppm	0.02	Tm	ppm		ppm	<0.05
K	%	2.46	mg/L	3.3	U	ppm	11.5	mg/L	<0.1
La	ppm	690	ppm	2	V	ppm	<20	mg/L	<0.1
Lu	ppm		ppm	<0.02	Y	ppm		mg/L	0.95
Mg	%	0.040	mg/L	14	Yb	ppm	28	ppm	<0.05
Mn	%	0.065	mg/L	11.6	Zn	ppm	445	mg/L	7.6
Mo	ppm		mg/L	<0.1	Zr	ppm	1 900	mg/L	<0.1

Source: TZMI

On the basis of the analyses completed, the solid residue is classified as a 'general solid waste' on the basis that neither the SCC1 or TCLP1 limits (as provided in *Appendix 1* of DECC, 2008) are exceeded for any contaminants for which these limits are nominated.

It is noted that the ore to be processed is expected to contain between 80 to 160ppm uranium and between 250 to 500ppm thorium. This equates to approximately 1 to 2Bq/g of radioactivity for the U^{238} , U^{235} and Th^{232} radionuclides. The mineralised ore also contains radionuclides from the uranium and thorium radionuclide decay chains and **Table 2.10** provides the activity levels of the major radionuclides as determined following a radionuclide deportment study of the processing facility (ANSTO, 2012). **Table 2.10** also provides the deportment of radionuclides in the products and wastes generated by the processing operations and identifies the activity levels of these radionuclides in the liquid and solid residue.

Table 2.10
Radionuclide Activity in Process Streams¹

Material		²³⁸ U	²³⁰ Th	²²⁶ Ra	²¹⁰ Pb	²¹⁰ Po	²³² Th	²²⁸ Ra	²³¹ Pa	²²⁷ Ac
Feed	Ore (S)	1480	1480	1480	1480	1480	1950	1950	71	71
Product	LREE Liquor (L)	0.092	5.3	13.8	780	1.7	7.0	18.2	0.24	609
	ZOH (35% Zr) (S)	270	5	12	29	410	6	15	75	0.2
	FeNb (S)	6	10	1	540	500	14	1	64	5
	HREE Liquor (L)	2.3	144	1.4	0.47	0.35	189	1.8	0.26	376
Solid Residue (S)		45	1040	1130	1080	1090	1400	1500	25	37
FeNb Slag (S) ²		420	3500	370	470	350	4600	490	8700	660
Liquid Residue (L)		266	21.2	0.11	10.1	3.7	27.9	0.14	0.37	0.74
Evaporated Salt (S)		4500	360	2	170	62	470	2	6	13
LREE = Light Rare Earth Element ZOH = Zirconium Hydroxide HREE = Heavy Rare Earth Element FeNb = Ferro-Niobium										
Note 1: Solids measured in Bq/kg and liquids measured in Bq/L (due to very small concentrations of some radionuclides)										
Note 2: The FeNb Slag would be slurried and deposited with the solid residue in the SRSF. This represents approximately 0.2% of the total residue to be stored within the SRSF.										
Source: Modified after JRHC (2013) – Table 2										

Table 2.11 provides the proportional department of the radionuclides to the products and waste streams of the processing operations.

Table 2.11
Overall Department of Radionuclides from Ore (%)

Material		²³⁸ U	²³⁰ Th	²²⁶ Ra	²¹⁰ Pb	²¹⁰ Po	²³² Th	²²⁸ Ra	²³¹ Pa	²²⁷ Ac
Feed	Ore	100	100	100	100	100	100	100	100	100
Product	LREE Liquor	0.0001	0.007	0.02	1.0	0.002	0.007	0.017	0.006	16
	ZOH (35% Zr)	0.66	0.01	0.03	0.07	1.0	0.01	0.03	3.8	0.008
	FeNb	0.001	0.002	0.0002	0.10	0.09	0.0018	0.0002	0.24	0.02
	HREE Liquor	0.002	0.10	0.001	0.0003	0.0003	0.10	0.001	0.004	5.7
Solid Residue		4.0	91	99.8	95	96	91	99.8	47	69
FeNb Slag ¹		0.11	0.9	0.093	0.12	0.09	0.9	0.093	46	3.5
Liquid Residue		95	7.6	0.039	3.6	1.3	7.6	0.039	2.80	5.6
LREE = Light Rare Earth Element ZOH = Zirconium Hydroxide HREE = Heavy Rare Earth Element FeNb = Ferro-Niobium										
Note 1: The FeNb Slag would be slurried and deposited with the solid residue in the SRSF. This represents approximately 0.2% of the total residue to be stored within the SRSF.										
Source: Modified after JRHC (2013) – Table 3										

ANSTO (2012) estimated that the combined solid residue would have an activity of 28Bq/g. Considered against the *Radiation Control Act 1990* (RC Act), the residue does not classify as a “radioactive substance” as the total activity is less than 100Bq/g. However, considered against the *NSW Waste Classification Guidelines* (DECC, 2008) the solid residue classifies as a ‘restricted solid waste’ as the Total Activity Ratio (TAR) and the Specific Activity Ratio (SAR) calculated using the formulae of DECC (2008) exceeds 1 (by virtue of the proportion of Group 1 Radioactive Substances as defined by Schedule 1 of the *Radiation Control Act 2013*) (JRHC, 2013).

The radionuclide deportment study illustrates that the solid residue would contain the majority of the thorium and associated decay chain activity. Whilst it is noted that the level of activity would remain equivalent to that of the ore, the potential impact of this level of radioactivity in the modified form and location of solid residue is assessed in Section 4.4.8.

2.9.2.3 Solid Residue Neutralisation and Disposal

Each of the solid residue streams generated during the heavy and light REE recovery would be acidic and delivered as a filter cake to a solid residue neutralisation area via conveyor. Lime slurry produced by the slaking of quicklime would be added to the acidic solid residues within an on-line neutralisation mixer. The neutral pH filter cake would be conveyed from the plant and discharged by mobile spreader onto a solid residue stockpile area. Any runoff from the stockpile would collect in a sump which would be added to the liquid residues pumped to the LRSF (see Section 2.9.3).

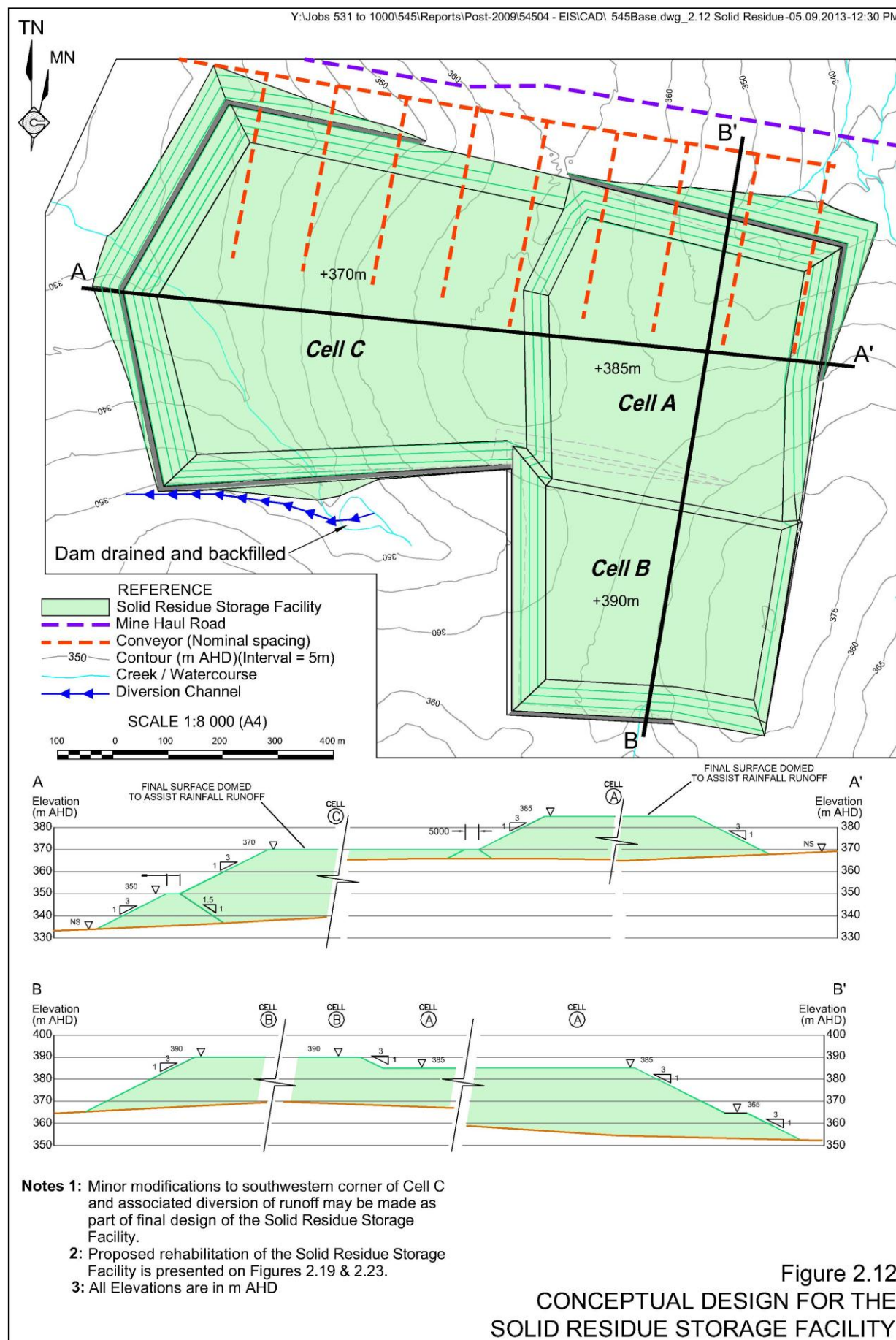
Based on the solid residue produced by the pilot plant at ANSTO's facility at Lucas Heights, the material would have a moisture content where the material can be handled as a semi-dry solid. Analysis of the residue indicates that while dry enough for handling by mobile equipment, it would be very 'sticky' and therefore difficult to load and unload from trucks. As a consequence, the solid residue would be conveyed from the plant to the active cell of the SRSF. On discharge to the active cell, a bulldozer would be operated to spread the material across the cell which would then be compacted either by track rolling or specialist compaction equipment.

2.9.2.4 Design of the Solid Residue Storage Facility

The design of the SRSF prepared by DECA (2013) is based on a cellular concept, where each cell can be filled, closed and rehabilitated independently of the other cells. In this way, the overall area of solid residue exposed at any one time would be limited making the management of rainfall and runoff easier, and allowing for the SRSF to be rehabilitated progressively over the life of the Proposal.

Detailed design of the SRSF would follow approval of the Proposal, however, **Figure 2.12** provides the overall concept, accounting for the maximum impact footprint and elevation required for the 20 year life of the Proposal, which includes the following features.

- Three separate cells, providing for a combined storage volume of 20Mm³, with a combined area of 103ha.
 - Cell A: 31ha.
 - Cell B: 24ha.
 - Cell C: 48ha.
- External slopes of 18° 1:3 (V:H) and a final combined upper surface area of approximately 81ha (refer also to *Drawing 120-12-303* of DECA, 2013 – **Appendix 6**).
- Maintenance of freeboard, between the top of embankment and residue surface, to accommodate rainfall from a 1:10 000 year event (460mm).



The storage cells and upstream faces of the Stage 1 embankments would be double-lined with a leak detection system installed between the two liners (refer to *Drawing 120-12-301* of DECA, 2013 – **Appendix 6**), for the location and design of the Stage 1 Embankments). The upper liner would be HDPE (or material with an equivalent permeability¹⁵) while the lower liner would be HDPE or compacted clay with a permeability of 1×10^{-9} m/s and thickness of 900mm (or equivalent combination of permeability and thickness) (refer to *Drawing 120-12-304* of DECA, 2013 – **Appendix 6**).

The leak detection system would comprise a network of small diameter filter pipes embedded in free draining coarse sand, gravel or synthetic drainage products. The pipes would be linked to an outfall pipe which will report to a lined sump for collection and recovery of seepage (for return to the SRSF surface or delivery to one of the salt crystallisation cells of the LRSF) (refer to *Drawing 120-12-304* of DECA, 2013 – **Appendix 6**).

2.9.2.5 Site Selection (Hydrological and Geotechnical Considerations)

Hydrological Considerations

The proposed location for the SRSF occurs on the divide between the catchments of Cockabroo Creek and Wambangalang Creek and would back onto the WRE. This location virtually eliminates the surface runoff which would report to the structures thereby reducing impacts on local hydrological flows and requirement for significant water diversion or containment structures.

It is noted that Cell C occurs within the upper valley of a tributary to Wambangalang Creek and while the catchment would be limited by the presence of Cells A and B it is noted that there could be potential for surface runoff to accumulate against the southern embankment of Cell C. Under most rainfall conditions, local evaporation would prevent soil saturation and waterlogging. However, to ensure that this does not occur, a diversion bank would be constructed to the south of the Cell C embankment to capture and divert water around the SRSF (see **Figure 2.12**) and discharge to the tributary flowing into Wambangalang Creek¹⁶.

Geotechnical Considerations

The foundation conditions are not critical to the overall design of the SRSF cells as each cell would be double lined with HDPE or a combination of HDPE and compacted clay. Notwithstanding this, the SRSF would be located primarily on the Wongarbon and Ballimore soil landscapes (see **Figure 2.6**) which SSM (2013) has identified as most appropriate for the construction of residue storage facilities due to the relatively deep and compact layer of clay which is typical of these soils. DECA (2013) indicates that there would be no stability issues with embankment foundations within such soils.

¹⁵ Several alternative lining materials are available and these would be considered during final design preparation. These include geomembranes with bentonite (geosynthetic clay liners or GCL's) and bitumen impregnated geomembranes. Any liner used would provide for a permeability not exceeding 1×10^{-9} m/s over 900mm (or equivalent).

¹⁶ It is noted that following final design of the SRSF and survey of the ground, minor modifications to the southwestern corner of Cell C may be made to allow for the placement of the proposed diversion drain. Any such modifications would not increase the area of impact, rather allow for the diversion bank to follow existing contours between 345m and 350m AHD without requiring significant earth works.

Local groundwater below the proposed SRSF location is approximately 15m to 20m below the surface (EES, 2013) and therefore would not affect embankment stability or the performance of the HDPE liners.

2.9.2.6 Construction of the Solid Residue Facility

Cell A

The initial external embankments forming Cell A would be constructed along the northern perimeter to a height of approximately 15m, tapering out to the natural surface at the western end and along the eastern side (refer to *Drawing 120-12-301* of DECA, 2013 – **Appendix 6**). A low embankment would also be initially constructed along part of the southern cell perimeter, again tapering to the natural surface. Following stripping of topsoil and subsoil (refer to Section 2.3.3), material would be excavated from the cell area and used to construct the embankments. This material would be removed relatively evenly across the cell area to flatten the final surface and avoid the creation of large depressions which could compromise the liners to be laid down. The embankments would have a crest width of approximately 5m and internal slopes of approximately 33° 1:1.5 (V:H) and external slopes of approximately 18° 1:3 (V:H).

On construction of the embankments and profiling of the internal surfaces (following borrow of material for embankment construction), the cells would be lined with a double layer of HDPE or equivalent. The intra-liner drainage would be installed with both the upper and lower liner fully tested for leakage at the completion of construction.

The Cell A Stage 1 embankments would provide for approximately 12 to 18 months of storage, after which the embankments would be progressively raised to a maximum elevation of 385m AHD. The indicative geometry of each embankment lift would be as follows.

- Crest width – 4m.
- Lift height – 2m.
- Overall outer (downstream) slope – 18°.
- Upstream face slope – 33°.

The embankment lifts would not be lined as there would be no phreatic surface within the stored compacted residue, and therefore no hydrostatic loading on the peripheral embankments (DECA, 2013).

Upstream construction methods would be used to minimise the volume of fill material required (refer to *Drawing 120-12-301* of DECA, 2013 – **Appendix 6**). In this form of construction, the borrowed material (to be excavated from the impact footprint of Cell B) used to construct the embankment lifts would be partly supported on the existing embankments and partly on the compacted residue.

The strength of the compacted residue ($\phi = 39$ degrees), together with the use of competent fill material and the 1:3 overall outer slope, would ensure the stability of the lift (DECA, 2013). A detailed stability analysis will be carried out at the final design stage to demonstrate that under all expected loading conditions, the embankments will remain stable with a high factor of safety against failure. Competent rock, subsoil and topsoil would be spread over the outer slope of the embankment to encourage vegetation establishment and provide long term erosion protection. Drainage channels on the benches of the outer faces would be used to control surface runoff and therefore minimise erosion.

Cell B

To adjoin Cell A to the south, the initial embankments would be constructed whilst solid residue is placed within the final lift of Cell A. The initial Cell B embankments would be constructed along the northern, western and southern perimeter of the cell forming a side valley storage (refer to *Drawing 120-12-301* of DECA, 2013 – **Appendix 6**). Construction would be as described for Cell A. As the initial storage fills, the embankments would be progressively raised (15m to 20m lifts), using upstream construction methods, up to a maximum elevation of 390m AHD.

Cell C

Adjoining Cells A and B to the west, an initial embankment would close off the shallow valley to provide for up to 12 months storage. Construction would be as described for Cell A. As the initial storage fills, the embankments would be progressively raised (15m to 20m lifts), using upstream construction methods, up to a maximum elevation of 370m AHD.

Construction of the SRSF could either be undertaken with the three cells constructed sequentially, i.e. allowing for Cell A to be constructed to final height prior to construction of Cell B then Cell C, or to begin construction of Cell B then Cell C prior to completion of the preceding cell. A decision would be made during operations with consideration of capital expenditure and performance of the residue, i.e. rate of effective compaction.

2.9.2.7 Operation of the Solid Residue Storage Facility

The solid residue would be delivered to the SRSF by conveyor with a rubber-tyred dozer used to push out and spread the material over the liner. The conveyor discharge point would be regularly relocated to reduce the volume of material requiring pushing within the cell. The layers of residue would be progressively compacted by a self propelled smooth drum compactor to achieve the required in situ density.

The residue would be pushed out and compacted in layers of 300mm or less to ensure that the material can be compacted to at least 95% of the maximum density attainable, thereby ensuring the material has a high strength allowing the outer side slopes to be formed at 18°.

The upper or working surface of the stack (in each cell) would be shaped to allow incident rainfall to flow to a pre-cast concrete well in which a submersible pump would be located. Similar to a decant tower system in a regular tailings storage facility, a slotted concrete tower would be progressively constructed above the well. The tower would be wrapped in a geomembrane allowing flow of filtered runoff to enter the well. This water would be pumped to one of the cells of the LRSF. *Drawing 120-12-305* of DECA (2013) (**Appendix 6**) provides a conceptual illustration of the manner in which incident rainfall and surface runoff would be managed within each cell of the SRSF.

A network of monitoring bores would be installed around the SRSF to enable the early detection of changes in the level or quality of the groundwater.

2.9.3 Liquid Residue Management

2.9.3.1 Sources, Characteristics and Volume

Liquid wastes would be generated at various points throughout the processing operations, however, they can generally be classified as chloride or sulphate liquid residue streams.

The chloride liquid residue streams would be generated by the zirconium, niobium and heavy REE treatment systems with the major cations being sodium and ammonium, and anions being chloride and sulphate. The chloride liquid residue streams would be mixed in an agitated tank with the resultant liquid likely to have a pH close to neutral (adjustments would be made by dosing with the alkaline lime slurry to raise the pH or sulphate liquid residues to lower the pH).

The sulphate liquid residue stream would be generated by the light REE processing system. This acidic residue would be transferred to an agitated neutralisation tank where lime slurry would be added to raise the pH. The sulphate liquid residue would be used to dose the chloride liquid residue to lower the pH of this stream.

On treatment and neutralisation, the liquid residues would have a salinity of around 62 500ppm. This salinity would gradually increase within the LRSF with the loss of volume by evaporation. As the salinity increases, salts would crystallise and be deposited on the base of the LRSF cells.

Table 2.12 provides a summary of the chemical composition of the combined and neutralised liquid residue (pH of 7.1 achieved without addition of lime) following analysis by the SCC method nominated in the *NSW Waste Classification Guidelines* (DECC, 2008).

Table 2.12
Liquid Residue Chemical Composition

Element	Composition (mg/L)	Element	Composition (mg/L)
Al	12	Nd	<1
Ca	17	Ni	1
Ce	<1	P	8
Cr	1	S	16 703
Fe	<1	Si	<5
Hf	<1	Ta	<1
K	29	Ti	<1
La	<1	U	30
Mg	22	Y	<1
Mn	45	Zn	4
Na	30 138	Zr	14
Nb	1		

On the basis of the analyses completed, the liquid residue is classified as a 'general liquid waste' on the basis that the contaminant threshold (CT1) limits (as provided in *Appendix 1* of DECC, 2008) are not exceeded for any contaminants for which these limits are nominated.

With reference to the deportment of the radionuclides within the liquid residue presented in **Table 2.10**, and the methods of classifying radioactive waste nominated in Part 3 of the *NSW Waste Classification Guidelines* (DECC, 2008), both the SAR and TAR are less than 1 (JRHC, 2013). On this basis the liquid residue is not classified as a restricted waste.

It is noted that the EPA may consider the classification of the waste on a case by case basis with respect to the elements contained within the liquid residue for which there are no contaminant threshold limits nominated in DECC (2008).

The total volume of liquid residue to be evaporated is likely to be up to 2.5Mm³ (2.5GL) each year. This equates to approximately 210ML/month.

2.9.3.2 Liquid Residue Storage Facility Design and Construction

The LRSF has been designed as a series of terraced salt crystallisation cells grouped into four distinct areas (LRSF – Areas 2 to 5) (see **Figure 2.1**). *Drawings 120-12-200 and 120-12-201* of DECA (2013) (**Appendix 6**) provide a more detailed illustration of Areas 2 & 4 and Areas 3 & 5 respectively. It is noted that initially seven LRSF areas were identified, however, following a review of annual discharge rates and daily water balance modelling, it was determined that only four of these areas would be necessary. The numbering of these areas has been retained to avoid confusion with DECA (2013) (**Appendix 6**) which continues to identify all seven LRSF areas.

The areas allocated to the LRSF occur on land either owned by the Applicant, or under contract to purchase, and which has been largely cleared of native vegetation for ongoing cropping and grazing¹⁷. Other criteria used in the identification of appropriate land for the LRSF are as follows.

1. The land is more than 200m from the Wambangalang Creek and 50m from other drainage lines (unless the area extends to the watershed).
2. The slope does not exceed 5%.
3. There are no water discharge areas.
4. The minimum width of the land is 200m.
5. The land is more than 50m from known road reserves and does not include any known road reserves.

The terrain for the four LRSF Areas varies from flat areas in closer proximity to Wambangalang Creek to steeper hill slopes to the east of the plant.

- LRSF – Areas 2 and 3: are located on the flatter areas adjacent to, and north of the plant location.
- LRSF – Areas 4 and 5 are located on the higher ground in the central part of the DZP Site.

¹⁷ Occasional trees and areas of ‘derived native grassland’ have been identified over a proportion of the LSRF – refer to Section 4.7.4.1.2

The total surface area of the salt crystallisation cells of the LRSF on construction would be approximately 425ha (see **Table 2.13**).

Table 2.13
Liquid Residue Storage Facility Areas

LRSF Area	No. of Cells	Area (ha)	Evaporative Surface Area (ha)
2	4	37.1	26.5
3	7	97.5	69.5
4	6	141.5	101.0
5	9	149.3	106.0
TOTAL	26	425.4	303.0

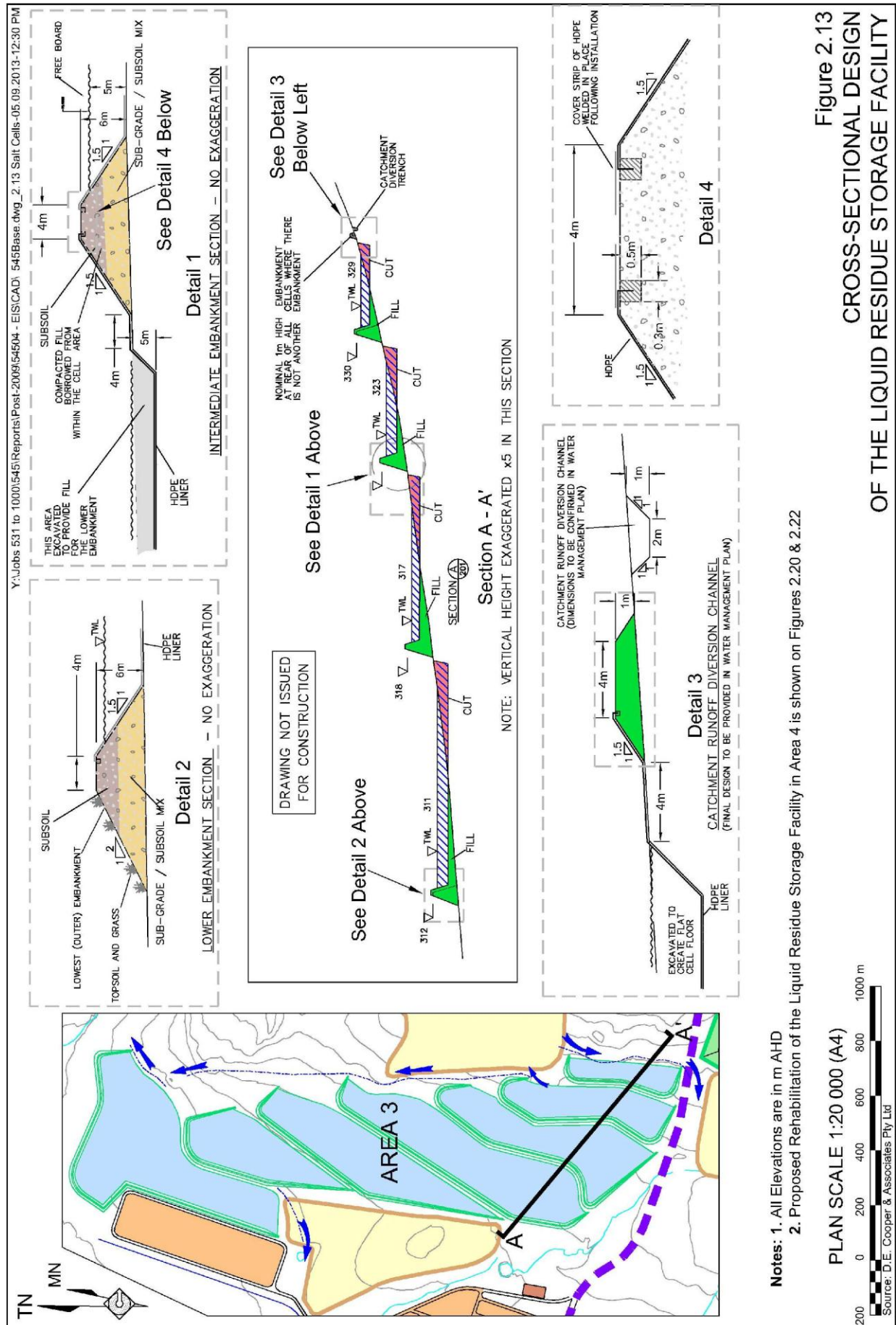
The individual salt crystallisation cells would be arranged in terrace formation against the existing topography. For this reason, the cells would be generally long and relatively narrow. This arrangement has advantages in terms of limiting the potential for wave run-up which has the potential to damage pond liners and embankments. **Figure 2.1** and the drawings of DECA (2013) provide the indicative arrangement of the salt crystallisation cells within LRSF Areas 2 to 5, with the final layout of each area to be optimised in terms of shape and overall water area at the final design stage.

Cut and fill earthworks would be completed to create a flat surface area within each cell with a 6m embankment constructed between the individual cells, providing for a water storage height of 5m and 1m freeboard. The 1m of freeboard provides for rainfall of a 1 in 10 000 year event (460mm), as well as additional height to account for possible wave run-up under windy conditions (DECA, 2013). It is noted that the LRSF would, under normal circumstances, be operated with considerably more freeboard than 1m. To promote maximum evaporation discharge would be undertaken to minimise the water level in each cell, i.e. liquor would be maintained in all cells to increase the total effective evaporative surface area and promote higher liquor temperature which would increase the evaporation rate. This notwithstanding, final design of the LRSF cells would include a detailed analysis of wave run-up and if necessary either the operating liquor level would be reduced, or the embankment height increased, to increase freeboard. Alternatively, a wave break device would be installed in each cell upstream of the embankment to mitigate the final wave height against the embankments. The embankments have been designed with a nominal crest width of 4m (the minimum required to allow a reasonable sized compactor to safely work on the upper levels) with 33° 1:1.5 (V:H) side slopes. The lowest (outer) embankment slope(s) for each terraced LRSF Area would be constructed at 27° 1:2 (V:H). The outer embankments would be spread with topsoil and seeded with grasses to protect against erosion. Drainage would be provided to divert surface runoff around the upper cells.

Figure 2.13, adapted from *Drawing 120-12-204* of DECA (2013), provides a typical cross-section through a series of terraced salt crystallisation cells within the LRSF.

2.9.3.3 Construction of the Liquid Residue Storage Facility

As discussed in Section 2.3.3, a layer of topsoil approximately 150mm thick would be excavated from the LRSF and stockpiled for future use in the rehabilitation of the DZP Site.



Subsoil would then be excavated from the upper 500mm to 600mm of the subsoil profile and temporarily stockpiled within the impact footprint of the LRSF. Soil investigations completed by SSM (2013) have confirmed that the depth of subsoil for the Wongarbon, Belowrie and Ballimore SLUs (on which the LRSF is located) generally exceeds 1.25m.

Following excavation and stockpiling of the subsoil (to be used in the construction of the embankments), the remaining subsoil profile and underlying weathered rock would be ripped, excavated and pushed to create a flat surface of each cell. As discussed in Section 2.3.3.2, and following formation of the salt crystallisation cell floor, the stripped subsoil (totalling approximately 2.3 million m³) would then be used to progressively construct the 6m high embankment for each cell. The overall volume of material required to construct these embankments would therefore be approximately 3 million m³. The balance of the material required to construct the embankments would be recovered from subsoil or weathered rock below the 600mm depth.

An inspection of the cell base would follow and any exposed rocks, sticks or other organic matter removed. The area would then be compacted to complete a foundation comprising compacted fine grained in situ material. In the event that the ground cannot be made sufficiently smooth, a layer of imported sand or a sheet of geotextile would be used. Each cell and embankment would then be lined with a single 1.5mm HDPE welded sheet. Both faces of the embankment would be covered with HDPE to prevent saturation of the embankment crests, and a potential failure (slumping) of the embankment faces. A review of the proposed controls to be implemented in the form of a *Cell and Liner Construction Protocol* and *Liner Integrity Testing Protocol* are provided in Section 4.6.4.2.6.

A capping strip of HDPE would be welded in place over the crests of the embankments once the HDPE liners have been secured on each face. **Figure 2.13** (based on *Drawing 120-12-204* of DECA, 2013) provides a more detailed illustration of the proposed cell and embankment lining. As the cells would take some time to fill, the liners would be held in place by sand bags or other weighted material, roped together to ensure that they cannot be displaced.

Once each cell has been completed, i.e. embankments constructed and the liners installed, an accurate survey would be undertaken and the depth/volume and depth area curves for each cell confirmed.

An accurately marked level staff would be installed in each cell to allow the water level to be read without the need for a formal survey. A protective floating ring around the staff would nullify the impact of wave height on the reading.

2.9.3.4 Operation of the Liquid Residue Storage Facility

The liquid residue would be pumped to salt crystallisation cells balancing the volume of water delivered with the performance of the cells. In order to minimise the possibility of the cells overtopping, the liquid residue would be discharged through individual valved outlets to each cell on the main delivery pipelines. The valves would be able to be opened and closed individually allowing each cell to be filled and kept topped up, under a pre-determined program. This would ensure that the evaporation area is maximised, and that there would always be adequate freeboard for the containment of rainfall and the design storm event.

The pipelines would be constructed from welded HDPE and would be sized to ensure that all pipes operate under a low pressure thus reducing the potential for failure. The pipelines would be buried. Isolation valves on all pipelines would be used to isolate sections of pipeline to enable repairs to be carried out. Flow meters with remote readout would be installed on all the major pipelines and at each discharge point. A pipe break or major leak would be automatically detected by the plant control software which would continually compare flow readings to different parts of the LRSF. Regular (every shift) visual monitoring of the pipes and cells would also be undertaken to detect minor leaks.

With the exception of the lowest elevation cell within each LRSF Area, an emergency spillway would be constructed on the inter-cell embankment. To account for the cascading nature of over-topping that could occur within the terraced arrangement of cells, the lowest cell would be operated with additional freeboard.

To ensure that the capacity of the salt crystallisation cells is maximised throughout the life of the Proposal, after several years operation, the Applicant would commence pumping liquid residue between cells to allow the salt accumulated in selected cells to consolidate and dry out sufficiently such that it can be excavated. A rubber-tired dozer or equivalent would be used to excavate the salt with care taken to retain at least 1m of salt between the dozer blade and cell liner. The excavated salt would be transported in trucks to the Salt Encapsulation Cells (refer to Section 2.9.4) for disposal. Following removal of salt from a cell, liquid residue from other cells would be pumped into this cell and the process repeated. A review of the proposed controls to be implemented in the form of a *Salt Harvesting Protocol* is provided in Section 4.6.4.2.6.

2.9.3.5 Monitoring Liquid Residue Storage Facility Operations

The pumping of the liquid residue to the LRSF would be closely monitored to ensure that the active evaporation area is being maximised, the potential for overtopping is being minimised and requirement to modify the discharge regime identified well ahead of time. A daily water balance model has been completed for the operation of the LRSF by SEEC (2013) as part of a Surface Water Assessment for the Proposal. Section 4.5.4.2 (Liquid Residue Storage Facility) and **Figure 4.25** provide the results of this water balance model and implications for operations, however, it is noted that experience provided by other sites with operating evaporation ponds suggests that the number of cells in active service may have to be changed from time to time depending on the variation in ambient conditions and in the quality of water being discharged to the ponds.

Several standard evaporation pans (Australian Standard Class A pans) would be located around the DZP Site. By monitoring the volume of water discharged to each cell and the change in the water level (and hence surface area) a data base which measures the performance of the cells would be progressively built. This data base would then allow the overall evaporation area to be optimised, and a timely indication given of the need to add additional area. Regular comparisons between the Class A pan data and the actual data would be valuable in this regard.

In addition to the volumetric monitoring of the ponds, multiple bores would be installed around all of the evaporation pond areas to monitor the groundwater movement and quality. The exact locations of these would be determined by reference to the geology and hydrogeology at each location following receipt of development consent. A review of the proposed controls to be implemented in the form of a *Leak Detection Response Strategy* is provided in Section 4.6.4.2.6.

2.9.3.6 Closure of the Liquid Residue Storage Facility

At the completion of the Proposal (20 year life), each cell would be decommissioned. The cell decommissioning process would involve the following activities.

- The residual liquid/brine within each cell would be allowed to evaporate and the residual salt to crystallise. To accelerate this process across the LRSF, some cells would be pumped dry with the liquid discharged to other cells. This would ensure that the crystallisation of salts is progressive across the cells of the LRSF allowing for early commencement of remaining decommissioning steps.
- Once crystallised, the salt would be collected using a wheeled front-end loader with any remaining salt removed from the liner by water jetting. This liquid would be pumped to one of the remaining salt crystallisation cells.
- The HDPE liner would be cut up and removed by an appropriately licensed recycling contractor.
- The compacted subsoil would be ripped and the subsoil contained with the embankment pushed evenly over the landform.
- Previously stockpiled topsoil would be spread over the subsoil to a depth of at least 100mm.
- Final rehabilitation of the landform would be undertaken (refer to Section 2.17.6.6).

2.9.4 Accumulated Salt Management

2.9.4.1 Characteristics and Volume

The crystallised salt remaining in the LRSF would be solid but retain a relatively high moisture content. It would be amenable to physical handling with earth moving machinery.

Samples of liquid residue were dehydrated by ANSTO (2012a) and the chemical composition of the residual salt assessed. **Table 2.14** provides the expected composition of various elements in the residual salt. It is noted that the chemical analysis does not add up to 100% as it does not include the hydrogen and oxygen of the various oxide and hydroxide forms of the elements contained in **Table 2.14** (SO₄ for example) and water retained in the salt.

Table 2.14
Chemical Composition of the Residual Salt

Element	Proportion (%)	Element	Proportion (%)
Al	0.10	Ni	< 0.01
Ca	0.05	P	< 0.01
Ce	< 0.01	S	11.8
Cl	17.8	Si	0.01
Fe	< 0.01	Ta	< 0.01
Hf	< 0.01	Th	< 0.01
K	0.04	Ti	< 0.01
La	< 0.01	U	0.02
Mg	0.47	Y	< 0.01
Mn	0.01	Yb	< 0.01
Na	22.4	Zn	< 0.01
Nb	< 0.01	Zr	0.03
Nd	< 0.01		
Source: ANSTO (2012a)			

ANSTO (2012) estimate that the activity level of the salt would not exceed 100Bq/g and therefore does not classify as a “radioactive substance” under the RC Act . However, when classified in accordance with Part 3 of the *NSW Waste Classification Guidelines* (DECC, 2008) the evaporated salt could classify as a ‘restricted solid waste’ as both the TAR and SAR calculated using the formulae of DECC (2008) exceed 1 (JRHC, 2013)¹⁸. It is estimated that there will be between 6Mt and 7Mt of salt deposited over the 20 year life of the operation.

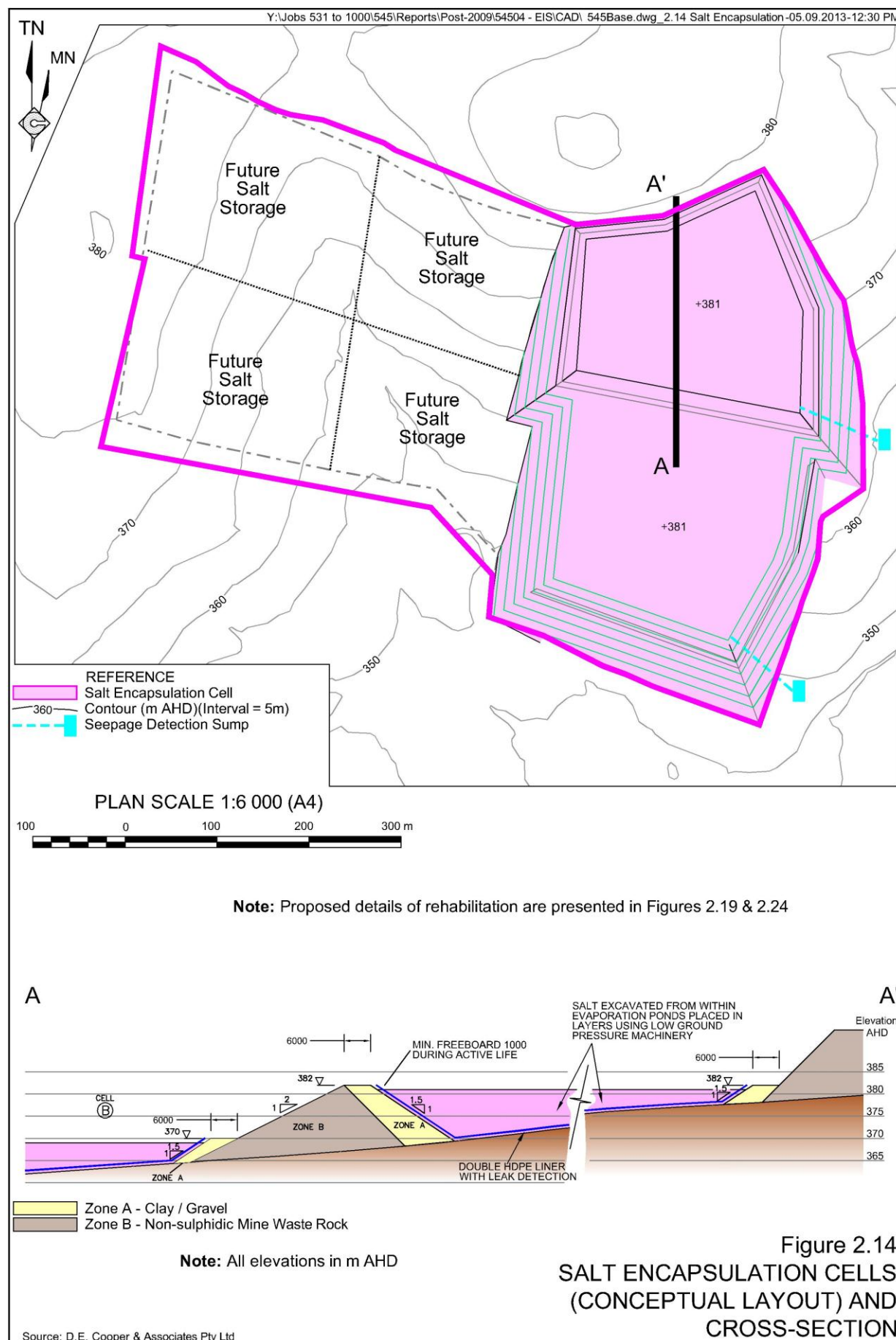
2.9.4.2 Salt Encapsulation Cell Design

The salt encapsulation cells would be constructed as a series of up to six cells, similar to the SRSF. **Figure 2.14** provides the conceptual layout of six adjoining cells (A to F) that would be constructed to the south of the WRE and east of SRSF Cell B. Each encapsulation cell would be fully lined with a double HDPE liner and leak detection layer in between the liners (the same as installed for the SRSF (refer to Section 2.9.2.6). The intra-liner drainage would be installed with both the upper and lower liner fully tested for leakage at the completion of construction.

2.9.4.3 Construction of the Salt Encapsulation Cell

The embankments of the salt encapsulation cells would be constructed to their final height before the liners are installed (the heights are identified on **Figure 2.14**). The embankments would be constructed from in situ clay and rock excavated from within each cell or non sulphidic mine waste rock. These materials are identified as Zone A and Zone B on the cross-section on the embankment provided on **Figure 2.14**. The in situ clay (Zone A) material would be placed and compacted in 300mm lifts with waste rock (Zone B) placed and compacted in 1m lifts.

¹⁸ It is noted that the SAR and TAR only exceed 1 when the inferred concentration of various radionuclides which would occur within the salt but have not been included in the analysis completed by ANSTO (2012a).



The geometry of the embankments would be as follows.

- Crest width – 6 m.
- Downstream face slope – 1:2 (V:H).
- Upstream (lined) face slope – 1:1.5 (V:H).

2.9.4.4 Operation of the Salt Encapsulation Cell

The salt would be excavated from the base of each salt crystallisation cell as a semi-solid low moisture content material. The material would be loaded into trucks and tipped into the salt storage cells. Access to the top of the retaining embankments would be by temporary ramps. Tipping locations round the cells would be provided with chutes comprising layers of geotextile to protect the liners.

It is expected that in the semi-solid state, the salt would flow to some extent, and therefore self level within the storage cells. There should be no requirement to use mechanical equipment to move the salt around once dumped.

Whilst considered unlikely that the liner system would fail, the leak detection system would provide for any water which passes through the upper liner to drain to monitor pits down slope of the external embankments. The pits could also be used to collect and pump water to the plant for treatment. If leakage is detected following the closure of the Proposal, an arrangement would be made to install permanent solar-operated pumps to deliver the seepage to one of the previously used LRSF cells, or purpose built cell, for evaporation. A network of bores would be installed around the salt encapsulation cells to monitor groundwater level and quality.

2.9.4.5 Management of Water

Some saline water would likely be released from the salt and this along with incident rainfall would collect on the surface of the deposited salt. While it is expected that each cell of the salt storage will be filled quickly (thereby limiting the volume of incident rainfall collected by the active cell), a pumping system would be installed to remove this water. This water would be pumped back to a lined salt crystallisation cell and operated as described in Section 2.9.3.4 with residual salt returned to the salt encapsulation cell.

2.9.4.6 Salt Encapsulation Cell Closure

Once the upper surface of the salt in the storage cells has dried to the stage where the surface can be accessed by mechanical equipment, the surface would be covered with a layer of clay (or alternatively a synthetic material such as bentonite mat) to prevent ingress of rain water. The clay would be protected from desiccation by a layer of waste rock which would be profiled to be water shedding via a series of engineered drains. Available subsoil then topsoil would be placed over the waste rock in line with the rehabilitation procedures described in Section 2.17.6.7.

2.10 AIR EMISSIONS MANAGEMENT

2.10.1 Introduction

The following subsections are included as part of the Proposal description to provide an understanding of the type and scale of air emissions that would be generated on the DZP Site. More detailed assessment on the impact of these emissions on local air quality is included in Sections 4.3 and 4.4.

2.10.2 Categories of Emissions

Air emissions from the Proposal are classified as:

- fugitive emissions – being defined as releases not confined to a stack, duct or vent and which generally include equipment leaks, emissions from the bulk handling or processing of raw materials, windblown dust and a number of other specific industrial processes (NPI, 2012);
- point source emissions – being defined as releases confined to a stack, duct or vent; or
- radiation emissions – being defined as radioactivity emitted from exposed areas, stockpiles or residues.

The following provides an overview of the sources, composition and rate (where applicable) of these emissions.

2.10.3 Point Source Emission and Management

The processing operations of the Proposal require the gaseous releases at various points to enable the relevant chemical reactions to take place efficiently. **Table 2.15** provides the stack emission locations, composition of relevant compounds and rate of emission anticipated by the Applicant.

The primary management method applied would be the installation of a scrubber, primarily to reduce the concentration of SO₂ within the emission. Continuous emission monitoring equipment would be installed on those stacks with the potential to release hazardous gases, e.g. SO₂ or hydrochloric acid (HCl).

The elevation of the stack emissions would be a secondary management measure. Notably, the sulphuric acid plant stack would be 90m above ground level which would allow for significant dispersion of gases and particulates before dropping to elevations where it could be encountered by people or biota.

Assessment of the likely impacts of stack emissions on the surrounding environment are considered in Section 4.3.7.

Table 2.15
Predicted Point Source Emissions

Stack Reference	Concentration mg/m ³ (dry)							Flow rate (m ³ /hr)	Height above ground level (m)
	SO ₂	SO ₃	H ₂ S	HCl	NO ₂	HF	Particulates		
Fe Precipitation Vent	<100	<100	<5	<100	<350	<50	<50	10 000	20
Sulphuric Acid Plant Stack	<1000	<100	<5	<100	<350	<50	<50	100 000	90
Roaster Heater Exhaust Vents	<100	<100	<5	<100	<350	<50	<50	20 000	30
Gas Boiler Stack	<100	<100	<5	<100	<350	<50	<50	50 000	30
Roaster Scrubber Stack	<100	<100	<5	<100	<350	<50	<50	20 000	30
Ore Mill Exhaust Vent	<100	<100	<5	<100	<350	<50	<20	50 000	20
Ammonia Scrubber Vent	<100	<100	<5	<100	<350	<50	<50	1 000	20
Zr Dryer Vent	<100	<100	<5	<100	<350	<50	<50	20 000	20
Nb Dryer Vent	<100	<100	<5	<100	<350	<50	<50	10 000	20
Ferro-niobium Process Stack	<100	<100	<5	<100	<350	<50	<50	10 000	30
Source: TZMI									

2.10.4 Fugitive Emission Sources and Management

Fugitive emissions would be primarily particulate matter eroded from stockpiles, cleared surfaces ahead of mining or construction of DZP Site infrastructure, the open cut, WRE and RSFs. A detailed discussion of the rates of emissions, proposed management and assessment of impacts on the surrounding environment is provided in Section 4.3.7.

2.10.5 Radiation Emissions

As previously discussed, the ore to be mined and processed contains naturally occurring uranium and thorium. As these radioactive elements decay, they produce radon (Rn) which is emitted as a gas under normal conditions. Radon is the only gas under normal conditions that has radioactive isotopes, and is considered a health hazard due to its radioactivity.

Therefore, wherever uranium and thorium occur over the DZP Site, radon may be emitted, albeit in low concentrations. Radon emission rates have been determined as part of the radiation assessment completed by JRHC (2013) (Part 3 of the *Specialist Consultant Studies Compendium*) and emissions modelled by PEL (2013) (Part 2 of the *Specialist Consultant Studies Compendium*). Section 4.3.7.8 provides a summary of radon emission concentrations and Section 4.4.8.2 and 4.4.8.3 review the potential impacts of these emissions.

2.11 WASTE MANAGEMENT

2.11.1 Production Waste

A detailed description of solid and liquid residue waste streams is provided in Section 2.9. In summary:

- Solid residue is classified as a restricted waste on the basis of residual radioactivity with the (approximate) 2.0Mt of wet residue (at 35% moisture) deposited in the SRSF annually.
- Liquid residue, which following assessment in accordance with the *NSW Waste Classification Guidelines Parts 1 and 3* (DECC, 2008) is classified as a general waste. However, on the basis of the high salinity, the 2.5GL of liquid residue generated each year would be deposited within the lined and contained LRSF.
- The crystallise salt which deposits in the LRSF would be classified as a restricted waste on the basis of residual radioactivity and would be excavated progressively and encapsulated within Salt Encapsulation Cells on the DZP Site.

As part of the current Proposal, no production waste would be removed from the DZP Site, although the Applicant will continue to investigate other disposal methods or markets for the crystallised salt.

2.11.2 Other Waste

The following identifies each of the main non-production waste streams that would be generated throughout the life of the Proposal and briefly describes how each class of waste would be stored or managed on site and subsequently removed from the DZP Site. The local waste disposal authority, the EPA and the health department would be consulted, as appropriate, on the acceptability of the proposed method of disposal prior to commencement.

Bulky Bags

An estimated 118 000 used bulky-bags would be generated each year. The majority of these bags would not have contained any classified Dangerous Goods and as such are therefore considered general waste. Used bulky-bags would be stored in skip bins or designated storage areas on covered and bunded surfaces adjacent to the main storage tanks or bins for the relevant reagent.

Prior to disposal, the used bags would be cleaned, within the covered and bunded storage areas and removed from the DZP Site by a waste removal contractor to the Dubbo City Council landfill site.

Pallets

Approximately 3 200 waste pallets would be generated each year, the majority of which would have been used for the packaging of Aluminium Powder (Class 4.1 UN1309 PGII). All used pallets would be stored separately from other used packaging material within designated and signed storage area on a covered and bunded surface adjacent to the FeNb processing circuit (see **Figures 2.9 and 2.10**).

The pallets would be rendered safe by cleaning and be disposed of in accordance with AS 1904-2004 (Sections 12.5 and 12.6). The Applicant would develop and implement a standard operating procedure to ensure that waste pallets (and Bulky bags and drums) are clean prior to removal for disposal. The procedure would incorporate the following general measures (within specific details on timing, location, storage and OHS requirements to be developed during the SZP Construction phase).

- All used pallets, bulky-bags and drums would be inspected directly following product removal and transfer to larger storage tank or bins.
- Any residues would be cleaned using brushes and deposited directly into the receiving product hoppers/bins/tanks.
- Cleaned pallets, bulky-bags and drums would be stored in a demarcated cleaned waste storage area for collection and subsequent disposal.
- Cleanliness would be determined by visual inspection, both by the section operator, and immediately prior to collection for disposal.

Where possible recycling of used pallets would be undertaken.

Drums

Approximately 12 700 waste drums (empty drums) would be generated each year, the majority of which would have been used for the packaging of Aluminium Powder (Class 4.1 UN1309 PGII). All used drums would be stored separately from other used packaging material within designated and signed storage area on a covered and bunded surface adjacent to the FeNb processing circuit (see **Figures 2.9** and **2.10**).

The used drums would be rendered safe by cleaning and be disposed of in accordance with AS 1904-2004 (Sections 12.5 and 12.6) and a standard operating procedure to be developed during the DZP construction phase (and equivalent to that described for used pallets above).

Packaging Materials

General waste packaging materials (not having contained dangerous goods) would be stored within areas to be nominated adjacent to usage areas, within skip bins (or equivalent) under cover and on concrete surfaces. The bins or waste packaging would be collected on a regular basis by a licensed waste contractor and transported to a licensed waste disposal facility or as specified by the supplier.

Used Equipment and Piping

All used/scrap piping and equipment would be removed to a dedicated storage area where it would be inspected by the site radiation officer and, where applicable, be cleaned prior to removal from site for disposal in an approved waste disposal site. Any residues removed during cleaning, if any, would be disposed of in the Solid Residue Storage Facility.

On cleaning, the equipment / scrap would be tested for radioactivity and if clean, removed from the DZP Site in accordance with the general waste stream to which it belongs. If residual radioactivity remains, further cleaning would be undertaken and the process repeated before removal from the DZP Site. The Applicant may dispose of certain scrap materials, such as used

conveyors, which could be difficult to remove residual radioactivity within the Solid Residue Storage Facility. These would be encapsulated within approximately 20Mm³ of solid residue which would consolidate and not leach to underlying groundwater or surface water.

General Waste (Including Kitchen Waste and Food Scraps)

Covered bins or skips would be located within lunch rooms, offices, outside workshops and elsewhere as required. Where these bins would be located in open areas, they would be fitted with animal-proof lids.

Collected on a regular basis by a licensed waste contractor and transported to a licensed waste disposal facility.

General Recyclables

Covered bins would be located within lunch rooms, offices and elsewhere as required. Where these bins are located outside a closed building they would be fitted with animal-proof lids.

Collected on a regular basis by a licensed recycling contractor and transported to an appropriate recycling facility.

Waste Oils and Greases

Placed within bunded tank(s) within the workshop area(s) and, where required, within smaller, temporary storage containers close to work areas. The contents of tanks and smaller containers would be consolidated into one or more larger tanks prior to collection.

Collected would be undertaken on a regular basis by a licensed waste contractor and transported to an appropriately licensed facility for recycling.

Batteries

Used batteries would be placed within a covered and marked used battery storage area until removed from site. Used batteries would be collected on a regular basis by an appropriate contractor and recycled.

Tyres

Tyres would be placed within a marked used tyre storage area until removed from site or used for another purpose.

Tyres would be re-used on site for construction of retaining walls, erosion protection, traffic control or would be removed from site for re-use elsewhere or recycling.

Scrap Steel/Metal

Stored in a specified area within the workshop area(s) or elsewhere as required, this waste would be collected on a regular basis by a scrap metal recycler.

Waste Water

Waste water from the ablutions facilities and lunchrooms would be treated using an appropriate waste water treatment plant approved by Dubbo City Council. The unit would be fully containerised and only require an in-ground transfer tank. Treated waste water would be suitable for process water. When required, solids from the treatment facility would be periodically removed during regular servicing operations and transported to a licensed disposal facility.

2.12 TRANSPORTATION

2.12.1 Overview

The Applicant's preferred method of transporting reagents and other materials to, and products from the DZP Site, would involve a combination of road and rail operations. However, while technically still 'open', there are a number of logistical, operational and economic factors to be addressed prior to the reopening of the long disused Dubbo-Molong Rail Line and incorporation of rail into the DZP transport task. These factors are considered as follows.

- While the likelihood is that the four key bulk reagents required by the Proposal could be sourced (via import) from the Port of Newcastle, the supply chain and suitable infrastructure has not been confirmed.
- The capital cost of the rail upgrade to Class 1 track, approximately \$30M¹⁹. The Applicant proposes to seek NSW government funding assistance, the results of which would influence the decision on the timing for rail line upgrade.
- There is no certainty that appropriate rail paths to and from the Port of Newcastle would be immediately available.
- There may be (significant) delay in the supply of new purpose-built rolling stock.
- There is a risk of under-utilisation of the trains on the paths dedicated to the Proposal. This would be a particular commercial risk to early in the operation of the Proposal as reagent supply chains and infrastructure are developed.
- There is potential to be some community reticence to the immediate reopening of the rail line (for the purpose of supplying reagents to the DZP) whilst the overall impact of the Proposal is considered.

On the basis of the factors listed above, the Applicant considers it would be at least five years from the commencement of the Proposal (approximately 2020) before the incorporation of the rail option would be feasible.

The Applicant would, within five years of receiving development consent, complete a thorough and comprehensive review of the transport task to assess the feasibility of the rail option. This report would be provided to DP&I and other relevant stakeholders and a final decision made as to the incorporation of the rail option into the transport task provided at this time. In

¹⁹ Notably, the Applicant would, independent to the rail line upgrade, be required to upgrade Obley and Toongi Roads at a cost likely to exceed \$15M.

recognition of this, the EIS considers the impacts of the Proposal with and without operating Toongi-Dubbo Rail Line. The preferred (rail) and alternative transport options, which are identified on **Figure 2.15**, are as follows.

Preferred Option A – Rail (to Toongi) and Minor Road

This option assumes the rail transportation of sulphur, caustic soda and hydrochloric acid all the way to the DZP Site at Toongi. Three trains would be operated on the Toongi-Dubbo Rail Line per week. The lower volume reagents to be sourced from Sydney would also be delivered by rail, however, these would then be unloaded at the Fletcher International Exports Terminal and delivered to the DZP Site by the existing approved heavy haulage route described for Option B.

The remaining reagents such as salt and limestone, and other fuels and materials would be delivered to the DZP Site by road using B-doubles, semi-trailers, specialised tankers or other arrangements.

Contingency Option B – Rail (to Dubbo) / Road (to Toongi)

Should Preferred Option A be delayed as suggested above, the Applicant proposes that the bulk reagents of sulphur, caustic soda and hydrochloric acid would be transported from Newcastle to a rail terminal operated by Fletcher International Exports Pty Ltd on the Merrygoen Rail Line north of Dubbo. The reagents would be unloaded at this rail terminal and transferred to trucks for delivery to Toongi by road utilising an approved heavy haulage route between the rail terminal and the Newell Highway and turning:

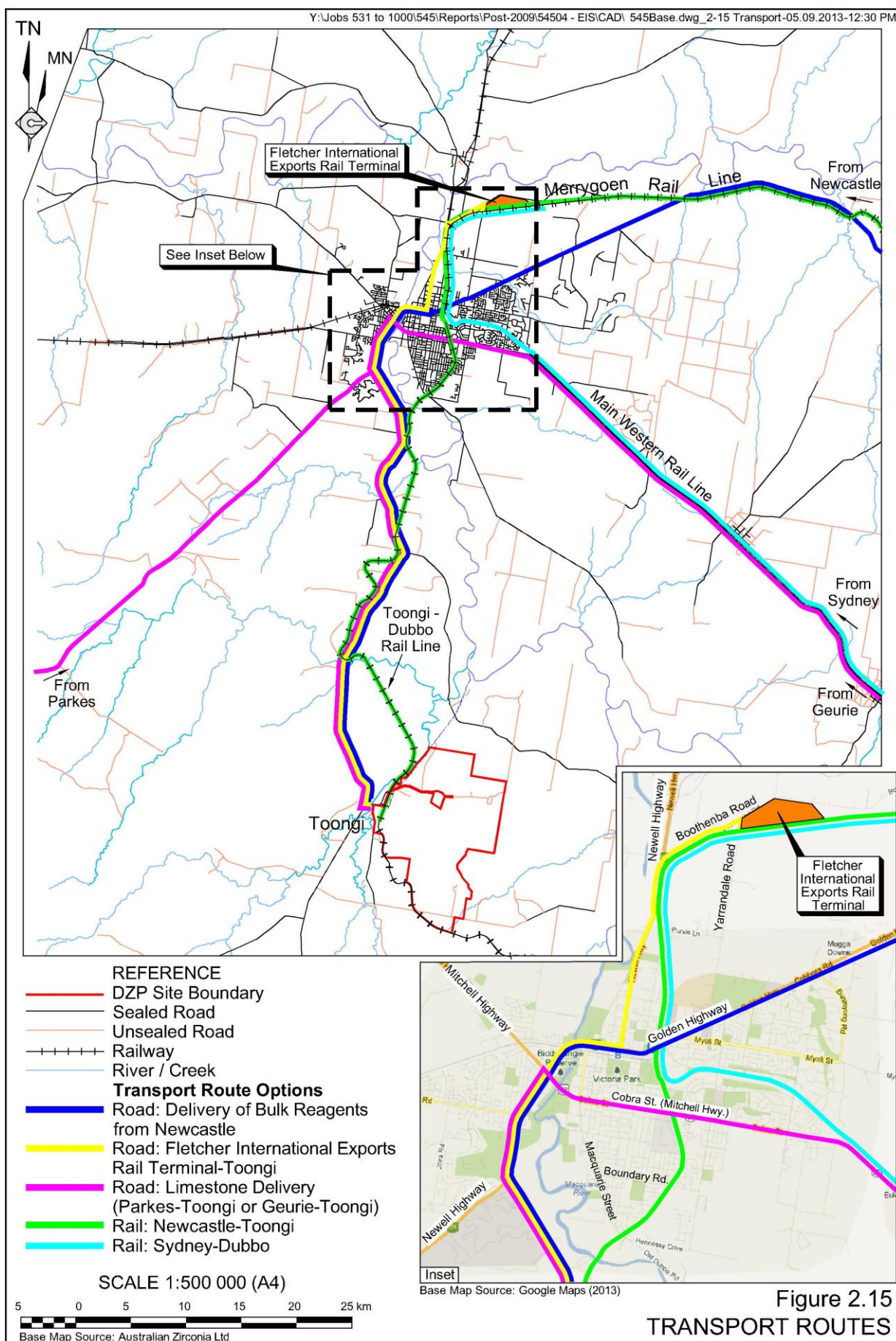
- right onto Yarrandale Road; then
- left on Boothenba Road before crossing the Merrygoen Rail Line at a signalled level crossing; then
- left onto the Newell Highway.

The trucks would then make a left hand turn onto Obley Road, followed by a left hand turn onto Toongi Road for delivery to the DZP Site.

Figure 2.15 identifies the location of the Fletcher International Exports Rail Terminal and the route that would be taken by trucks between the rail terminal and the DZP Site. It is noted that B-doubles would not be able to be utilised for transport between the Fletcher International Exports Rail Terminal and DZP Site. As a result, the total number of truck movements for these reagents would be greater than that which would be required if these reagents were transported to the DZP Site solely by road (Option C).

Contingency Option C – Road

In the event that the use of the rail terminal of Fletcher International Exports becomes unavailable or impractical for unforeseen reasons, the Applicant would transport the majority of processing reagents and other materials (excluding those transported to Dubbo from Sydney by general freight rail) to the DZP Site by road. This contingency option would also be implemented in the event that access to the rail network is delayed for significant periods.



With the bulk reagents, i.e. sulphur, caustic soda, limestone, salt and hydrochloric acid, to be sourced from locations external to the Dubbo LGA, the transport of these would primarily utilise B-Doubles. Other lower quantity reagents and those requiring specialist tankers, e.g. quicklime, would be transported to the DZP Site by a combination of semi-trailers, tankers and other road registered arrangements.

Table 2.16 provides an estimate of the weekly truck movements (during operations) associated with each option.

Table 2.16
Obley Road Daily Truck Movements

Option	Truck Type	Loaded	Empty / Return	Total
Preferred Option (A) – Rail to Toongi / Supplementary Road	B-Double	30	30	60
	Single	14	14	28
	Total	44	44	88
Contingency Option (B) – Rail to Dubbo / Road to Toongi	B-Double	30	30	60
	Single	49	49	98
	Total	79	79	158
Contingency Option (C) – Road Only	B-Double	42	42	84
	Single	27	27	54
	Total	69	69	138
Note 1: The Applicant is also investigating the use of High Mass Limit trucks under Performance Based Standards accreditation which would increase the pay load of each B-Double by 2t to 2.5t (refer to Section 2.12.4.3)				

The following subsections provide detail the proposed transport operations, both within and surrounding the DZP Site. The Applicant notes that a *Transportation Management Plan*, incorporating management measures to minimise the risk of potential safety- and environmental-related impacts associated with transportation would be completed prior to the commencement of the Proposal and this would further define the specific transport option(s) to be undertaken.

2.12.2 Internal Transportation

2.12.2.1 Site Access

Construction of the proposed DZP Site Entrance and DZP Site Access Road and intersection with Toongi Road is described in Section 2.2.7.1.

All vehicles would normally access the DZP Site via Toongi Road and the DZP Site Access Road. The Applicant would maintain automated security gates managed from a gate house at the DZP Site Entrance.

2.12.2.2 Haul Road Network

One main internal haul road between the open cut and the Processing Area ROM Pad (the Mine Haul Road) would be maintained (**Figure 2.1**). The Mine Haul Road would be designed, constructed and/or maintained in accordance with the document *Managing Urban Storm Water*

– *Volume 2C – Unsealed Roads* published by the then Department of Environment and Climate Change in 2008 (DECC, 2008a). In summary, the Mine Haul Road would be constructed to the following parameters.

- The width of the haul roads would be a minimum of three times the width of the largest haul truck. Typically, the total haul road width would be approximately 20m, for dual access sections of the haul road.
- A safety bund, a minimum of half the wheel height of the largest vehicle likely to travel the road, would be positioned on the downslope side of the haul road where it is located adjacent to, or traverse steep slopes.
- The haul road would typically be constructed with a gradient of no more than 1:7 (V:H).
- In order to maintain all weather access, the haul road surface would be sheeted with suitable waste rock materials recovered during the mining activities.
- The haul road would be routinely maintained and watered to suppress the generation of dust.
- Construction would be in a manner that avoids excessive erosion during rain events. Surface runoff would be contained as part of the overall dirty water management system.

A number of other temporary haul roads would be operated during the construction period, and following the construction period, of various structures such as SRSF Cells, to allow access of mobile equipment and trucks to these areas of the DZP Site. The temporary haul roads would be constructed and maintained in the same manner as described above, although the necessity for sheeting would be reviewed prior to road construction based on the length and volume of use of the particular road.

2.12.2.3 Light Vehicle Road Network

A range of access tracks would be constructed within the DZP Site to provide access to the SRSF, LRSF, WRE, soil stockpiles, and other sections of the DZP Site. These access tracks would also be constructed generally in accordance with the document *Managing Urban Storm Water – Volume 2C – Unsealed Roads* (DECC, 2008a) and would be maintained in a manner that would minimise the potential for erosion and sedimentation and dust lift off.

2.12.2.4 Separation of Mine and Non-Mine Traffic

Vehicular access to the ‘operational’ sections of the DZP Site would be restricted through implementation of barricade systems and gates. Access to those sections of the DZP Site would be restricted to approved heavy and light vehicles and approved drivers. Where non-approved vehicles or drivers require access to the DZP Site, they would be escorted.

2.12.3 Rail Transportation

2.12.3.1 Overview

Transport Options A and B include a rail transport component. In the event Option B is undertaken, this would be managed in accordance with the approvals, licences and operating procedures of the Fletcher International Export Rail Terminal. The description of rail transportation therefore focuses on Option C, using the upgraded Toongi-Dubbo Rail Line.

2.12.3.2 Rail Movements

The Applicant would require three rail movements per week to deliver the bulk reagents of sulphur, caustic soda, soda ash and hydrochloric acid. These would be delivered in containers as discussed in Section 2.7.

A Class 1 rail line would allow the maximum gross weight per wagon to be 92t and the train would run with, on average, 26 wagons.

The operation and timing of trains along the Merrygoen Rail Line cannot be controlled by the Applicant and as such the Proposal requires 24 hour, 7 days a week train operation to ensure the flexibility to operate within the train paths allocated. While daytime loading would be preferable, it may not always be possible.

2.12.3.3 Unloading/Loading Operations

Once trains are stationary on the DZP Rail Siding, forklifts would be used to unload the full reagent containers, placing them in designated areas of the Rail Container Laydown and Storage Area. Empty containers would be loaded onto the stationary train for return to the relevant supplier (with details of reagent supply provided in Section 2.7). Train loading and unloading would likely take 1 to 3 hours (depending on the number of containers) and could be completed consecutively, train loading immediately after unloading, or over two distinct periods.

Unless required to accommodate rail path allocation, loading and unloading of wagons would not be undertaken after 10:00pm and before 6:00am (the night time period). Occasions when night time loading or unloading may be required would be to accommodate a late arrival / early departure rail path schedule. The Applicant would instruct operators to avoid 'banging' of containers when loading to the wagon or placing within the Rail Laydown and Temporary Storage Area. This would be enforced with operators failing to adhere to this requirement removed from these operations.

An appropriate *Rail Management Plan* would be prepared incorporating all operational and safety measures to be implemented prior to the commencement of rail transportation for the Proposal.

2.12.3.4 Infrastructure Maintenance

Following construction of the rail line and commencement of operation, a *Maintenance Plan* would be implemented. The following is indicative of the Maintenance Plan that would be implemented by a competent rail maintenance contractor.

A hi-rail inspection of the line would be undertaken on a weekly basis and any anomalies identified and listed. If the anomaly identified can be corrected on the day, it would be, otherwise it would be reported and corrected in accordance with the base operating standards for that class of line.

The hi-rail team would consist of 1 x supervisor and 1 x driver/labourer and as noted above would correct any minor infrastructure needs, such as missing clips or pumping sleepers.

Turnouts and catch points would be inspected quarterly, with a written report prepared and submitted to the operator and any works that may be required identified and included in the report.

Between August and September each year (before the summer months), a welded track stability analysis (WTSA) would be completed. A WTSA provides for the checking of the alignment and super-elevation of all curved track to ensure curves are on line and the correct amount of superelevation has been applied within the operating standard. At the same time, the creep peg measurements would be recorded and checked to ensure the longitudinal rail creep is within the operating standard.

During the summer months if the air temperature reaches or exceeds 38°, a mandatory hi-rail inspection would be undertaken to ensure the track is not misaligning.

2.12.4 Road Transportation

2.12.4.1 Site Access

Access to the DZP Site is discussed in Section 2.2.6.

2.12.4.2 Proposed Upgrade to Public Roads

A description of the public road network between the DZP Site and the Newell Highway is provided in Section 2.2.5 along with details of the proposed upgrades. Further detail and justification for these upgrades is provided in Part 11 of the *Specialist Consultant Studies Compendium*.

The Applicant accepts responsibility for upgrading Obley and Toongi Roads and is liaising with Dubbo City Council to establish a Voluntary Planning Agreement or formal contributions plan which would define the relative contribution of the Applicant and Council to ongoing maintenance of these roads.

2.12.4.3 Traffic Types and Levels

Traffic types associated with the Proposal would include the following.

- Light vehicles: including passenger vehicles, light trucks and buses.
- Heavy vehicles: including rigid trucks, semi-trailers, tankers and B-Doubles delivering consumables, processing reagents and supplies.

- Oversize and overweight vehicles: delivering components of the processing plant and mobile earthmoving fleet. The Applicant would ensure, where practicable, that all oversize and overweight vehicles would have the appropriate permits and approvals and would be appropriately escorted, when required. It is noted, however, that obtaining the required approvals is typically the responsibility of the road transportation contractor.

As noted in Section 2.12.1, the number of heavy vehicle movements to be generated by the Proposal would depend on whether rail is incorporated into the transport operations and in what form, i.e. to Dubbo or Toongi. **Table 2.17** provides estimated daily vehicle movements on Obley and Toongi Roads during the construction and operations stages of the Proposal. The existing traffic levels on the roads surrounding the DZP Site are presented in Section 4.12.2.5.

Table 2.17
Estimated Daily Traffic Movements¹

Period	Option	Light Vehicles	Heavy Vehicles	Oversize
Construction	-	400	18	2
Operations	A	220	98	
	B	220	158	
	C	220	138	
Note 1: Two vehicle movements = one return trip				
Source: Alkane Resources Ltd				

To limit any inconvenience to existing road users, and properly manage the risk posed by additional heavy vehicle movements on Obley and Toongi Roads during the construction period, the Applicant would prepare and implement a *Road Traffic Management Plan*. This plan would document the proposed construction schedule and likely traffic levels during this time. The scheduling of road upgrades to be presented in the plan would focus on those aspects of the current road construction and alignment representing the greatest hazard to traffic, and nominate restrictions to be enforced on traffic movements until these upgrades are completed.

2.13 FACILITIES AND SERVICES

2.13.1 Facilities

A description of the principal infrastructure that would be established for the Proposal is provided in Section 2.2, with facilities associated with the processing operations described in Section 2.6.2. This subsection provides a description of the other facilities that would be required.

In addition to the buildings and structures of the DZP Site Administration Area identified in Section 2.6.2 and **Figure 2.9**, the Applicant would establish a workshop area within the Processing Plant Area. The workshop area would comprise the following components.

- Workshop building(s), including a concrete sealed floor and vehicle inspection bays. A small bund or drain around the perimeter of the building would contain potentially contaminated runoff and an oil/water separator would be incorporated in the drainage plan.

- A stores facility.
- A hardstand area comprising an unsealed area for storage of excess equipment awaiting use or removal from site, or parking of mobile equipment.
- A fuel bay and refuelling area incorporating a concrete bunded storage area containing fuel tanks, unused oil and grease, waste oil tank and a concrete sealed refuelling area. All potentially contaminated surface water runoff would be directed to an oil/water separator.

A Contractor Management Area would also be established adjacent to the Processing Plant Area (see **Figure 2.1**). This area would indicatively include the following.

- A transportable building for use as the contractor's office and crib room.
- A workshop building, including a two-bay open-front workshop with concrete floor, apron and workshop office, a basic stores facility (containers) plus fenced storage area, fuel and oils storage facilities (self-bunded tanks) and waste oil management facilities.
- An ablutions facility.

2.13.2 Services

2.13.2.1 Electricity Supply

Power for the processing plant and the various buildings within the DZP Site would be provided by a distribution system from the proposed sub-station described in Section 2.2.7. The distribution network would be partially above ground and partially buried.

Power for mine dewatering pumps and mobile lighting towers would be supplied by diesel generators. Lighting in the vicinity of the processing plant and workshops would be provided by mains-powered lights. All lights would, where practicable, be orientated away from residences within the local area and local roads (The Springs Road, Toongi Road, Obley Road), i.e. to the east.

The Applicant estimates that once the processing plant and remaining Project-related activities are being undertaken at the proposed rate, the annual power consumption within the DZP Site would be approximately 137GWhr.

If haul trucks are required to pass beneath any overhead power lines, the power lines would be elevated to a height where the haul trucks can pass safely beneath them.

2.13.2.2 Communications

The site office would be serviced by telephone and data lines. In addition, communications within the DZP Site would be via two-way radio and/or mobile phone.

2.13.2.3 Hydrocarbons

All diesel fuel for the mobile equipment would be stored in above ground tanks with a total indicative capacity of 100 000L. These tanks would be either self-bunded or located within a bunded fuel bay in the vicinity of the workshop within the Mining Contractor's Area (**Figure 2.1**). Bunding, if required, would be sized to meet the OEH containment requirements and AS 1940:2004 - *Safe storage & handling of flammable & combustible liquids*.

A sealed refuelling area would be located adjacent to the fuel bay with all drainage from both areas directed to an oil/water separator. All haul trucks and graders and some light vehicles would utilise the refuelling area while the excavators, bulldozers and generators would be refuelled at their work site using a mobile fuel tanker.

Any bulk oils, greases and waste oils would also be stored within this bunded fuel bay or alternative appropriately bunded areas.

It is anticipated that the mining fleet and operations within the Processing Plant Area would require on average approximately 935 000L of diesel per year. An additional 650 000L of diesel would be consumed each year for the transportation of containers between the Processing Plant Area and Container Laydown and Storage Area.

Based on the three transport options currently being reviewed (refer to Section 2.13), diesel consumption is presented in **Table 2.18**.

Table 2.18
Diesel Consumption

	Option A: Rail (to Toongi) and Minor Road	Option B: Rail (to Dubbo) / Road (to Toongi)	Option C: Road
Road	3 519 394	3 688 029	6 887 615
Rail	1 891 604	1 816 544	448 148
Total	5 410 998	5 504 573	7 335 763
Note 1: Sydney-Dubbo (448,148L) + Newcastle-Dubbo (1,368,396L)			
Note 2: Sydney-Dubbo (448,148L) + Newcastle-Toongi (1,443,456L)			

In addition, the processing operations would require approximately 13 000 000 normal cubic meters²⁰ of compressed natural gas to produce 461TJ of energy per year.

2.13.2.4 Potable Water

Potable water and water for the ablutions facilities would be sourced from the proposed water pipeline and would be appropriately treated within the on-site Potable Water Processing Plant before being used.

²⁰ Measured at standard temperature and pressure.

2.13.2.5 Operational Water

Based on the rise in elevation from the take-off point from the Macquarie River (see Section 2.2.2.2) to the processing plant water tank (14m), and the proposed 22 hour pumping schedule, this would deliver water at a rate of 174L/s (Darling Irrigation, 2013).

Water usage for dust suppression would be extremely variable throughout the year, being dependent upon seasonal conditions, but is estimated to total approximately 40ML per year.

2.13.2.6 Sewage and Waste Water

Sewage from ablutions facilities within the DZP Site would be treated through an appropriately licensed on-site waste water treatment system. Solids removal would be serviced by a licensed waste collection and disposal contractor, as required.

2.14 HOURS OF OPERATION AND PROJECT LIFE

2.14.1 Hours of Operation and Workforce Rosters

Table 2.19 presents the proposed hours of operation for each of the relevant components of the Proposal.

Processing operations would be undertaken on a continuous roster, seven days per week. Mining operations would be undertaken on a 10 to 10.5 hour day, 5 to 5.5 days per week for 48 weeks per year. It is envisaged that all operational personnel would be sourced locally and the bulk (estimated 80%) of the workforce would be sourced locally.

Table 2.19
Proposed Hours of Operation

Activity	Proposed Days of Operation	Proposed Hours of Operation
Vegetation clearing and topsoil stripping	7 days a week (per campaign)	Daylight hours
Construction operations	7 days a week	Daylight hours ¹
Mining operations	5.5 days a week	7:00am to 6:00pm
Blasting operations	5.5 days a week	9:00am to 5:00pm ²
Maintenance operations	7 days a week ³	24 hours per day
Processing operations	7 days a week	24 hours per day
Rehabilitation operations	5.5 days a week	Daylight hours
Note 1: Low noise generating work such as electrical installation and plant fit-out may be undertaken outside of these nominated hours of operation.		
Note 2: Unless required for misfire re-blast, emergency or safety reasons.		
Note 3: Maintenance operating hours on the mining fleet will be as for the mine production hours		
Source: Australian Zirconia Limited		

2.14.2 Project Life (This Application)

The Applicant has designed the open cut to provide for 20 years supply of ore to the processing plant at a rate of 1Mtpa. Accounting for a 2 year construction period prior to the delivery of any ore to the processing plant, periods of lower or slower production than 1Mtpa, and a decommissioning and rehabilitation phase, the life of the Proposal as defined by this EIS is likely to be 25 years.

2.14.3 Future Project Life

The Applicant notes that the ore body from which the rare metals and rare earths are to be extracted continues at depth below the open cut floor nominated for this Proposal. Conservative estimates of the ore reserves suggest that mining and processing could continue for in excess of 80 years. As the Applicant approaches the exhaustion of the ore reserves nominated for this Proposal, it is likely separate application would be made to continue mining and processing operations at the DZP.

2.15 EMPLOYMENT AND ECONOMIC CONTRIBUTION

2.15.1 Site Establishment and Construction

The construction phase of the Proposal would be an extended one due to the large and complex nature of the processing plant, length of rail line and public road to be upgraded or constructed, and the large area of land to be developed for the purpose of the LRSF. The Applicant estimates a period of 18 months to two years would be required to complete construction and during this time the number of employees would fluctuate from week to week depending on the specific tasks being completed and requisite contract workforce. On average, the Applicant estimates that between 300 and 400 people would be employed at any given time for the site establishment and construction phase, peaking during periods of labour intensive construction activities.

The technical specialists and consultants from outside the local area would reside in hotels, motels, caravan parks or rental accommodation in the local area for the duration of their activities. There is no intention to establish camp accommodation for the construction workforce.

2.15.2 Operations

At full production, the Proposal would employ up to 250 persons in operational and management roles.

The operational workforce would be a residential one, preferentially sourced from the local area. The Applicant has already received considerable interest from persons residing in Dubbo or surrounding villages and towns for employment, should the Proposal be approved. A limited number of specialist or technical positions, e.g. chemical engineers, metallurgists, industrial chemists, would have to be sourced from outside the local area, and inevitably there would be movement from surrounding areas to Dubbo to take up the employment opportunities provided by such a large employer. The Applicant has reviewed the position descriptions required for

the Proposal and considers that only 10% to 15% of positions (25 to 35) are of a specialist or technical nature that would require import from more established mining regions. On this basis, the Applicant aims to employ 80% of the start-up operational workforce from Dubbo or surrounding areas.

The Applicant recognises the potential flow-on impact to other industries, rental / housing markets and local services and infrastructure of drawing such a large number of employees from the Dubbo LGA. Ultimately, this would lead to local population growth as those leaving other industries or jobs to take up work for the Proposal are replaced. The impact of this is considered in a Socio-economic Assessment completed for the Proposal by Diana Gibbs and Partners (DGP, 2013) which is provided as Part 12 to the *Specialist Consultant Studies Compendium* accompanying this EIS.

2.15.3 Economic Contributions

Based on a mining rate of 1Mtpa and annual production of 75 000tpa of products, the Proposal would generate a total revenue stream of in excess of \$500 million/year. The total capital investment required to deliver the project would be between \$670 million and \$995 million, with Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA) generated estimated at around \$5.4 billion over the life of the Proposal²¹.

In addition to the direct capital investment and revenue generated, the Proposal would generate over \$50 million additional annual stimulus for the local and NSW economies through wages, payment for utilities, and purchase of other locally-provided goods and services. The annual payment of wages would approximate \$34 million and given the Applicant's preference for employing personnel from the Dubbo LGA, this money should largely remain within the local area. An estimated \$13.4 million would be paid to local utilities with additional expenditure on locally purchased goods and services likely to exceed \$5 million annually.

The Applicant would also contribute payment of rates to Dubbo City Council and has committed to entering into a yet to be finalised Voluntary Planning Agreement (VPA) with Council to account for the use of local infrastructure and services. The implementation of a VPA notwithstanding, the Applicant has committed to upgrading Obley and Toongi Roads, which would benefit all users of these roads, at a cost likely to exceed \$15 million.

Further consideration of the economic contribution and impact of the Proposal on the local, regional and NSW economies is provided in a Socio-economic Assessment completed for the Proposal by DGA (2013) (Part 12 to the *Specialist Consultant Studies Compendium* accompanying this EIS).

²¹ It is noted that the rare metal and rare earth resource significantly exceeds that which could be mined and processed within 20 years. Subject to a future development application, there is potential for the operation of the DZP to continue well beyond 20 years with a commensurate increase in the EBITDA generated by the DZP.

2.16 SAFETY AND SECURITY

2.16.1 Public and Employee Safety (DZP Site)

Measures would be implemented to ensure the safety of visitors, contractors and employees, as well as ensuring the security of facilities and equipment from unauthorised access. It is the Applicant's policy that each person employed on, or visiting the DZP Site would be provided with a safe and healthy working environment. In order to achieve this, the Applicant would implement a recruitment, induction and training program to:

- ensure compliance with statutory regulations and maintain constant awareness of new and changing regulations;
- eliminate or control safety and health hazards in the working environment in order to achieve the highest possible standards for occupational safety in the mining industry;
- ensure the suitability of prospective employees through a structured recruitment procedure;
- provide relevant occupational health and safety information and training to all personnel;
- develop and constantly review safe working practices and job training;
- conduct regular safety meetings and provide an open forum for input from all on-site personnel;
- provide effective emergency arrangements for all on-site personnel, visitors and general public protection;
- maintain good morale and safety awareness through regular employee assessment and counselling; and
- ensure all contractors adopt and maintain Applicant's policy objectives and safety standards at all times.

Central to all aspects of site public and employee safety would be the preparation and implementation of a *Health, Safety & Environmental (HS&E) Plan* or equivalent. The *HS&E Plan* would include identification of roles and responsibilities, procedures for investigation of near misses and safety incidents, and requirement for a regular and trigger-related review and audit of the system. The *HS&E Plan* would incorporate the following to maintain a level of safety and security appropriate for the proposed activities.

- Establishment and maintenance of fencing around the perimeter of the DZP Site and other fencing as required in order to isolate grazing stock and unauthorised individuals from site activities.
- Use of locked gates to exclude access when site personnel are not working in component areas.
- Installation of and maintenance of safety signage around the DZP Site and perimeter fencing, where necessary.

- Security when there are no authorised personnel on site.
- All visitors entering and departing the DZP Site would be required to report to the gatehouse or other nominated locations for registration including time of arrival and departure, and an induction, if required.
- Install appropriate controls to ensure that the stability of the open cut, WRE and residue storage facilities are maintained.

2.16.2 Public Safety (Toongi-Dubbo Rail Line)

The Molong Branch Line from Dubbo East Junction is currently unfenced and used by local residents for recreational pursuits such as dog walking and jogging.

The Applicant would comply with the requirements of JHR with respect to fencing the Toongi-Dubbo Rail Line. The Applicant recognises the preference of some members of the local community to leave the section of rail corridor adjacent to Margaret Crescent unfenced and would argue that this is not unreasonable given the low speed travel of the train along this section of rail and excellent visibility available. Should fencing be required within Dubbo City limits, this is likely to be in the form of 2m high cyclone fencing. Beyond Dubbo City limits, the fencing is likely to be in the form of rural (cattle proof) fencing.

2.16.3 Explosive Storage

Detonators and boosters would be stored within a designated Magazine Area located adjacent to the open cut. This area would be secured by a 1.8m high security fence topped with barbed wire and a lockable gate. In addition, the Magazine Area would be the subject of regular inspection by security personnel working for or contracted to the Applicant. The magazines contained within the Magazine Area would be likely to be transportable structures which would be constructed, secured, maintained and permitted in accordance with the relevant guidelines. Bulk explosives would be transported to the DZP Site on the day of each blast.

2.17 SITE DECOMMISSIONING, REHABILITATION AND LAND USE MANAGEMENT

2.17.1 Introduction

As far as practicable, the Applicant would adopt a progressive approach to the rehabilitation of disturbed areas within the DZP Site to ensure that, where practicable, areas where mining, waste rock placement or solid residue storage are completed quickly, shaped and vegetated to provide a stable landform. The nature of the Proposal dictates, however, that the largest areas of disturbance on the DZP Site, namely the LRSF, remains active for the life of the Proposal and as a consequence the opportunity to undertake progressive rehabilitation on this structure would be minimal.

To compensate for the noted restrictions in the ability of the Applicant to undertake progressive rehabilitation, and as a component of a proposed *Biodiversity Offset Strategy*, biodiversity enhancement management activities over areas of the DZP Site that would be

undisturbed by mining and associated activities would also be a feature of the Applicant's *Integrated Land Management Plan*. These biodiversity enhancement activities would integrate with the proposed rehabilitation, remnant vegetation and continued farming activities over some areas of the DZP Site to form part of the final landform. The progressive formation of the post-mining landform, revegetation and enhancement of biodiversity on the DZP Site would also minimise the potential Project-related visual amenity and air quality impacts at surrounding residences.

The following subsections describe the Applicant's proposed approach to site decommissioning and rehabilitation and:

- outline the rehabilitation objectives of the Applicant with respect to the rehabilitation of the DZP Site and Macquarie River Water Pipeline (Section 2.17.2);
- provide an overview of the strategic management of rehabilitation, which includes the categorisation of rehabilitation domains, establishment of a rehabilitation hierarchy, and establishment of completion criteria, performance indicators and monitoring programs (Section 2.17.3);
- describe the proposed final land use and landform, including details on the integration of biodiversity conservation and ongoing and future agricultural operations (Sections 2.17.4 and 2.17.5);
- describe the rehabilitation procedures to be applied to each component of the DZP Site and Macquarie River Water Pipeline (Section 2.17.6);
- describe the proposed rehabilitation maintenance procedures, post-mining management and noxious weed management (Section 2.17.7); and
- describe the proposed Project *Biodiversity Offset Strategy* (Section 2.17.8).

Following the receipt of development consent, all rehabilitation-related requirements nominated would be addressed and the rehabilitation objectives, criteria and activities proposed in the following subsections updated in the form of a *Mining Operations Plan* (MOP) which would to be submitted to the DRE and would consider the following documentation.

- Mine Rehabilitation – Leading Practice Sustainable Development Program for the Mining Industry (Commonwealth Government, 2006).
- Mine Closure and Completion – Leading Practice Sustainable Development Program for the Mining Industry (Commonwealth Government, 2006).
- Strategic Framework for Mine Closure (ANZMEC, 2000).

It is noted that the Applicant operated the Peak Hill Gold Mine (PHGM), located approximately 48km to the southwest of the DZP Site between 1996 and 2002. Most of that site, which included open cut mines, waste rock emplacements, a heap leach and residue storage facilities, has now been fully rehabilitated and a large proportion of a Security Deposit has been released by DRE. The rehabilitation objectives, methods and procedures described in the following subsections build upon the operational experience of the Applicant at the PHGM. **Plates 2.9 to 2.12** present views of the completed rehabilitation within the Peak Hill Gold Mine site.



2.17.2 Rehabilitation Objectives

The Applicant's rehabilitation objectives are divided into three specific categories, namely:

- landform establishment;
- growth media development; and
- ecosystem development (final land use).

The specific objectives associated with each category are as follows.

Landform Establishment

- To stabilise all disturbed areas and minimise erosion and dust generation.
- To reduce the visual impact upon surrounding residents by early establishment of vegetation in areas where mining-related operations have been completed.
- To blend the created landforms with the surrounding topography.
- To provide a low maintenance, geotechnically stable and safe, non-polluting landform which provides land suitable for the final land use of biodiversity conservation or agriculture.

Growth Media Development and Ecosystem Establishment

- To provide for soil management over the life of the Proposal which addresses the constraints related to the extended period between stripping and replacement on the final landform.
- To achieve a soil profile capable of sustaining the specified final land use.
- To provide for surface micro-habitats such as fallen timber, surface rocks or other features which would encourage colonisation by specific native flora and fauna.
- To establish native vegetation with the species diversity commensurate to the ecological communities disturbed.

Ecosystem Development (Final Land Use)

- To protect, enhance and extend those sections of the DZP Site with remnant native vegetation, focusing particularly on that vegetation classified as endangered ecological communities under the NSW TSC Act or Commonwealth EPBC Act.
- To develop habitats on the final landform which encourage colonisation by native flora and fauna with specific niche requirements.
- To implement biodiversity enhancement measures within sections of the DZP Site so as to extend, improve, protect and link areas of remnant native vegetation and generally improve the biodiversity value of the DZP Site.
- To retain areas on the DZP Site amenable to future agricultural or industrial activities.

2.17.3 Strategic Rehabilitation Management

2.17.3.1 Rehabilitation Domains

Rehabilitation domains refer to areas of related disturbance based on processes and use prior to rehabilitation and for which decommissioning and rehabilitation activities would be similar. A description of each domain is as follows.

Domain 1 – Infrastructure Areas (D1)

This domain would include the DZP Site Administration Area, Rail Container Laydown and Storage Area, Processing Plant Area, DZP Site Access Road, Macquarie River Water Pipeline, Mine Haul Road, and any other miscellaneous buildings or roads.

Domain 2 – Surface Water Management Structures (D2)

This domain includes all clean and dirty water dams, diversion drains and associated infrastructure.

Domain 3 – Waste Rock Emplacement Area (D3)

This domain includes the waste rock emplacement areas and soil stockpile locations.

Domain 4 – Liquid Residue Storage Facility (D4)

This domain includes the seven separate areas of the LRSF and associated infrastructure.

Domain 5 – Solid Residue Storage Facility (D5)

This domain includes the SRSF, Salt Encapsulation Cells and associated infrastructure.

Domain 6 – Final Void Area (D6)

The final void area would include the post-mining void and any associated access.

The rehabilitation objectives described in Section 2.17.2 relate to all rehabilitation domains.

2.17.3.2 Rehabilitation Hierarchy

The rehabilitation hierarchy for the Proposal follows a modified rehabilitation hierarchy based on the DRE model proposed in current *Rehabilitation Management Plan Guidelines* (DRE, unpublished) but is aligned to the rehabilitation objectives in Section 2.17.2. A summary of each phase of the rehabilitation hierarchy is as follows.

Decommissioning

Specific details of decommissioning completion criteria would be covered in a *Mine Closure Plan* to be prepared closer to completion of mining activities. In general, however, the decommissioning phase of the rehabilitation hierarchy involves the cessation of usage of infrastructure, as well as its demolition, removal and any remediation of the land that may be required. Specific decommissioning activities that relate to completion criteria at this stage in the rehabilitation hierarchy are outlined in Section 2.17.6.2.

Landform Establishment

The landform establishment phase involves the earthworks required to cover and/or profile all or part of each domain to create a landform suitable for the proposed final land use and which blends with the adjacent topography. This stage would also include the construction of any drainage structures needed for the area. Specific procedures relating to landform establishment that relate to completion criteria at this stage of the rehabilitation hierarchy are outlined in Section 2.17.6.

Growth Media Development and Ecosystem Establishment

The growth media development phase of the rehabilitation hierarchy involves the replacement of soil over disturbed areas and preparation of the soil for revegetation including fertiliser or ameliorant application, and ripping or scarifying the soil. It also covers the revegetation of the rehabilitated landform and biodiversity offset areas with native species commensurate with the targeted final land use. Specific procedures relating to growth media development and ecosystem establishment are outlined in Section 2.17.6.

Ecosystem Development (Final Land Use)

The ecosystem development (final land use phase) of the rehabilitation hierarchy occurs once monitoring shows that there is adequate vegetation over the area. An area may be in this stage for a long period of time, depending on what the final land use outcome is. During this stage, the area would continue to be monitored and would not reach its nominated sustainable end land use until monitoring determines that the completion criteria summarised in **Table 2.20** have been met.

2.17.3.3 Strategic Rehabilitation Completion Criteria, Associated Performance Indicators and Monitoring Strategy

The strategic rehabilitation completion criteria, associated performance indicators and monitoring strategy for the Proposal are summarised in **Table 2.20**. While the rehabilitation criteria are based on the DRE model, it has been modified to align with the rehabilitation objectives outlined in Section 2.17.2 and the rehabilitation hierarchy discussed in Section 2.17.3.2. The rehabilitation criteria aim to achieve the following.

- The ongoing refinement of completion criteria and monitoring programs that would facilitate lease relinquishment following mine closure.
- Alignment with rehabilitation and biodiversity offset area objectives.
- The facilitation of continuous improvement in restoration management practices of the rehabilitation and biodiversity offset areas.

Table 2.20
Strategic Rehabilitation Completion Criteria, Associated Performance Indicators and Monitoring Strategy

Page 1 of 2

Rehabilitation Objective	Completion Criteria	Performance Indicator	Monitoring Strategy
Landform Establishment	The landform morphology fits in with the surrounding landscape.	Slopes are at or less than 18° for the WRE, SRSF, LRSF and Salt Encapsulation Cells. . Final slopes of open cut (void) walls are stable.	<i>Annual</i> includes up to date survey of landforms and constructed and rehabilitated.
	The rehabilitated area does not represent an erosion hazard.	Erosion does not exceed 0.3m (gully) deep.	Quarterly visual inspection by Environmental Officer or other nominated (and appropriately trained) personnel.
Growth Media Development and Ecosystem Establishment – Native Vegetation	Appropriate native plant species richness is present for the restored community.	Comparison to control site established in equivalent remnant vegetation.	Vegetation monitoring by ecologist to assess species richness (prior to lease relinquishment).
	Appropriate density/structure of native overstorey species is present.	Comparison to control site established in equivalent remnant vegetation.	Vegetation monitoring by ecologist to assess over storey structure (prior to lease relinquishment).
	Appropriate density/structure of native mid storey species is present.	Comparison to control site established in equivalent remnant vegetation.	Vegetation monitoring by ecologist to assess mid storey structure (prior to lease relinquishment).
	Appropriate native groundcover is present.	Comparison to control site established in equivalent remnant vegetation.	Vegetation monitoring by ecologist to assess species richness (prior to lease relinquishment).
	Appropriate micro-habitat features established.	Comparison against commitments made, and specific criteria of relevant species management plan(s).	As nominated in relevant species management plan(s).
Growth Media Development – Agricultural Land	Areas retained for future agricultural or industrial activities.	Nominated areas maintained free of woodland vegetation and weed species.	Annual monitoring for weed species to be reported in <i>AEMR</i> .
Ecosystem Development (Final Land Use)	The area and its sustainability is consistent with the intended land use.	Establish areas of rehabilitation consistent with approval conditions. Land use classifications to include: <ul style="list-style-type: none"> • Native vegetation. • Agricultural land. • Biodiversity enhancement. 	<i>AEMR</i> to quantify areas. <i>Biodiversity Offset Management Plan</i> to be audited every 3 years.

Table 2.20 (Cont'd)
Strategic Rehabilitation Completion Criteria, Associated Performance Indicators and Monitoring Strategy

Page 2 of 2

Rehabilitation Objective	Completion Criteria	Performance Indicator	Monitoring Strategy
Ecosystem Development (Final Land Use) (Cont'd)	There are no potential hazards inconsistent with the intended land use.	The site is free of safety or environmental hazards including: <ul style="list-style-type: none"> holes, tunnels or unstable areas; mining infrastructure or debris; or hazardous materials. 	Quarterly visual inspection by Environmental Officer or other nominated (and appropriately trained) personnel.
	The soil pH is representative of the intended land use.	pH levels are within the range generally acceptable for plant growth (5.0 to 8.5), or equivalent to appropriate analogue site(s).	Annual soil analyses by Environmental Officer or other nominated (and appropriately trained) personnel.
	Exotic weeds or vegetation are not competing or impacting on the intended land use.	Noxious weeds are not present within rehabilitation or biodiversity enhancement areas until data from analogue sites is available.	Annual visual inspection by Environmental Officer or other nominated (and appropriately trained) personnel.
	Feral pests are not impacting on the intended land use.	Feral pests are not present within rehabilitation or biodiversity offset areas until data from analogue sites is available.	Annual visual inspection by Environmental Officer or other nominated (and appropriately trained) personnel.
Note: EFA Score = Ecological Function Analysis Score.			

Specific rehabilitation criteria and a monitoring program would be outlined in a *Mining Operations Plan, Rehabilitation Management Plan* or equivalent to be submitted and approved following receipt of development consent. The rehabilitation criteria would be regularly refined through monitoring and revised through an updated management plan to be approved by DP&I and DRE.

The rehabilitation monitoring strategy for the Proposal would generally be in accordance with the monitoring program implemented successfully at the PHGM. The objective of the monitoring program would be to evaluate the restoration progress of the mine rehabilitation towards fulfilling ecological community land use objectives and closure criteria. The purpose of monitoring activities would be to ensure the sustainable re-colonisation and ongoing management of native flora and fauna, and to guide continual improvement of rehabilitation practice.

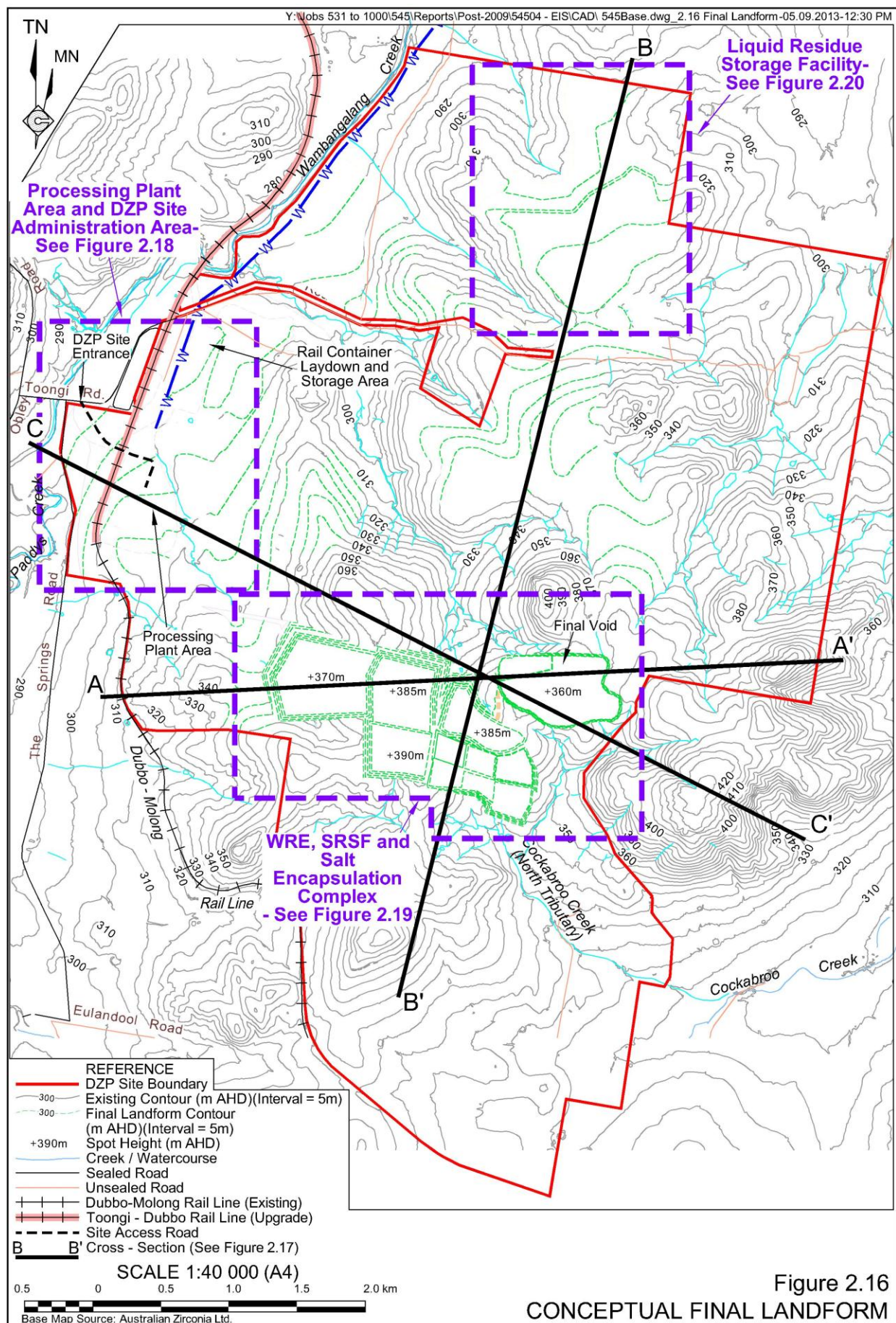
2.17.4 Final Landform

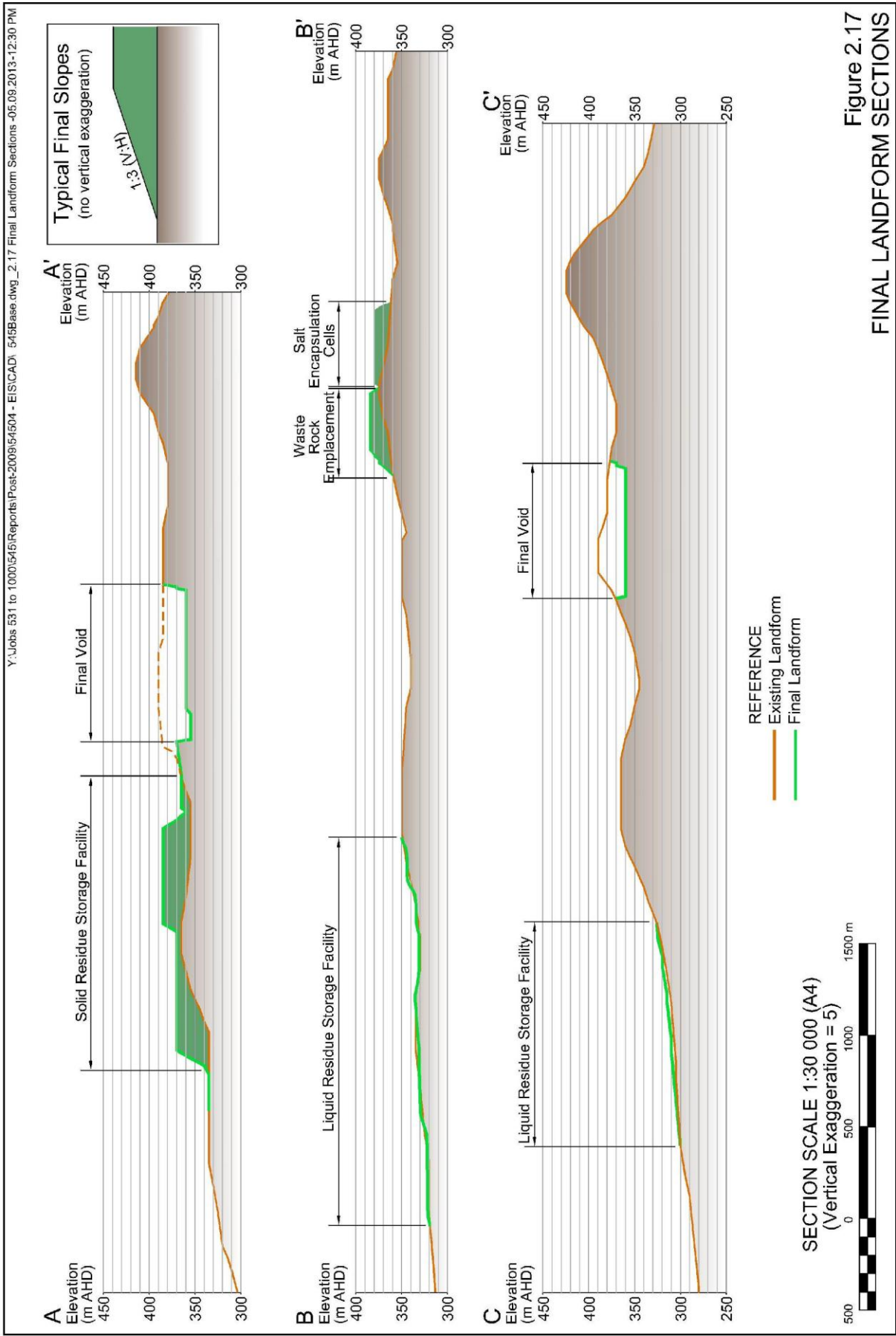
Figure 2.16 presents the final landform of the DZP Site with selected conceptual cross-sections provided in **Figure 2.17**. In summary, the final landform would include the following components.

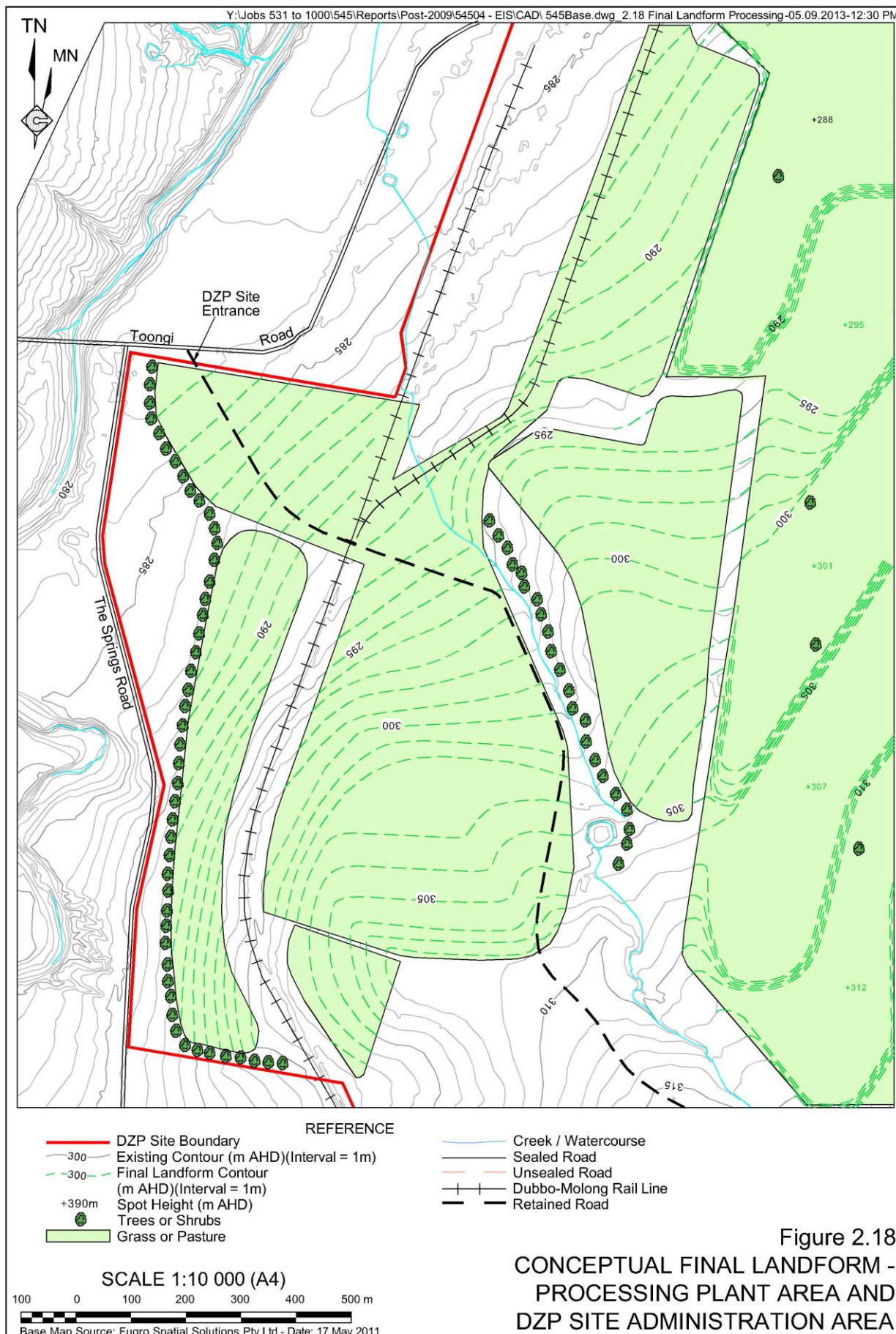
- Removal of all processing plant, office and ancillary infrastructure, including concrete pads (unless required for a future land use) with the remaining landform profiled to approximate that which existed prior to the establishment of the infrastructure. **Figure 2.18** provides a more detailed illustration of the proposed final landform concept for the Processing Plant and DZP Site Administration Area.
- A single appropriately bunded, fenced and signed final void. **Figure 2.19** includes a more detailed illustration of the proposed final landform concept for the open cut.
- A shaped and revegetated complex of the WRE, SRSF and Salt Encapsulation Cells²² comprising undulating upper surfaces, outer faces with maximum slopes of approximately 18° 1:3 (V:H) and appropriately located and designed surface water control structures to minimise the risk of erosion and sedimentation. **Figure 2.19** includes a more detailed illustration of the proposed final landform concept for the WRE, SRSF and Salt Encapsulation Cells.
- A return to the pre-DZP landform over areas covered by the LRSF with the liner removed and disposed of off site. Material contained within the embankments respread over the former salt crystallisation cells and the areas covered with topsoil and revegetated. **Figure 2.20** includes a more detailed illustration of the proposed final landform concept for the rehabilitation of the LRSF – Area 4. The other three LRSF areas would be rehabilitated in the same manner as presented in **Figure 2.20**.
- Any vegetated bunds and surface water infrastructure, including sediment basins, would be retained.
- The Macquarie River Water Pipeline and Natural Gas Pipeline would either be excavated and removed or retained depending on the preference of future landowners.
- The rail line infrastructure would be retained.

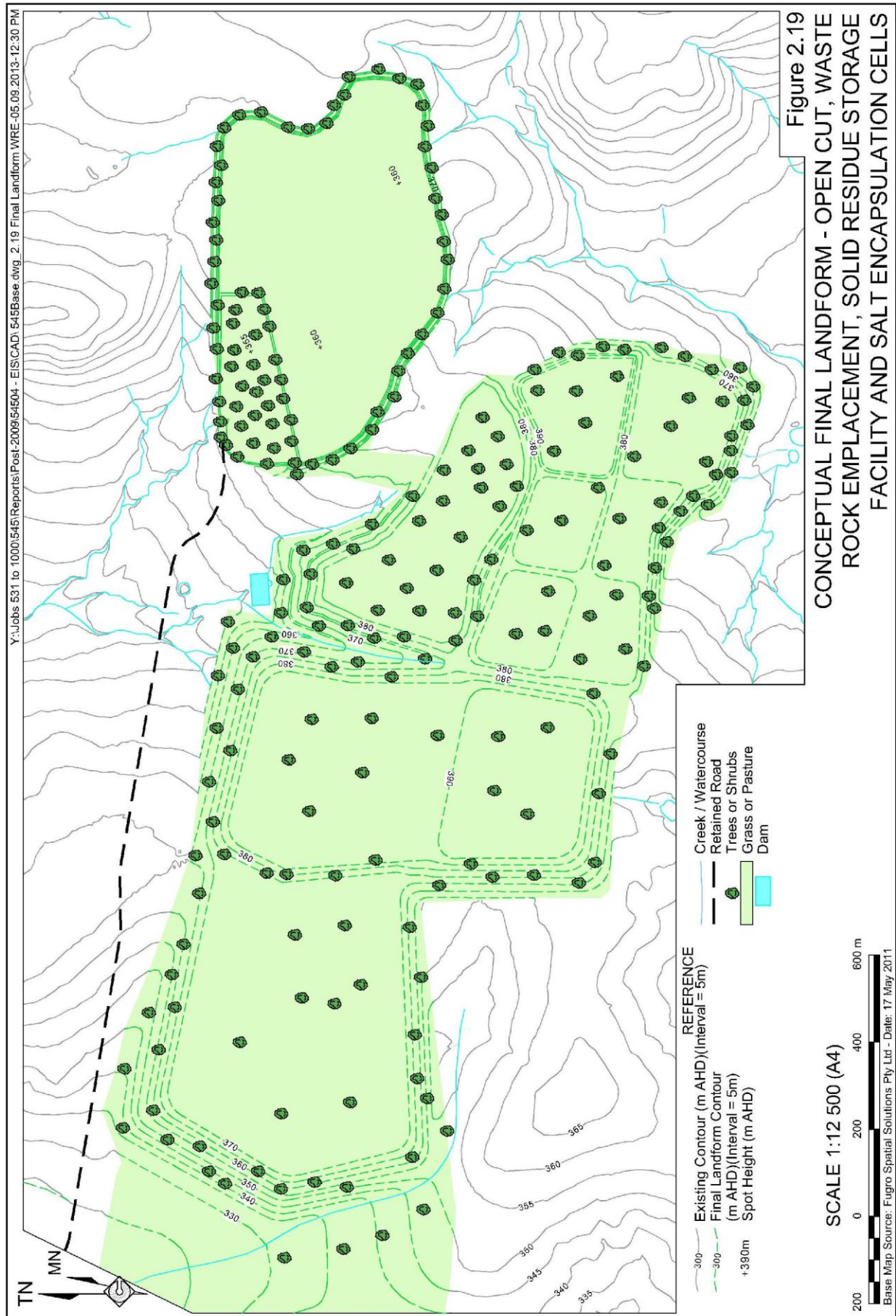
Landform ultimately influences land use, and vice versa, consequently the landform concept presented by **Figure 2.16** could be modified during the life of the Proposal to reflect any changes to the intended final use of the land.

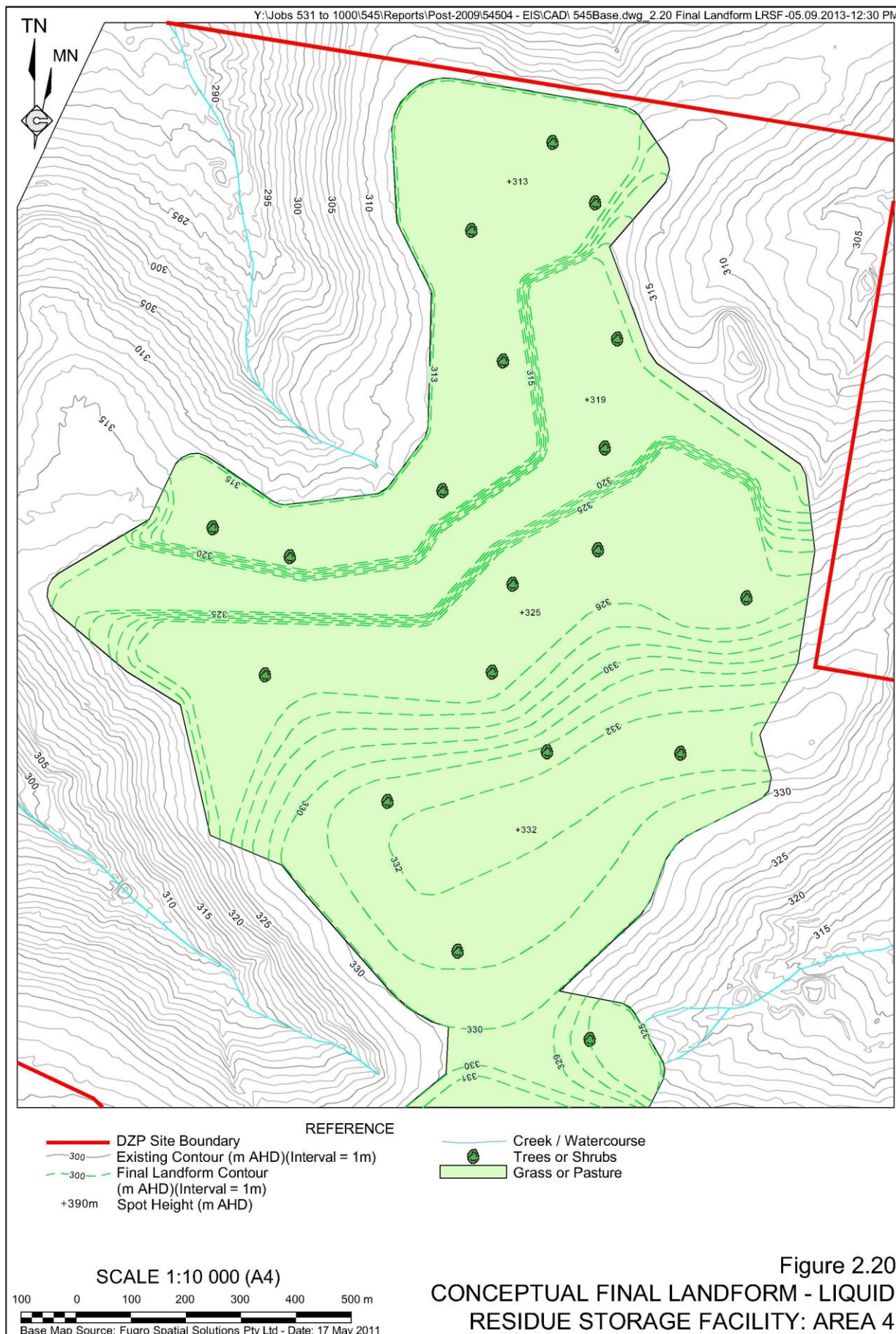
²² The potential to encapsulate the salt in the open cut at the end of the life of the Proposal is considered a feasible alternative, however, acknowledging the potential for continued mining of the ore at greater depths, an out-of-pit disposal site has been presented.











2.17.5 Final Land Use

Final land use would ultimately be determined in consultation with the community and the relevant government agencies, e.g. DP&I, DPI, DRE, OEH, Dubbo City Council and the rail line operator prior to decommissioning of the Proposal. In proposing a final land use for the DZP Site, the Applicant has considered the current land use on the various properties to be impacted, the infrastructure that would be developed and the proximity to other industry.

Land uses considered included:

- a return to agriculture;
- the development of other industry; and/or
- the conservation of biodiversity.

A return to agriculture on the DZP Site would have practical application as the Proposal has been designed to minimize impacts on local drainage, with additional water storing infrastructure retained which would be of value to grazing. This land use would also ensure that the DZP Site retains an economic value post-completion of the Proposal. It is noted that certain elements of the Proposal may not be compatible with agricultural activities, e.g. the rehabilitated SRSF, WRE, Salt Encapsulation Cells and open cut void. This notwithstanding, such features would be managed in such a way as to ensure no hazard is created.

The Proposal would also provide for infrastructure on the DZP Site potentially suited to other industry, e.g. natural gas supply, rail infrastructure, high standard roads and hard stand surfaces, buildings with electricity supply, and water delivery and storage infrastructure. The location of the DZP Site presents a possible constraint to industry reliant on regular transport to and from the site as even with the availability of a rail and high quality road link to Dubbo, this distance could impact on competitiveness. Industries or enterprises likely to be suited to the DZP Site would therefore have specific requirements suited by the infrastructure provided and be unconstrained by the isolation of the site from larger commercial centres. The Applicant has recently fielded enquiries regarding the possible suitability of the DZP Site, both during and at completion of the Proposal, for the establishment of renewable energy (solar) generation facilities. This could form part of the development of a larger solar electricity generation hub within the Dubbo LGA under consideration by a third party. Given the occurrence of significant areas of land not required for the Proposal on the DZP Site, and additional land owned by the Applicant surrounding the DZP Site, there is potential for such a project to be developed concurrently with the Proposal (and provide a significant proportion of the DZP's energy requirements). At the completion of the Proposal, the DZP Site and retained infrastructure would be ideally suited to an expansion of solar energy generation and delivery to the NSW power grid. Any such industry or enterprise would be considered on merit and would be subject to the appropriate planning assessment.

The development of land for conservation is also considered a practical final land use, as once established this would require minimal ongoing management (which could be undertaken in conjunction with concurrent agricultural activities) and would be positively affected by the significant distance to the larger regional centre of Dubbo (reducing the potential for encroachment by other development). The regulatory framework within which the Proposal is assessed also places high importance on offsetting impacts to biodiversity. Greatest value/credit is placed on the improvement or enhancement of land which contains native vegetation communities which have been degraded by processes such as clearing, grazing and

weed encroachment and incorporation of this into some form of conservation estate. Section 2.17.8 provides further detail on the Applicant's proposed development and management of biodiversity enhancement areas as a component of a *Biodiversity Offset Strategy*.

On the basis of the above, it has been proposed that the final land use of the DZP Site would integrate areas of biodiversity enhancement and conservation with agriculture (see **Figure 2.21**). The Applicant would continue to investigate other industrial land uses which could take advantage of the infrastructure developed for the Proposal, with these potentially replacing some areas of agricultural activity and which would be subject to future development application.

2.17.6 Rehabilitation Methods and Procedures

2.17.6.1 Introduction

Following receipt of development consent, and as a component of a *Mining Operations Plan* for the DZP Site, the Applicant would prepare a detailed rehabilitation plan. This would provide the agreed final landform and land uses (including any land excised for biodiversity offsetting purposes), detailed progressive rehabilitation schedule and specific revegetation species mix to be used as part of direct seeding and ameliorative planting over the DZP Site. The following subsections provide a summary of the methods that the Applicant would adopt for each of the identified rehabilitation domains to meet the objectives described in Section 2.17.2, achieve the conceptual final landform described in Section 2.17.4 and the principal land uses described in Section 2.17.5 (see **Figure 2.21**).

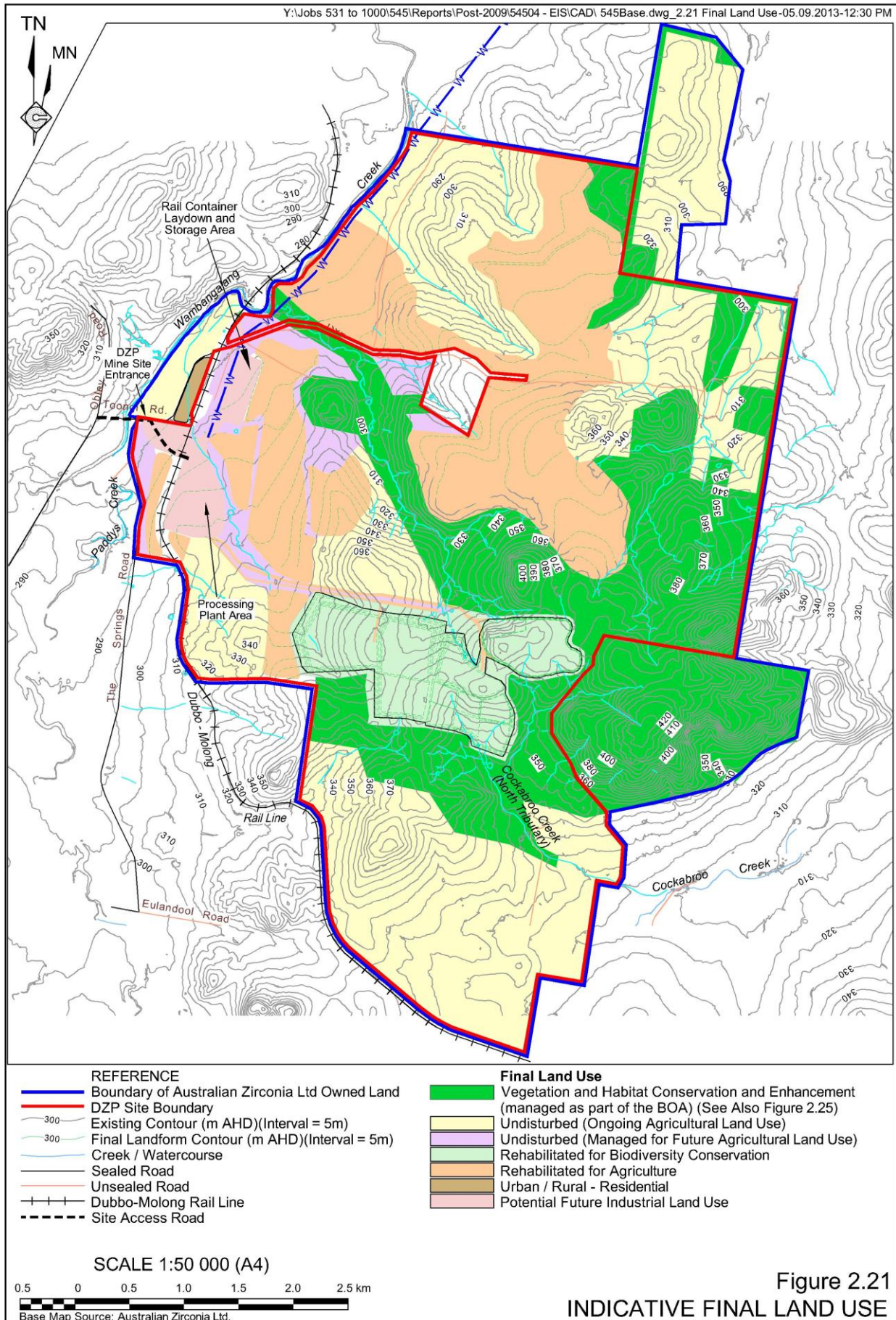
2.17.6.2 Decommissioning Activities

Decommissioning activities would be undertaken upon cessation of mining and processing activities. The following structures and facilities would be decommissioned and removed prior to final rehabilitation of the DZP Site.

- The DZP Site Administration Area, Rail Container Laydown and Storage Area components and Processing Plant Area.
- Various fuel storage, workshops, offices and ablutions structures.
- Roads not to be maintained in the final landform.
- Contour banks constructed to divert water around the LRSF.

It is proposed to retain the following items of infrastructure, i.e. would not be decommissioned, which would remain available for future land use.

- Rail line infrastructure.
- Macquarie River Water Pipeline.
- Natural Gas Pipeline.
- Electricity transmission lines, transformers or sub-stations.
- The DZP Site Access Road between Toongi Road and the rail line.



DZP Site Administration Area, Rail Container Laydown and Storage Area and Processing Plant Area (Domain D1)

Prior to the cessation of mining and processing activities, the Applicant would attempt to identify a buyer for the processing plant (in its entirety or in part). Should the Applicant successfully negotiate the sale, the various buildings and miscellaneous tanks, conveyors and other structures would be dismantled and transported from the DZP Site. Should relocation or sale not eventuate, the structure would be separated into smaller sections with parts on-sold as scrap metal and any useable elements transported to a storage facility off site.

The buildings and structures erected/constructed would be dismantled or demolished, washed down with high powered water sprays and transported off site.

Hydrocarbon storage facilities (for diesel, natural gas and oils) would be pumped out. A thorough assessment of the soil directly below and surrounding the storage facilities and refuelling area(s) would be conducted to ensure any contaminated soil would be identified. Any contaminated soil classified as “*Restricted Solid Waste*” (under *NSW Waste Classification Guidelines*, DECCW 2008) would be excavated for treatment on site within a specific bioremediation area or disposed of at an appropriately licensed facility. The fuel storage facilities would be on-sold or re-used at another site.

All concrete pads, footings and foundations of buildings or structures to be dismantled or demolished would be broken up and removed (and recycled) or covered and all areas to be rehabilitated would be re-profiled to mimic pre-mining levels.

Roads

The Applicant intends to remove the majority of DZP Site roads (some roads may be retained to provide ongoing access to the DZP Site lands). The DZP Site roads to be removed would be decommissioned (and rehabilitated) as follows.

- i) The roads would be closed, with a lockable gate constructed or maintained to prevent access.
- ii) The compacted surface would be ripped, removed by truck and disposed of within the waste rock emplacement.
- iii) All compacted sub-base and base-course material would be ripped, excavated and disposed of within one of the waste rock emplacements or recycled, if appropriate.

The roads would be rehabilitated through further ripping, the resspreading of topsoil and re-seeding with pasture species or native tree and shrub species depending on the land use designated for that section of the road.

Infrastructure Areas

Once infrastructure decommissioning has been completed, the remaining infrastructure would be rehabilitated as follows.

- Any internal haul roads and other access tracks, with the exception of those required for future land use, would be ripped, covered with previously stockpiled topsoil and seeded with locally occurring tree, shrub or grass species (dependent on the intended final land use). Section 2.17.6.8 provides details as to the indicative revegetation activities to be completed over this and other rehabilitation domains of the DZP Site.
- Remaining hardstand areas would be scraped to remove any material not appropriate for rehabilitation, ripped, and covered with previously stockpiled topsoil. Revegetation would be undertaken as described generally in Section 2.17.6.8.
- Appropriate drainage controls would be installed.

Figure 2.18 presents the proposed final landform concept for the Processing Plant and DZP Site Administration Area.

2.17.6.3 Domain 2 – Surface Water Management Structures

Of the surface water management structures that would be constructed on the DZP Site, the majority would be retained and provide for additional water storage for future land uses. Rehabilitation would be limited to the removal of any accumulated silt or sediment, minor profiling activities as required and revegetation using the indicative methods and species list described in Section 2.17.6.9. On rehabilitation of the LRSF, the diversion of water around these structures would no longer be required and as such, these would be pushed over by bulldozer or grader, profiled and revegetated with species appropriate to the final land use. The rehabilitated landform would be inspected following significant rainfall and remedial works undertaken to correct any erosion observed.

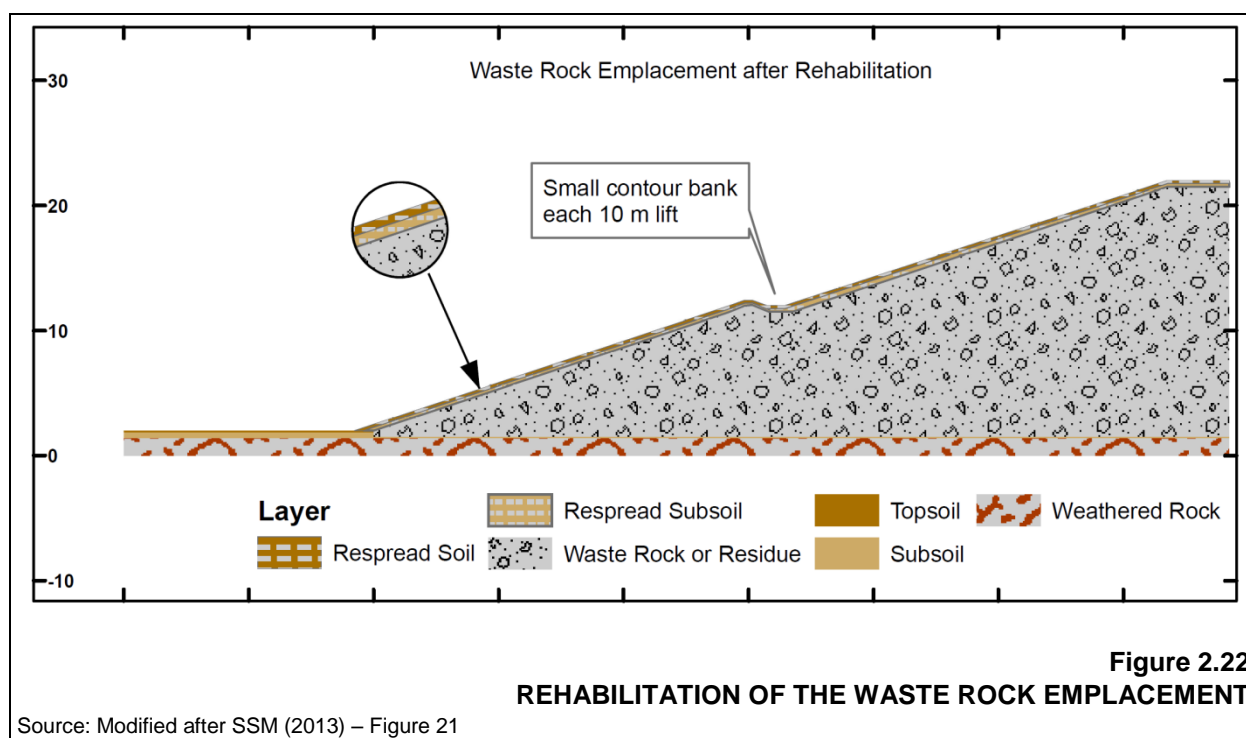
2.17.6.4 Domain 3 – Waste Rock Emplacement

Completed sections of the waste rock emplacement would be progressively shaped as they are no longer required for mining-related purposes. Remaining sections of the waste rock emplacement would be shaped following completion of mining operations. **Figure 2.19** presents the proposed final landform concept for the WRE, as part of the larger open cut, WRE, SRSF and Salt Encapsulation Cells complex.

During shaping operations, contour banks would be constructed on the rehabilitated landform. These structures would direct water at non-erosive velocities from the emplacement to the natural landform or to high-slope, drop-down structures such as flumes. These drop-down structures would be constructed on the slopes of the final landform to direct the surface water flows collected by the contour banks initially to sediment basins and then, following completion of rehabilitation operations, to natural drainage lines.

Soil would be placed on the shaped landform in accordance with the following procedures.

- Large rocks would be excavated and placed deeper below surface to prevent these from protruding and affecting growth medium establishment and water retention of the soil to be respread.
- Soil material would be placed on the shaped landform. While subject to review prior to resspreading, it is proposed to use at least 500mm of subsoil followed by 150mm of topsoil. **Figure 2.22** provides an indicative cross-section of the replacement of soil over the final landform.



- The surface of the shaped landform would be left even but roughened. This would assist in maintaining soil stability, maximising seed retention and germination and minimising erosion.
- Rocks of appropriate dimensions or roof tiles would be placed over the surface of the final landform to encourage the colonisation of the WRE first by ant species and then by the Pink-tailed Worm-lizard. Methods for habitat creation are described in greater detail in a *Pink-tailed Worm-lizard Plan of Management* prepared as a draft by Biosphere Environmental Consultants and appended to the Terrestrial Ecology Assessment for the Proposal (Part 6 of the *Specialist Consultant Studies Compendium*) (see also Section 4.7.5.4.2).
- If required, artificial covers such as bitumen impregnated straw or mulches would be used to stabilise the soils on the shaped landform.

The shaped landform would be revegetated with an appropriate species mix to be determined by an appropriately qualified and experienced rehabilitation consultant. Section 2.17.6.9 provides further discussion on the Applicant's revegetation strategy which is common to all domains.

2.17.6.5 Domain 4 – Liquid Residue Storage Facility

Throughout the life of the Proposal, and as salt accumulates in the salt crystallisation cells of the LRSF, specific cells would be isolated from liquid residue discharge to allow the salt to dry out sufficiently so that light mobile equipment can safely operate on the surface. As required, any liquid or brine retained within the cell would be pumped to other cells to accelerate the drying and salt crystallisation process. In this way, excavation of salt would not have to wait for the entire LRSF to dry out, rather cells would be dried and excavated sequentially.

The salt would be loaded to lined haul trucks, delivered to the Salt Encapsulation Cells and placed within the cells as discussed in Section 2.9.4.4. On complete decommissioning of each cell, the liner would either be re-used to cover the salt within the Salt Encapsulation Cells (to prevent the leaching of salts to the surface by capillary action) or carefully loaded to trucks for disposal off site (at an appropriately licensed facility).

The underlying compacted land would be deep ripped, graded, and then deep ripped again to aerate and break up this layer. Subsoil contained within the inter-cell embankments would then be removed to expose the 'sub-grade' material below. This sub-grade material would then be spread over the ripped landform to recreate the natural slope (with some undulations retained around the locations of the embankments and deepest sections of cut). This would effectively require the reverse cut and fill operations to those undertaken to create the flat bottomed cells on the sloping landform. **Figure 2.20** presents the proposed final landform concept for LRSF – Area 4 (which is indicative of the rehabilitation and final landform of LRSF – Areas 2, 3 and 5).

The subsoil would then be respread to a depth of approximately 500mm and ripped to aerate this layer and provide for keying of the topsoil to be spread over the top. A layer of approximately 100mm to 150mm of topsoil would then be spread over the subsoil, lightly scarified and seeded with pasture or crop species dependent on the intended final land use. **Figure 2.23** provides an indicative cross-section through of the landform of the LRSF, during operation and following rehabilitation.

Given the variable depth of subgrade (likely to contain predominantly subsoils from the deeper soil profiles of the soil landscapes targeted for the construction of the LRSF), the soil profiles over the LRSF final landform would display a range of properties. Some areas would have relatively undisturbed subsoil, while other areas would have sub-grade that has been placed at a range of thicknesses. This would result in a soil that could be much deeper than the 500mm of material that would be spread.

The upslope contour banks would then be rehabilitated as discussed in Section 2.17.6.3 and natural surface flows restored.

2.17.6.6 Domain 5 – Solid Residue Storage Facilities

As the outer walls of the SRSF and Salt Encapsulation Cells are completed, these would be treated in the same way as the outer walls of the WRE (see Section 2.17.6.4). **Figure 2.19** presents the proposed final landform concept for the SRSF and Salt Encapsulation Cells, as part of the larger open cut, WRE, SRSF and Salt Encapsulation Cells complex.

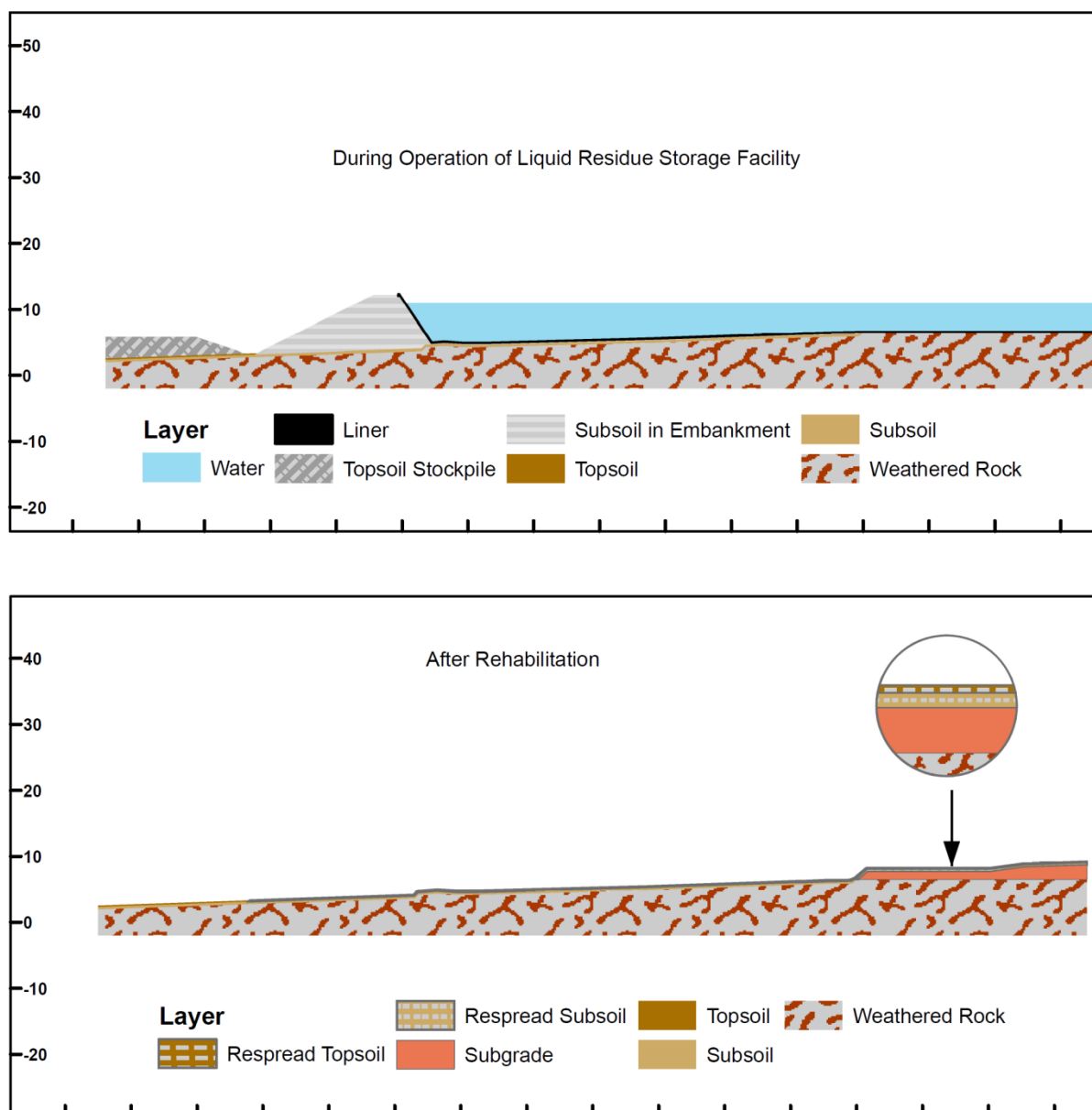


Figure 2.23
REHABILITATION OF THE LRSF

Source: Modified after SSM (2013) - Figures 18 and 20

The following considers the rehabilitation of the SRSF and Salt Encapsulation Cells separately as the approach to final landform creation would be different in each case given the different nature of the material being encapsulated.

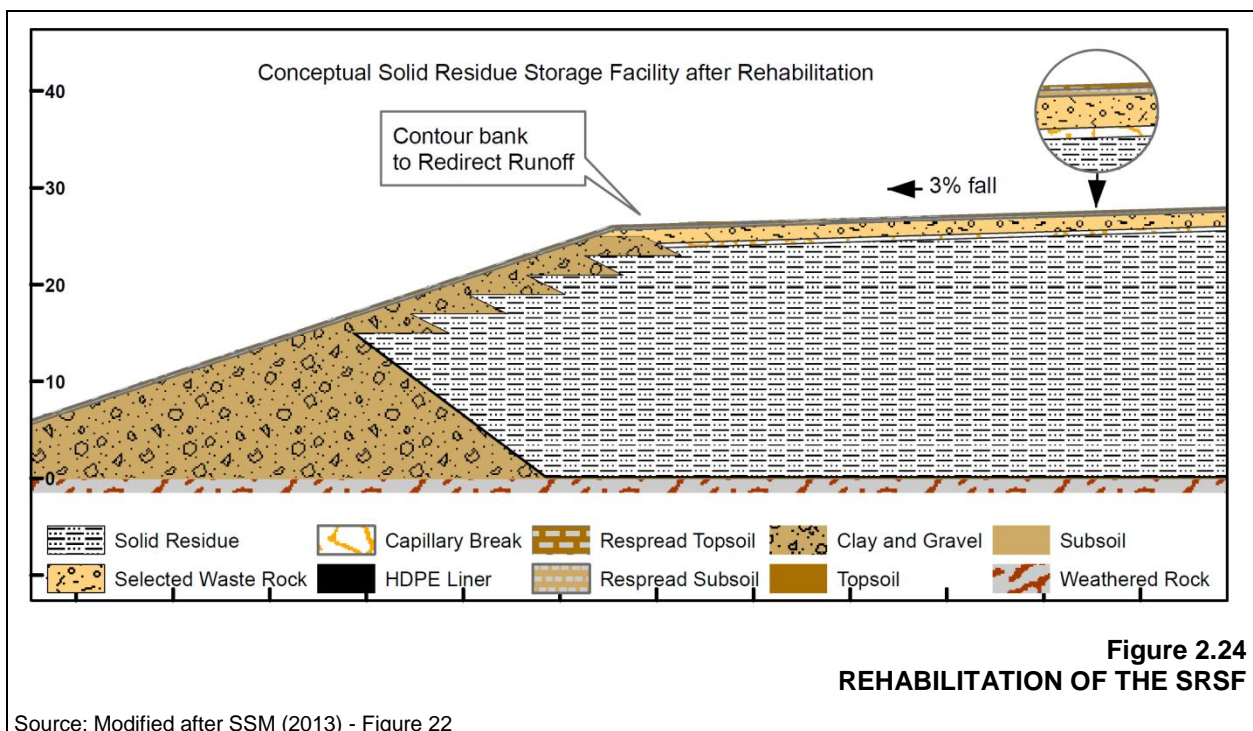
Solid Residue Storage Facility

The outer batters of the SRSF would be treated in the same way as the outer walls of the WRE (see Section 2.17.6.4), i.e. profiling, drainage construction, soil application and vegetation establishment.

Over the upper surface of the SRSF, a cover (or cap) of weathered waste rock would be placed over the top of the facility to contain the residue and to minimise the effects of rainfall moisture on the stockpiled material. The surface of the cover would drain to the edge of the stockpile, and a drainage system would be constructed to redirect water to the natural surface while protecting the integrity of the stockpile. The cap would operate as a store and release system (as described by DITR, 2007) in which heavy rainfall is allowed to drain from the surface while rainfall moisture that enters the soil is stored until it is released by evaporation or plant transpiration.

The layers of the cap proposed are as follows and illustrated on **Figure 2.24**.

- A layer of up to 500mm of subsoil and 100mm of topsoil which would function as a growth medium for vegetation. It would have continuous pores for root growth, absorb air and water, and be able to store water and nutrients.
- A layer of selected waste rock (approximately 2m thick) containing clay to silt sized particles, would capture and store rainfall moisture as described by Fourie & Tibbett (2012).
- A capillary break consisting of coarse material that is typically fine gravel (with hydraulic conductivity of less than 1×10^{-5} m/s or 1m/day). The prime function of the capillary break is to minimise capillary rise of leachate from the solid residue into the store and release layer.



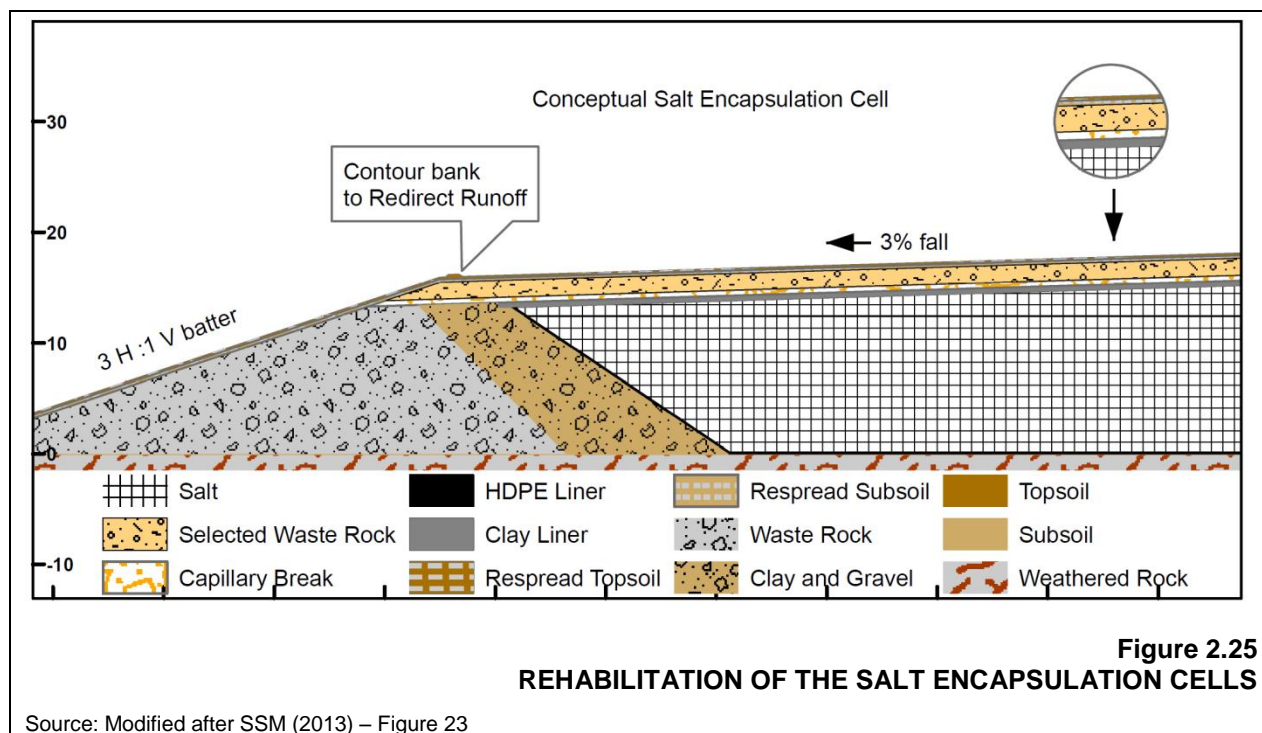
The capped, profiled and topsoiled surfaces would then be revegetated with a combination of the native grass and shrub species (refer to 2.17.6.8).

Salt Encapsulation Cells

The outer batters of the Salt Encapsulation Cells would be treated in the same way as the outer walls of the WRE (see Section 2.17.6.5), i.e. profiling, drainage construction, soil application and vegetation establishment. The floor and inside of the embankments of each Salt Encapsulation Cell would be lined with a double HDPE Liner.

A cover of weathered waste rock material would be constructed over the Salt Encapsulation Cells, similar to the cover over the SRSF. Distinct from the SRSF, an impermeable layer would be placed beneath the capillary break. This could take the form of a geotextile or compacted clay liner of low hydraulic conductivity (less than 1×10^{-7} m/s or 300mm/year, DITR, 2007). This liner would limit water diffusion into the salt and limit the movement of salts into the above layers by capillary rise. Material for the liner could be sourced from the deconstructed LRSF as noted in Section 2.17.6.7.

Figure 2.25 provides an indicative cross-section through of the landform of the Salt Encapsulation Cells following rehabilitation.



2.17.6.7 Domain 6 – Final Void Area

Figure 2.19 presents the proposed final landform concept for the open cut and surrounds, as part of the larger open cut, WRE, SRSF and Salt Encapsulation Cells complex.

Prior to the commencement of mining operations within the open cut, a 1.3m to 1.4m high safety bund would be constructed around the open cut. These bunds, which would have been vegetated throughout the life of the Proposal, would be retained. Following completion of mining operations, the bund would be extended across the haul ramp to prevent vehicular access and revegetated with native shrub species.

Topsoil would be spread over disturbed land around the perimeter of the open cut and retained berms (where these can be accessed safely by mobile equipment). Tubestock plantings, or seed scattering, of native tree and shrub species would be undertaken around the perimeter of the open cuts and on the retained berms (where safe to do so), however, it is expected that most vegetation established within this domain would be as a result of germination from natural seed dispersal from nearby trees and shrubs.

The final depth of the open cut would remain above the groundwater table and given the elevated position of the open cut, i.e. without any surface water catchment, accumulation of water in the void is unlikely.

2.17.6.8 Indicative DZP Site Revegetation Strategy

Revegetation of the DZP Site would be undertaken as either;

- revegetation of the rehabilitated final landform; or
- biodiversity enhancement planting and seeding of native species as a component of a *Biodiversity Offset Strategy*.

The Applicant has 14 years of experience with rehabilitation techniques at the PHGM to guide techniques, with further experience likely to have been obtained from the recently approved Tomingley Gold Mine. This section focuses on the revegetation of those areas of the DZP Site to be disturbed by the mining, processing, waste management or related activities of the Proposal. It is noted that the Applicant proposes to enhance and manage vegetation over other areas of the DZP Site as part of a proposed *Biodiversity Offset Strategy* and this is described in Section 2.17.8.

As indicated by **Figure 2.21** and described in Section 2.17.5, there would be a distinction between the rehabilitation and revegetation strategy for those domains to be returned to agricultural production (or possible some other commercial / industrial use) (Domains 1, 2 and 4) and those to be managed for the re-establishment of native vegetation (Domains 3, 5 and 6). The following provides the detail of the proposed revegetation strategy for these two distinct final land uses.

Agricultural Production

Following final landform profiling and coverage with topsoil, these areas would be sown with a mixture of pasture species appropriate to the season. The seed mixture would be determined by the intended crop or agricultural activities proposed for the land. Fertiliser and possibly soil ameliorants may be applied depending on soil conditions and intended crop or pasture. Contour banks may be constructed as required over this landform to assist in surface runoff retention and prevention of erosion.

Native Vegetation Re-establishment

Over the remaining areas of disturbance, i.e. within the open cut void, on the batters of the WRE, SRSF and Salt Encapsulation Cells, a mixture of native and introduced species of grasses and legumes would be used for rapid stabilisation of batters. Following stabilisation, the Applicant would commence a program of revegetation, using both tubestock planting and direct seeding techniques, to create native woodland vegetation communities across the DZP Site.

The species to be used as part of this revegetation program would vary dependent on the final landform, i.e. hill top, slopes or drainage line / flats, however, the objective would be to create an open grassy woodland of:

- 10% tree cover (with an average of 30m between each tree);
- 10% mid-stratum (shrub cover); and
- 80% grassy ground cover.

Table 2.21 presents an indicative list of species that would be used during rehabilitation planting programs over these three landforms.

Table 2.21
Indicative Rehabilitation Native Species List

	Hill Tops	Slopes	Drainage Lines / Flats
Landscape features	Tall or mid-high woodland or open woodland with trees to about 15 m high.	Tall or mid-high woodland or open woodland with trees to about 15 m high.	Tall woodland up to 20 m high.
Landscape position	Topographic highpoints and rocky outcrops.	On lower slopes and alluvial plains	On undulating plains, footslopes or hillslopes
Dominant canopy species¹	Tumbledown Red Gum (<i>Eucalyptus dealbata</i>), Mugga Ironbark (<i>E. sideroxylon</i>), Blakely's Red Gum (<i>E. blakelyi</i>)	White Box (<i>E. albens</i>), Inland Grey Box	Fuzzy Box (<i>E. conica</i>), River Red Gum (<i>E. Camaldulensis</i>)
Main associated canopy species¹	Inland Grey Box (<i>E. microcarpa</i>), Kurrajong (<i>Brachychiton populneus</i>), Red Stringybark (<i>E. macrorhyncha</i>), Hill Oak (<i>Allocasuarina verticillata</i>), Currawang (<i>Acacia doratoxylon</i>)	Kurrajong, Tumbledown Red Gum, Yellow Box (<i>E. melliodora</i>), Bulloak (<i>Allocasuarina luehmanni</i>)	Yellow Box, Poplar Box (<i>E. populnea</i> subsp. <i>bimbi</i>)
Mid-Stratum Species	<i>Acacia hakeoides</i> , <i>A. pycnantha</i> , <i>A. decora</i> , <i>Dodonaea viscosa</i> , Western Boobialla (<i>Myoporum montanum</i>), <i>Pittosporum angustifolium</i> , Silver Cassia	Western Rosewood (<i>Alectryon oleifolius</i>), <i>A. implexa</i> , Native Olive (<i>Notelaea microcarpa</i>), Boobialla (<i>Myoporum montanum</i>), Sticky Wallaby Bush (<i>Beyeria viscosa</i>), Quinine Bush (<i>Alstonia constricta</i>), Wilga (<i>Geijera parviflora</i>)	<i>A. deanei</i> , Wilga (<i>Geijera parviflora</i>), <i>A. implexa</i>
Groundcover Species	<i>Austrodanthonia caespitosa</i> , Kangaroo Grass, Redleg Grass (<i>Bothriochloa macra</i>), Finger Orchids (<i>Caladenia</i> sp.), Greenhoods (<i>Pterostylis</i> sp.) <i>Dichopogon strictus</i> , <i>Hydrocotyle laxiflora</i> , <i>Podolepis jaceoides</i> , <i>Vittadinia cuneata</i> , Rock Fern (<i>Cheilanthes tenuifolia</i>) <i>Lomandra filiformis</i> , Weeping Grass (<i>Microlaena stipoides</i>), Rock Isotome (<i>Isotoma australis</i>), Hoary Guinea-flower (<i>Hibbertia obtusifolia</i>)	Queensland Bluegrass (<i>Dichanthium sericeum</i>), Kangaroo Grass (<i>Themeda australis</i>), Barbed Wire Grass (<i>Cymbopogon refractus</i>), <i>Aristida ramosa</i> , <i>Desmodium brachypodium</i> , Speargrass (<i>Austrostipa scabra</i>), <i>Cyperus gracilis</i> , <i>Glycine tabacina</i> , Corkscrew Grass (<i>Austrostipa setacea</i>)	Speargrass, <i>Aristida ramosa</i> , <i>Lomandra filiformis</i> , <i>Einadia nutans</i> , Windmill Grass (<i>Chloris truncata</i>), <i>Ajuga australis</i> , <i>Crinum flaccidum</i> , <i>Glycine clandestina</i> , <i>Glycine tabacina</i> , <i>Desmodium varians</i> , Slender Bamboo Grass (<i>Austrostipa verticillata</i>), Yanganbil (<i>Austrostipa bigeniculata</i>)
Source: Modified after OzArk (2013a) – Table 14			
Note 1: 50% of all canopy species planted			

The indicative species list includes tree, shrub and grass species and would be refined with experience and the actual species used would be presented in the AEMRs that would be prepared for the Proposal. As noted in Section 2.17.6.1, more specific detail on the exact species mix to be used, and the planting techniques to be implemented, would be provided as the *Rehabilitation Management Plan* component of a MOP to be prepared following receipt of development consent.

The Applicant would undertake a program of collecting seed from native vegetation within and surrounding the DZP Site for use during rehabilitation and enhancement operations. In addition, the Applicant would also undertake revegetation trials to determine the most appropriate mechanism and species mix for rehabilitation within the DZP Site. Details of the trials would be included in the AEMR.

2.17.7 Rehabilitation Management and Monitoring

The Applicant's commitment to effective rehabilitation would involve an ongoing monitoring and maintenance program following completion of mining-related operations. Areas being progressively rehabilitated would be regularly inspected, including during AEMR meetings. During these inspections, the following would be noted.

- Evidence of any erosion or sedimentation from areas with establishing vegetation cover.
- Success of initial cover crop or grass cover establishment.
- Success of tree and shrub plantings.
- Natural regeneration of native species.
- Adequacy of drainage controls.
- General stability of the rehabilitated areas.

Post-mining rehabilitation, remediation and enhancement activities would include but not be limited to the following.

- Where rehabilitation success appears limited, maintenance activities would be initiated. These may include re-seeding and where necessary, re-topsoiling and/or the application of specialised treatments.
- If drainage controls are found to be inadequate for their intended purpose, or compromised by wildlife or native vegetation, these would be replaced.
- Temporary fences would be installed to exclude native fauna, if grazing appears to be excessive.
- In the event areas of excessive erosion and sedimentation are identified, remedial works such as importation of additional fill, subsoil or topsoil material, or redesigning of water management structures would be undertaken.
- Appropriate noxious weed control or eradication methods and programs would be undertaken in consultation with the Department of Primary Industries – NSW Agriculture (DPI-Ag) and / or the local Noxious Weeds Inspector.

No time limit has been placed on post-mining rehabilitation monitoring and maintenance. Rather, maintenance would continue until such time as the objectives outlined in Section 2.17.2 are achieved to the satisfaction of the relevant government agencies.

2.17.8 Biodiversity Offset Strategy

2.17.8.1 Introduction

The DGRs issued on 4 May 2012 required that the Applicant provide:

“a comprehensive offset strategy to ensure the development maintains or improves the terrestrial and aquatic biodiversity values of the region in the medium to long term.”

OzArk (2013) determined there would be some residual impacts on native vegetation as a result of the Proposal and, consequently, adopted the BioBanking Assessment Methodology (BBAM) and BioBanking Credit Calculator (Version 2) to calculate the credits required and the credits available within a proposed Biodiversity Offset Area.

The following subsections provide a summary of:

- the critical features of a *Biodiversity Offset Strategy* (BOS) as required by OEH and DSEWPaC.
- residual impacts on native vegetation as a result of the Proposal and the credits required to offset the impact;
- the proposed Biodiversity Offset Area (BOA) and credits available within that area;
- credit calculation results; and
- proposed strategies.

Following receipt of development consent, the Applicant would prepare a detailed *Biodiversity Management Plan* in consultation with OEH, DP&I, Central West Catchment Management Authority and other relevant government agencies that would provide further details on the implementation of the Plan, e.g. details of the BOS relevant to residual impacts on Matters of National Environmental Significance under the EPBC Act would be referred to DSEWPaC for review and feedback. It is proposed that the Plan would be prepared within 12 months of receipt of development consent.

2.17.8.2 Biodiversity Offset Requirements

NSW Office of Environment and Heritage Requirements

In December 2010, the then Department of Environment, Climate Change and Water (DECCW) issued an interim policy on assessing and offsetting biodiversity impacts of Part 3A developments (DECCW, 2010). This policy was updated in June 2011 to reflect changes to the EP&A Act and include ‘State Significant Development’ assessed under Division 4.1 of the Act

(OEH, 2011²³). This policy seeks to provide a consistent and transparent approach to impact assessment and offsetting for projects assessed under Division 4.1 of the EP&A Act. This policy also provides the basis for aligning NSW and Commonwealth assessment and offsetting processes by providing an assessment pathway that is likely to satisfy both NSW and Commonwealth requirements.

Under this policy, the Applicant is required to:

- describe, quantify and categorise the biodiversity values and impacts of a proposal;
- identify, for benchmarking purposes, the offsetting that would be required to meet, improve or maintain the standard; and
- provide the information for calculating offsets under this policy.

OEH (2011) relies on the ability of an assessment to categorise and quantify the biodiversity values of land to be impacted and that to be used to offset the impacts. The BBAM provides an approved method of completing such categorisation and quantification, establishing benchmark requirements for offsets based on the type, condition and quantum of the biodiversity to be disturbed. BBAM considers biodiversity at either the 'ecosystem' or 'species' level. OEH (2011) requires that the nominated offset strategy be considered against benchmark requirements (generated by BBAM) to determine whether it meets one of the following biodiversity outcomes.

- Improve or maintain. The benchmark offsets nominated by BBAM are achieved.
- No net loss. With the exception that 'red flag' areas, e.g. EECs or threatened flora, are not protected, the benchmark offsets nominated by BBAM are achieved.
- Mitigated net loss. The nominated offset does achieve the benchmark nominated by BBAM, however, a lesser quantum is justified on the basis of other factors.

OEH (2011) acknowledges that it may not be feasible or appropriate to apply the BBAM in all cases. In such cases, the policy states that "*offsets are to be negotiated on a case by case basis and in accordance with DECCW's offsetting principles*". The referenced "DECCW offsetting principles" are those provided in the *Principles for the use of Biodiversity Offsets in NSW* presented as Appendix II of the *Guidelines for Biodiversity Certification of Environmental Planning Instruments – Working Draft* published by the then Department of Environment and Climate Change (DECC, 2007a). DECC (2007a) requires that, in order to adequately compensate for the disturbance, the offset must:

1. address impacts remaining after mitigation or prevention measures have been undertaken;
2. meet all regulatory requirements;
3. never reward ongoing poor performance;
4. complement other government programs such as national parks and reserves;
5. be underpinned by sound ecological principles;

²³ It is noted that the nominated expiry date for the interim policy, June 2012, has passed. No formal policy position from the OEH has been subsequently provided.

6. aim to result in a net improvement in biodiversity over time;
7. be enduring, i.e. they must offset the impact of the development for the period that the impact occurs;
8. be agreed upon prior to the impact occurring;
9. be quantifiable, i.e. the impacts and benefits must be reliably estimated;
10. be targeted, i.e. they must offset the impacts on a “like for like or better” basis;
11. be located appropriately, i.e. they must offset the impact in the same region;
12. be supplementary, i.e. beyond existing requirements and not already funded by another scheme; and
13. be enforceable, i.e. through development consent conditions, licence conditions, covenants or a contract.

Commonwealth Department of Sustainability, Environment, Water, Population and Communities Requirements

DSEWPac recently released an *EPBC Act Offset Assessment Guide* (DSEWPac 2012) that applies to any new referrals and variations to approval conditions from 2 October 2012 and any projects currently under assessment. Offsets are only relevant to EPBC Act approvals declared as a ‘controlled action’. DSEWPac notified the Applicant on 4 January 2013 that the Proposal represents a controlled action based on impacts to the listed threatened species, Pink-tailed Worm-lizard, *Aprasia parapulchella*.

DSEWPac (2012) states that impacts should first be avoided and mitigated and that while both direct and indirect impacts are considered, direct offsets should meet at least 90% of the measureable conservation gain by:

- improving existing habitat;
- creating new habitat;
- reducing threats; and/or
- averting the loss of individuals or its habitat.

DSEWPac (2012) notes that a range of considerations at both the impact and proposed offset site(s) are to be taken into account as follows.

- Matters to be considered at the impact site.
 1. Presence and conservation status of protected matters likely to be impacted by the proposed action.
 2. Specific attributes of the protected matter being impacted at a site, for example: the type of threatened species or ecological community habitat, the quality of habitat, population attributes such as recruitment or mortality, landscape attributes such as habitat connectivity, or heritage values.
 3. Scale and nature of the impacts of the proposed action – including direct and indirect impacts.
 4. Duration of the impact (not of the action).

- Matters to be considered at the offset site.
 1. Extent to which the proposed offset actions correlate to, and adequately compensate for, the impacts on the attributes for the protected matter.
 2. Conservation gain to be achieved by the offset. This may be through positive management activities that improve the viability of the protected matter or averting the future loss, degradation or damage of the protected matter.
 3. Current land tenure of the offset and the proposed method of securing and managing the offset for the life of the impact.
 4. Time it will take to achieve the proposed conservation gain.
 5. Level of certainty that the proposed offset will be successful. In the case of uncertainty, such as using a previously untested conservation technique, a greater variety and/or quantity of offsets may be required to minimise risk.
 6. Suitability of the location of the offset site. In most cases, this will be as close to the impact site as possible. However, if it can be shown that a greater conservation benefit for the impacted protected matter can be achieved by providing an offset further away, then this will be considered.

2.17.8.3 Summary of Impacts

2.17.8.3.1 Ecosystems

As is discussed in Section 4.7.4.1.1, six native vegetation communities have been mapped within the area to be disturbed. This includes a significant area of derived grasslands within community CW213 and accordingly, OzArk (2013) has categorised this community as either:

- CW213 Quality Remnants: >50% native groundcover and / or possesses native mid and upper stratus (and not subject to cropping); or
- CW213 Derived Grasslands: >50% weeds and subject to rotational cropping.

The BBAM was applied to these communities to objectively quantify the ecosystem credits required due to the Proposal.

Table 2.22 provides a summary of the communities and the BBAM results.

2.17.8.3.2 Species

Species credits are created or required for impacts on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates. Species credits are applied where a threatened species has been recorded but not predicted to occur by the BBAM credit calculator (OzArk, 2013a). OzArk (2013a) considered species credits requirements for the threatened fauna species Pink-tailed Worm-lizard, Grey Falcon, Little Pied Bat, Square-tailed Kite and Little Eagle generated by the proposed impacts and provided for in the proposed offset. These can be viewed in *Table 17* of OzArk (2013a).

Table 2.22
Summary Table - Existing Vegetation Ecosystem Credits

Vegetation Community	Impacted Area (ha)	Ecosystem Credits Required	Offset Area Required (Tier 1 / Tier 2) ¹ (ha)
DZP Site			
CW112 Blakely's Red Gum – Yellow Box grassy woodland of NSW South West Slopes Bioregion	0	-	-
CW121 Bulloak – White Cypress Pine woodland mainly in the NSW South West Slopes Bioregion	0	-	-
CW138 Fuzzy Box – Inland Grey Box on alluvial brown loam soils of the NSW South West Slopes Bioregion	0.1	17	1.8 / 2.8
CW143 Heathy Shrublands on rocky outcrops of the western slopes	0	-	-
CW212 White Box – Tumbledown Gum woodland on fine-grained sediments on the Central West slopes	27.1	1 448	155.7 / 241.3
CW213 White Box – White Cypress Pine – Inland Grey Box woodland on the central western slopes of NSW	457.7		
• Quality Remnants	43.7	890	96 / 148
• Derived Grasslands (>50% weeds, rotational cropping)	414	8 010	861 / 1 335
Obley Road			
CW145 Inland Grey Box tall grassy woodland on alluvial loam and clay soils in the South Western Slopes and Riverina Bioregions	1.1	62	6.7 / 10.3
Total	484.9	10 365	1 121.2 / 1 737.4
Note 1: Tier 1 = 9.3 credits per hectare Tier 2 = 6 credits per hectare			
Source: OzArk (2013) – Modified after Table 17			

The following species are considered by OzArk (2013a) to be of particular importance²⁴, each of which are considered “vulnerable” under the respective acts.

- *Aprasia parapulchella* Pink-tailed Worm-lizard (TSC Act, EPBC Act)

Identified by Dr David Goldney in 2000 and Dr Arthur White and OzArk in 2012 to 2013, this species has a very low Tg²⁵ value (0.35) reflecting its poor ability to respond quickly to habitat improvements, hence many credits were generated by this species for offsetting. 1 286 species credits were generated by the proposed impact to 25.5ha of good and 9.8ha of medium quality habitat (including known records of the species) on the DZP Site.

- *Philothea ericifolia* (EPBC Act)

Identified by GCNRC (2002a), the identified population is outside the proposed impact footprint and therefore no species credits are generated.

²⁴ OzArk (2013a) refer to ‘important species’ as those considered truly ‘rare’ or unusual within the Dubbo LGA.

²⁵ The ability of a species to respond to improvement in the site value or other habitat improvement through management actions. The value is based upon the lowest value of effectiveness of management actions scales to the species life history, conservation value etc. Low Tg = very sensitive species (high credits are generated).

2.17.8.4 Proposed Biodiversity Offset

2.17.8.4.1 Biodiversity Offset Area

During the development of the Proposal, and following vegetation surveys to establish the type, condition and coverage of the vegetation communities likely to be disturbed, areas of remnant vegetation to the east of the open cut on Dowds Hill were identified as a possible Biodiversity Offset Area (BOA). Following establishment of a defined impact footprint, additional areas of remnant native vegetation across the DZP Site were identified and added to the proposed Biodiversity Offset Area.

Figure 2.26 illustrates the proposed BOA which is focussed on the conservation of the remnant vegetation of Dowds Hill and linkage of this regionally significant remnant, incorporating areas of remnant vegetation communities, to other significant vegetation or habitat remnants including.

- The remnant vegetation of Wambangalang Creek which itself provides a corridor to the Macquarie River.
- The remnant vegetation within the road easement of Benolong Road to the north. Identified remnants of two endangered ecological communities have also been included within this proposed corridor.
- Important but potentially isolated habitat for the NSW and Commonwealth listed threatened species, Pink-tailed Worm-lizard, to the west, northwest and north of Dowds Hill.

The proposed BOA as presented on **Figure 2.26** is approximately 1 021ha, comprising 653.1ha (64%) native vegetation communities, 306.8ha (30%) associated derived grassland communities and 61.1ha (6%) currently cleared land (without derived native grassland) or white cypress pine monoculture. It is noted that the final BOA may vary slightly from that presented on **Figure 2.26** to account for specific ecological or other features identified during final survey of the areas. For example, the BOA could be enlarged slightly to include a stand of remnant vegetation currently excluded or it could be reduced slightly to accommodate existing fence lines or cleared paddocks. Any modification is unlikely to increase or decrease the size of the BOA as proposed by more than 10ha (<1%) and therefore not impact on the suitability or function of the offset.

2.17.8.4.2 Ecosystem Offsets

Once the all field survey was completed and the DZP impact footprint finalised, the BBAM was applied to the communities within the proposed BOA to objectively quantify the ecosystem credits acquired. **Table 2.23** provides a summary of the communities and the BBAM results.

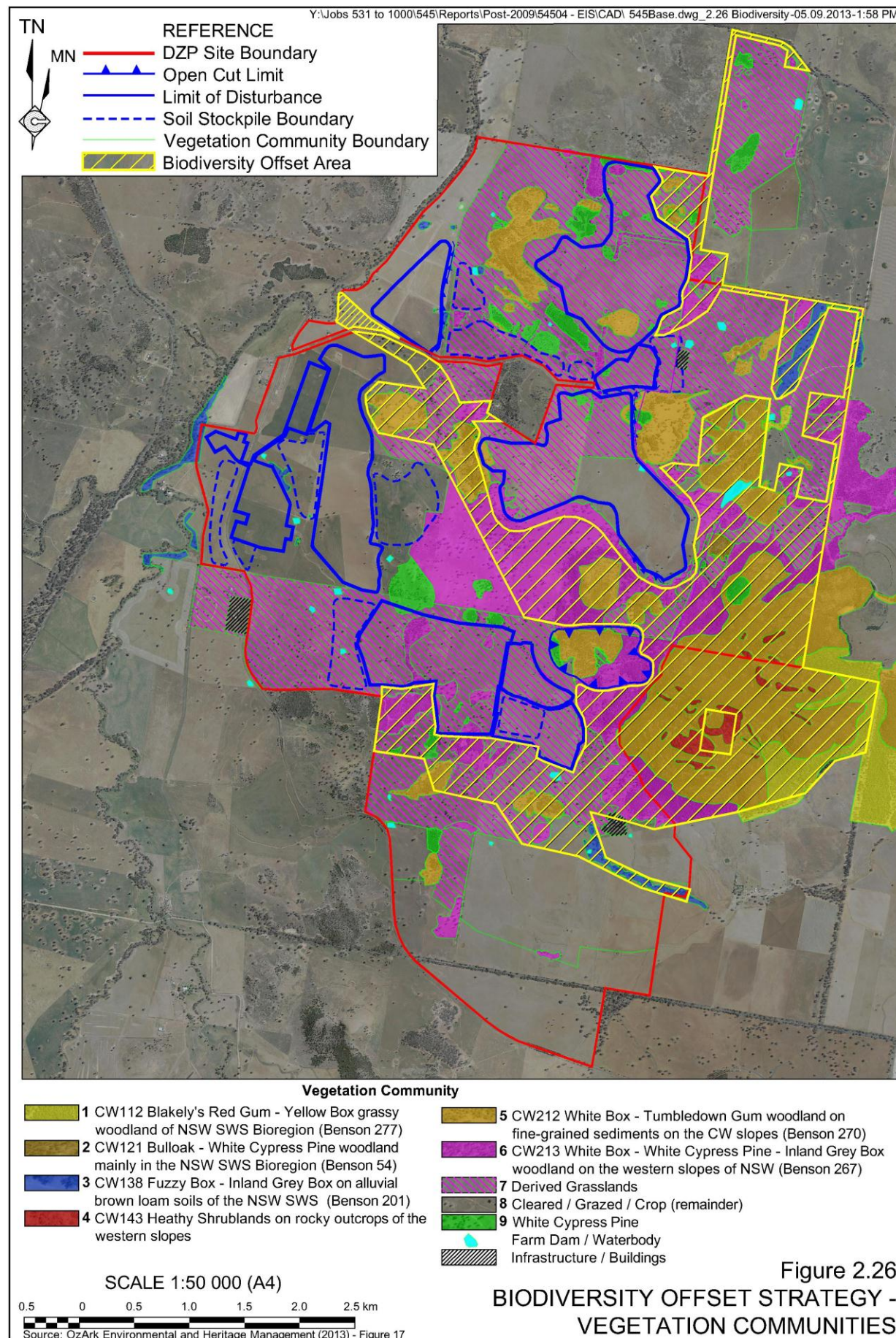


Table 2.23
Summary Table - Biodiversity Offset Area Ecosystem Credits

Vegetation Community	Maximum Available Area (ha)	Ecosystem Credits Generated
CW112 Blakely's Red Gum – Yellow Box grassy woodland of NSW South West Slopes Bioregion	39.2	374
CW121 Bulloak – White Cypress Pine woodland mainly in the NSW South West Slopes Bioregion	3.9	404
CW138 Fuzzy Box – Inland Grey Box on alluvial brown loam soils of the NSW South West Slopes Bioregion	21.9	238
CW143 Heathy Shrublands on rocky outcrops of the western slopes	25.5	237
CW212 White Box – Tumbledown Gum woodland on fine-grained sediments on the Central West slopes	256.1	4 067
CW213 White Box – White Cypress Pine – Inland Grey Box woodland on the western slopes of NSW <ul style="list-style-type: none"> • Quality Remnants • Derived Native Grasslands (>50% weeds, rotational cropping) 	613.3	6 185
CW145 Inland Grey Box tall grassy woodland on alluvial loam and clay soils in the South Western Slopes and Riverina Bioregions	0	0
Cleared Land	61.1	0
Total	1 021	10 490
Source: Modified after OzArk (2013a) – Table 16		

Comparison of the Tier 1 and Tier 2 offset requirements of **Table 2.22** to **Table 2.23**, indicates that a surplus of credits are provided for some communities (CW112, CW121, CW138, CW143 and CW212) while a deficit remains for others (CW213 and CW145).

Section 4.7.6.2.1 (following detailed analysis and justification by OzArk 2013a) demonstrates that the proposed offset provides for an adequate Tier 3 outcome when variation rules are applied.

2.17.8.4.3 Species Offsets

Table 17 of OzArk (2013a) confirms that a surplus of credits for the Little Pied Bat (4 284) and Pink-tailed Worm-lizard (148).

A deficit of 347 credits remain for the following raptor species, Grey Falcon, Little Eagle and Square-tailed Kite. OzArk (2013a) note that a credit deficiency for such species is a common outcome using BBAM because these species all have very large home ranges (50km² to 100km²) and can use a wide range of vegetation communities for feeding, breeding and roosting. The issue is magnified for the Proposal based on the large area of CW213 Derived grassland (>50% weeds, rotationally cropped) which while of not great significance is considered feeding habitat and effectively doubles the offset requirements. A review of the adequacy of the offset in light of these credit deficits is considered in Section 4.7.6.2.1.

With respect to the important species nominated by OzArk (2013a), the proposed BOA provides for the following.

- *Aprasia parapulchella* Pink-tailed Worm-lizard. The conservation and enhancement of 82.3ha of high quality habitat, 42ha of low quality habitat and

114.7ha of medium quality habitat for this species generates 1 434 species credits (a surplus of 148 credits).

The Pink-tailed Worm-lizard has also been identified as a Matter of National Environmental Significance (NES) that could be significantly impacted by the Proposal. Offsetting impacts on this species also consider the *EPBC Act Offset Assessment Guide*, which requires that the proposed offset be considered with respect to the quantity and quality of habitat included, along with the net improvement provided by the management measures proposed by the Applicant. OzArk (2013a) applied the EPBC Act Offsets Policy credit calculator to determine that:

- by applying a condition score to the area to be impacted, the quantum of the impact was 31.8ha;
 - the net present value of the offset is 50.4ha;
 - the percentage of the impact offset would 158.6%; and therefore
 - the direct offsets are adequate.
- *Philotheca ericifolia*. No species credits area required, however, the proposed BOA would include the recorded population of this species (providing for 6 credits).

2.17.8.5 Integrated Land Management Strategies

Management of the BOA would be incorporated into an *Integrated Land Management Plan* (ILMP) for the DZP Site and all lands to be owned by the Applicant. The ILMP would be prepared using the standard format and template as presented in the *Guide to Establishing a Biodiversity Offset Area*. Appendix 17 of OzArk (2013a) provides a detailed outline of the standard and additional management actions to be defined within the ILMP following approval of the Proposal and confirmation of the BOA.

The standard management actions would be as follows.

- Management of grazing for conservation.
- Weed control.
- Management of fire for conservation.
- Management of human disturbance.
- Retention of regrowth and remnant native vegetation.
- Replanting or supplementary planting where natural regeneration would not be sufficient.
- Retention of dead timber, particularly hollow logs.
- Erosion control.
- Retention of surface rocks.

Additional management actions are as follows.

- Cat and/or fox control (all vegetation types).
- Exclusion of miscellaneous feral species, in particular feral pigs (all vegetation types).
- Feral and/or native herbivore control/exclusion (e.g. rabbits, goats, etc.) (all vegetation types).
- Thinning of cypress pine regrowth in accordance with “*Some observations of the benefits of thinning cypress stands and discussion of management options for western forests and woodlands*” (Cameron 1999) (Woodland Vegetation).
- Preparation of an integrated weed management strategy (all vegetation types).
- Creation of surrogate habitats for Pink-tailed Worm-lizard through relocation of surface rocks and/or placement of roof tiles (density of 1m to 4m spacing) (grassland or open woodland on trachyte formations)
- Strategic replanting of a diverse range of species to boost species richness.
- Site preparation and planting of local provenance species in all of the overstorey, mid-storey, shrub and ground layers.
- Introduction of hollow logs from the adjoining disturbance areas.

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