Section 2

Description of the Proposal

PREAMBLE

This section describes the proposed Dubbo Zirconia Project including:

- *the objectives of the Proposal;*
- *an overview of the Proposal and the approvals required;*
- *the infrastructure that would be established and/or relocated;*
- *the site preparation that would be undertaken;*
- *the proposed mining and processing operations and management of waste rock and processing residue;*
- *ancillary activities that would be undertaken; and*
- *the proposed rehabilitation of the areas that would be disturbed throughout the life of the Proposal, including the re-establishment of native vegetation communities and agricultural land, and development and implementation of a Biodiversity Offset Strategy.*

The Proposal is described in sufficient detail to provide the reader with an overall understanding of the nature and extent of the activities proposed, how the various activities would be undertaken and to enable an assessment of the potential impacts on the surrounding environment. The boundaries and dimensions of the various components described throughout this section are indicative only.

Details of the safeguards and management measures that the Applicant proposes to implement to minimise or negate the potential impacts on components of the surrounding environment are provided in Section 4 of this document.

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2.1 INTRODUCTION

2.1.1 Project Objectives

The principal objectives of the Proposal are to:

- maximise the recovery of the rare metals and REEs contained within the Toongi ore body through efficient mining and processing operations;
- minimise the consumption of water, power and chemical reagents required by the processing operations;
- ensure that the waste by-products of the processing operations are managed to minimise the risk of pollution (short-term impact) or contamination (long-term impact), as well as minimise the impact footprint required to manage these;
- implement continual improvement such that the quality and quantity of waste generated by the processing operations is continually reviewed and modified to minimise consumption and waste generation;
- establish, re-establish and/or upgrade local/regional infrastructure for the purposes of the Proposal but which could also have beneficial uses for other industry/activities;
- undertake all activities in an environmentally responsible manner to ensure compliance with relevant criteria/goals or reasonable community expectations;
- provide a stimulus to the economy of the Dubbo Local Government Area (LGA) and surrounds through employment opportunities and supply of services required for the development and operation of the Proposal;
- work cooperatively with the surrounding community to build socio-economic capacity within communities influenced by the Proposal; and
- achieve the above objectives in a cost-effective manner to ensure security of employment, the continued economic viability of the Applicant and ultimately a return on investment for shareholders.

2.1.2 Project Overview

2.1.2.1 Component Areas

As discussed in Section 1.1, the Proposal incorporates four component areas, namely:

- the DZP Site;
- Toongi-Dubbo Rail Line and Natural Gas Pipeline Corridor;
- Macquarie River Water Pipeline corridor; and
- public road network (Toongi Road and Obley Road).

It is noted that an additional component of the Proposal would be the construction of an electricity transmission line (ETL) to supply power to the DZP Site which is to be assessed separately under Part 5 of the EP&A Act by the energy provider, Essential Energy.

The following sections provide an overview of the operations of each of these component areas.

2.1.2.2 DZP Site

Figure 2.1 provides the proposed indicative layout of the DZP Site and the following provides an overview of the various activities to be undertaken.

- Ore would be mined by standard drill and blast, load and haul methods from a shallow Open Cut developed to a maximum depth of 32m below natural ground level (355m AHD) (remaining above the groundwater table).
- Waste rock from the margins of the ore body would be transferred to a small Waste Rock Emplacement (WRE) to the southwest of the open cut.
- The ore would be hauled to a Run-of-Mine (ROM) Pad where it would be crushed and ground before being transferred to the processing operations of the Processing Plant Area, located to the immediate east of the Toongi-Dubbo Rail Line (see Section 2.1.2.3), for the separation of the rare metals and REEs.
- A rail siding would be constructed as a spur from the Toongi-Dubbo Rail Line along with a Rail Container Laydown and Storage Area for the unloading and temporary storage of reagents and loading of products for despatch.
- Solid residues produced by the processing of the ore would be neutralised with crushed and washed limestone and transported on a conveyor to a Solid Residue Storage Facility (SRSF).
- Water used in the processing operations which cannot be recycled would be pumped to a Liquid Residue Storage Facility (LRSF), comprising a series of terraced salt crystallization cells within four separate areas of the DZP Site.
- Salt which accumulates within the LRSF (approximately 6.7Mt over the life of the Proposal) would be periodically excavated from the salt crystallization cells and disposed of within a series of Salt Encapsulation Cells adjoining the WRE and SRSF.
- Other features of the DZP Site illustrated on **Figure 2.1** and critical to the development and operation of the Proposal include:
  - DZP Site Administration Area;
  - Mine Haul Road;
  - contractor management area; and
  - soil stockpile areas.

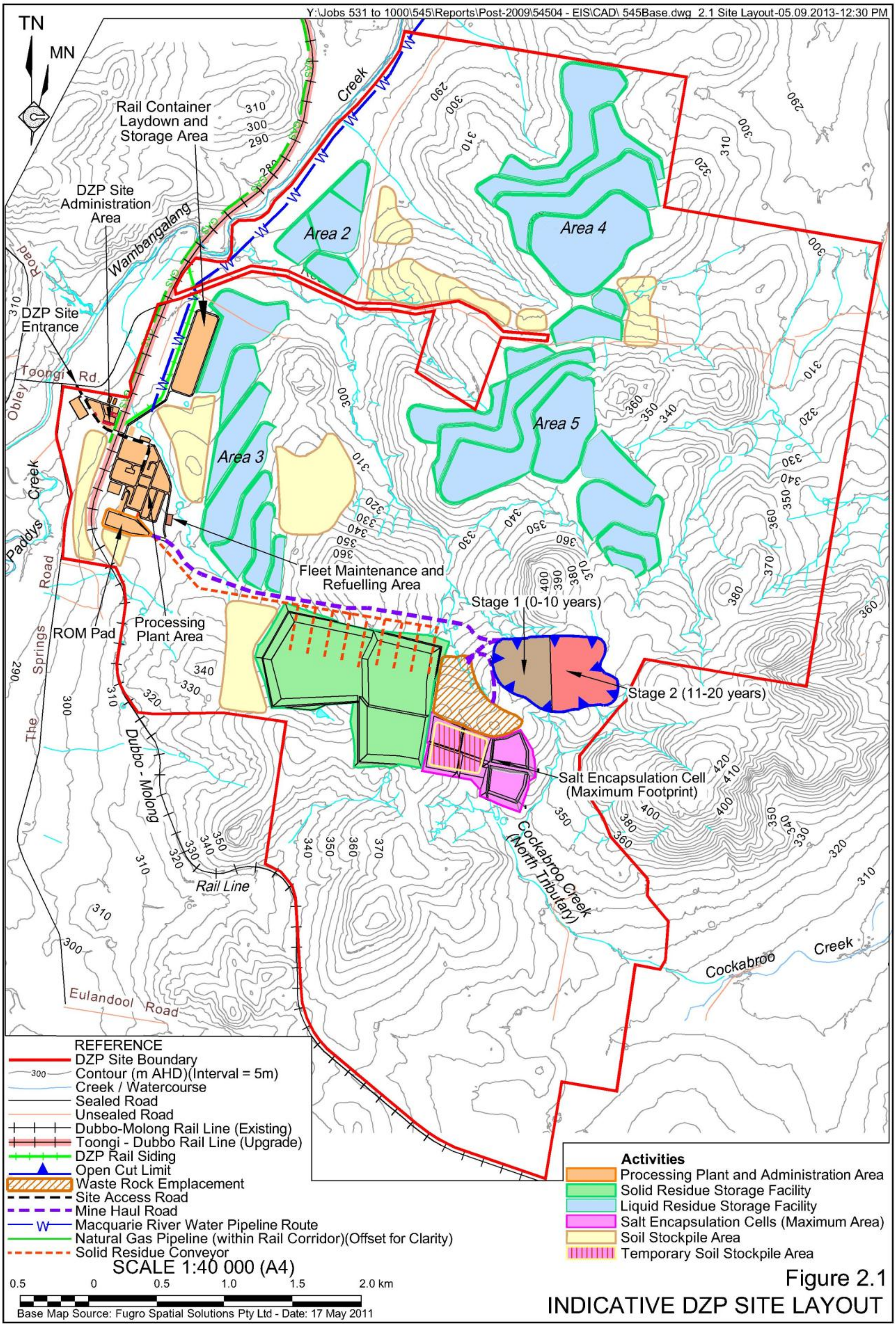

Figure 2.1
INDICATIVE DZP SITE LAYOUT

The nature of the Proposal requires that the majority of the areas to be disturbed remain operational for the life of the Proposal. As a consequence, the ability to progressively rehabilitate the DZP Site would be limited to features such as the WRE and outer embankments of the RSFs and Salt Encapsulation Cells. While progressive rehabilitation of the DZP Site would be restricted, the Applicant has designed and would implement a *Biodiversity Offset Strategy* (BOS) which would include preservation of areas of remnant native vegetation in good condition (requiring minor maintenance measures such as weed control and feral pest management) and enhancement of areas in moderate to low condition (requiring more intensive management such as weed and exotic species eradication, supplementary planting and habitat creation). Further detail of the proposed BOS is provided in Section 2.17.8 and **Figure 2.23**.

2.1.2.3 Toongi-Dubbo Rail and Natural Gas Pipeline Corridor

The processing operations require significant volumes of chemical reagents and other raw materials. While significant volumes of these reagents and materials would be delivered by road, the Applicant has identified the upgrade and use of the Toongi to Dubbo section of the currently disused Dubbo-Molong Rail Line as an opportunity to reduce the volume of traffic on the public road network.

Figure 2.2 provides the proposed alignment of the Toongi-Dubbo Rail Line, the key features of which are as follows.

- Upgrade of the Toongi to Dubbo section of the Dubbo-Molong Rail Line to a Class 1 track (92t gross/67t pay load capacity).
- Replace or upgrade steel bridges, culvert structures and timber bridges. Notably, the main Macquarie River Bridge requires only maintenance work to two of the 25 spans in order to accommodate the proposed re-opening of the rail line.
- Re-instatement, civil works and installation back to the required standard at each of the 26 level crossings between the Dubbo East Junction on the Main Line and the proposed DZP Rail Siding. Of the 26 crossings:
  - seven are major crossings (of local roads), four of which occur in Dubbo (Wingewarra Street, Cobra Street, Boundary Road and Macquarie Street) and three between the Macquarie River and the proposed DZP Rail Siding (Cumboogle, Glengarra and Toongi); whilst
  - the remaining 19 vary from farm access points to livestock crossings, with retained access to be negotiated with John Holland Rail (who are responsible for the maintenance and operation of the line under contract to Country Rail Contracts of Transport for NSW).

Section 2.2.4 provides further detail on the proposed upgrade of the rail line and Section 2.12.3 discusses the proposed management of rail transport operations. The timing for the re-opening of the Toongi-Dubbo Rail Line in relation to the commencement of operations remains to be confirmed. While it would be the preference of the Applicant to incorporate rail transportation from the commencement of operations, consideration of various logistical, operational and economic factors indicates that it would be at least five years (approximately 2020) before this would be feasible. In recognition of this, the EIS considers the impacts of the Proposal with and without operating Toongi-Dubbo Rail Line.

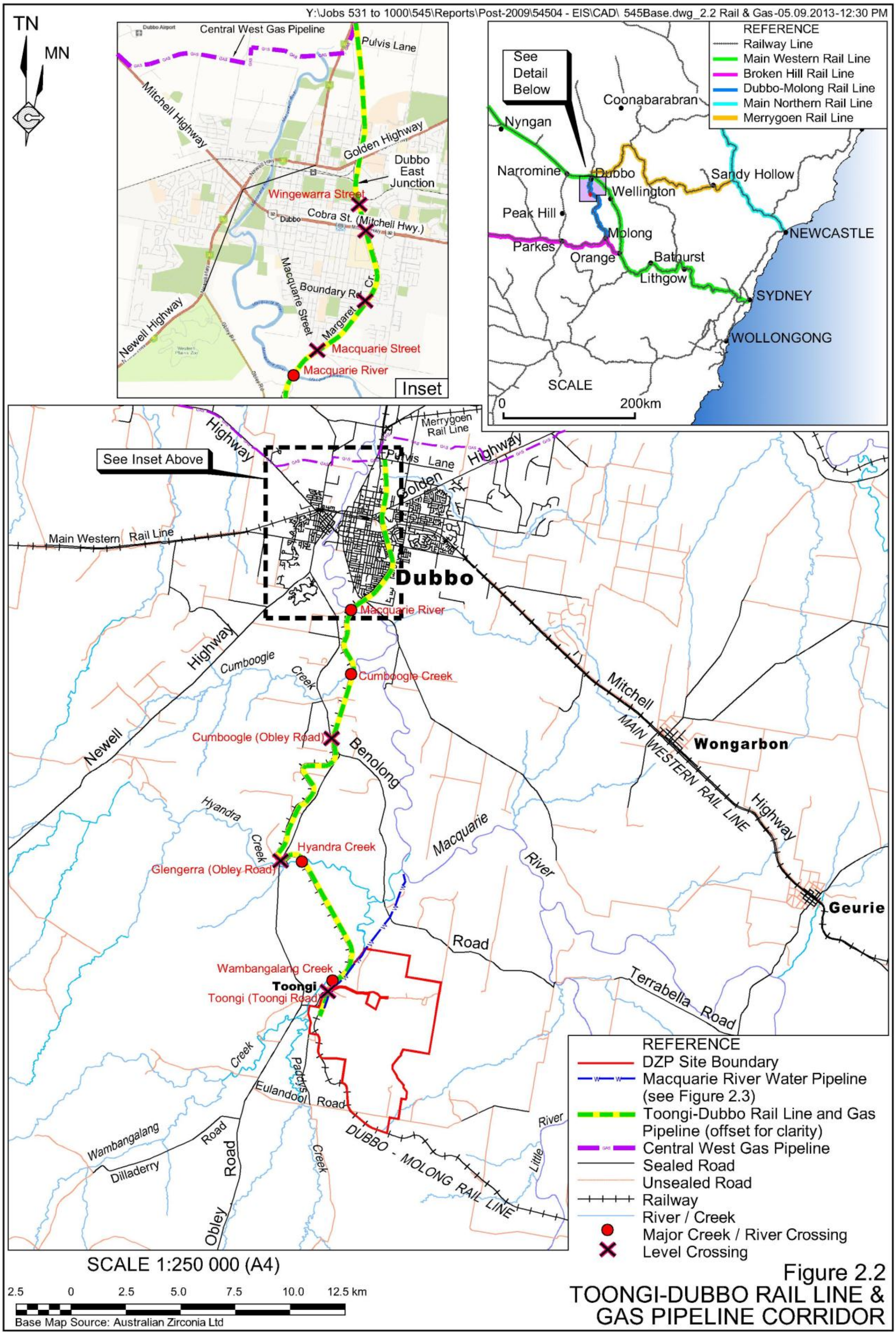

Figure 2.2
TOONGI-DUBBO RAIL LINE & GAS PIPELINE CORRIDOR

Figure 2.2 also identifies the proposed natural gas pipeline between the Central West Pipeline (of APA Group) at Purvis Lane, Dubbo, and the DZP Site which would deliver up to 970TJ/year[1] of natural gas for the heating of various circuits within the processing plant.

2.1.2.4 Macquarie River Water Pipeline Corridor

Processing operations would require up to 4.05GL of water annually which would be sourced (partially or completely) from the Macquarie River (under licence) and transferred to the DZP Site by pipeline.

Figure 2.3 provides the proposed alignment of the Macquarie River Water Pipeline, the key features of which are as follows.

- A pumping station which incorporates a dual water inlet, wet well and vertical mounted axial flow pump configuration.
- A 400mm to 450mm diameter HDPE pipeline within an embedded trench.

Section 2.2.2 provides further detail on the proposed design and installation of the pipeline and associated infrastructure. Section 2.13.2.5 discusses the proposed management of the delivery of this water.

2.1.2.5 Public Road Network

As noted in Section 2.1.2.3, significant quantities of the processing reagents and other raw materials would be delivered by road, via the Newell Highway, Obley Road and Toongi Road. Section 2.2.5 provides further detail on the proposed modifications to these roads and Section 2.12.4 discusses the proposed management of road transport operations.

2.1.3 Approvals Required

The Proposal would require development approval from the Minister for Planning and Infrastructure under Division 4.1 of the *Environmental Planning and Assessment Act 1979*. In addition, the following licences, leases, permits, agreements and approvals would be required to allow commencement of the Proposal.

1. An Environment Protection Licence issued by the Environment Protection Authority (EPA) under Section 47 of the *Protection of the Environment Operations Act 1997*.
2. A Mining Lease issued by the Department of Trade and Investment, Regional Services and Infrastructure – Division of Resources and Energy (DRE) under the *Mining Act 1992*. The Applicant currently holds Exploration Licence (EL) 5548 over the DZP Site and will submit a Mining Lease Application (MLA) encompassing the proposed activities/operation of the DZP Site.

[1] Current estimates of natural gas requirements are for 461TJ/year.

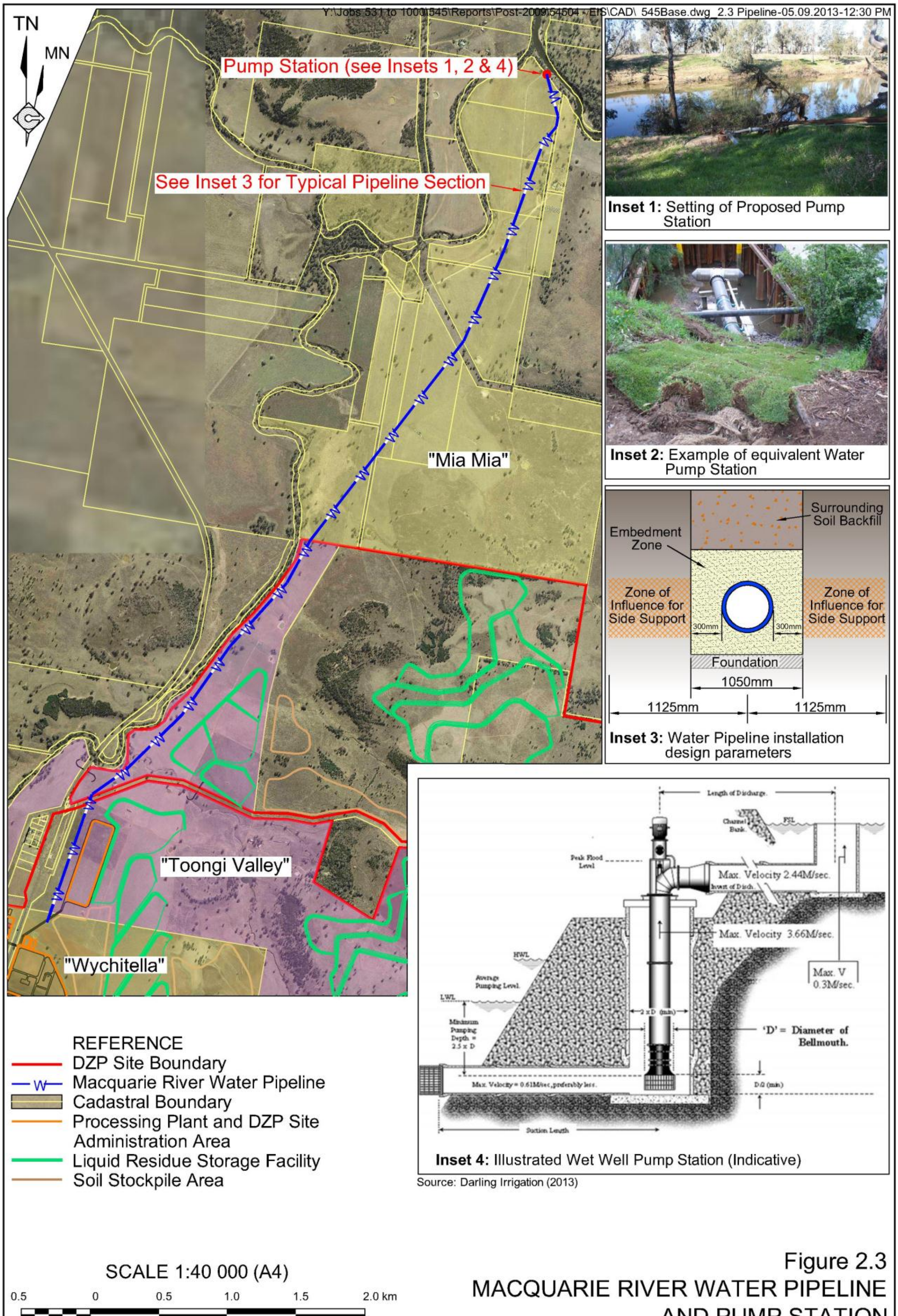

Figure 2.3
MACQUARIE RIVER WATER PIPELINE AND PUMP STATION

3. Water Supply Works and Use Approvals issued by the NSW Office of Water (NOW) in accordance with Section 92 of the *Water Management Act 2000* for the construction and use of any proposed water extraction source(s), e.g. pump accessing river water, bore accessing groundwater[2].
4. *Water Access Licences* (WALs) issued by NOW under the *Water Management Act 2000* would be required to provide for and nominate the annual volume of water that can be drawn from the approved Water Supply Work for the Approved Water Use (see 3 above). The WAL and allocation must comply with the rules of the relevant Water Sharing Plan, e.g. the *Water Sharing Plan for the Macquarie and Cudgegong Regulated Rivers Water Source*.
5. Controlled Activity Approvals (CAAs) issued by NOW under the *Water Management Act 2000* are required for any works carried out in or within 40m of a river, lake or estuary (as defined by the Dictionary of the WM Act)[1].
6. One or more Section 138 Permits, issued by the Dubbo City Council under the *Roads Act 1993*, for all works (as described by Section 138 of the *Roads Act 1993*) affecting classified roads, namely:
   - Obley Road; and
   - Toongi Road.
7. A licence agreement between John Holland Rail (JHR) and the Applicant to upgrade the Toongi to Dubbo section of the Dubbo-Molong Rail Line.
8. A licence issued in accordance with Part 3 of the *Pipelines Act 1967* for the construction and operation of the proposed natural gas pipeline[1].
9. An approval from the NSW Dams Safety Committee for the design and construction of the solid and liquid residue storage facilities.
10. A Licence issued by Workcover Authority of New South Wales for the storage and use of explosives and other dangerous goods within the DZP Site. This licence is typically only granted after DRE approves a *Security Plan* for the storage and handling of explosives (including explosive precursors).

Additionally, the Proposal will require approval from the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities (DSEWPaC) in relation to impacts on matters protected by the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The need for an approval under the EPBC Act was established following the referral of the Proposal to DSEWPaC (8 November 2012) which subsequently determined it to be a Controlled Action on the basis of potential impacts on threatened species (4 January 2013). DSEWPaC has indicated that assessment of the Proposal will be undertaken bi-laterally with the NSW State Significant Development assessment process being undertaken by DP&I.

[2] By virtue of Section 89K of the EP&A Act, such an authorisation or approval cannot be refused if it is necessary for carrying out State Significant Development that is authorised by, and substantially consistent with a development consent under Division 4.1.

2.1.4 Geurie Limestone Quarry

The Applicant is developing a proposal for a limestone quarry near Geurie, approximately 22km east of the DZP Site (see **Figure 1.1**), and plans on making a separate application to Wellington Shire Council during 2014. Acknowledging that supply of limestone from this source cannot be guaranteed, as there is currently no approved quarry operation in this location, the assessment of impacts associated with the transportation of limestone consider both supply from this source (delivered via the Mitchell Highway and Newell Highway) as well as an established source of limestone at Parkes (delivered via the Newell Highway) (refer to Section 2.7.4).

2.2 DZP SITE AND EXTERNAL INFRASTRUCTURE ESTABLISHMENT

2.2.1 Introduction

In order for mining, processing and product transportation to be undertaken on the DZP Site, various infrastructure and other site features would be required to be established. The various site establishment activities described in the following subsections are as follows.

- The Macquarie River Water Pipeline (Section 2.2.2).
- The natural gas pipeline within the Toongi-Dubbo Rail and Gas Pipeline Corridor (Section 2.2.3).
- The Toongi-Dubbo Rail Line (Section 2.2.4).
- Upgrades to the public road network (Section 2.2.5).
- The DZP Site Entrance and Access Road (Section 2.2.6).
- Electricity Transmission Line and infrastructure (Section 2.2.7).

Site establishment would also include the construction of various infrastructure and facilities associated with processing operations (Section 2.6), processing residue management and storage (Section 2.9), other site facilities and services (Section 2.13). The infrastructure and facilities associated with these activities are included in the relevant referenced subsections.

The site establishment phase, i.e. from commencement to completion of all DZP Site infrastructure and facilities, is anticipated to take between 18 months and 2 years although it is noted that mining and processing would be undertaken concurrently for a period towards the end of the site establishment phase (as ore feedstock would be necessary for plant commissioning).

2.2.2 Macquarie River Water Pipeline

2.2.2.1 Water Supply Pipeline

The alignment of the water pipeline would traverse three properties, namely "Whychitella"[3], "Toongi Valley"[3] and "Mia Mia"[4], as illustrated on **Figure 2.3**.

"Whychitella" property

- Contains the discharge end of the water pipeline and Process Water Pond.

"Toongi Valley" property

- Northward from the Process Water Pond adjacent to the Toongi-Dubbo Rail Line, traversing Toongi Road.
- North-northeast beyond Toongi Road adjacent to Wambangalang Creek.

"Mia Mia" property

- Diverging from Wambangalang Creek, north-northeast, traversing an unformed road reserve and then Benolong Road.
- From Benolong Road, a slight northerly re-alignment, traversing several unformed road reserves before arriving at the Macquarie River on Lot 4 DP 753220 (at the existing "Mia Mia" property river pumping location) (see **Inset 1** of **Figure 2.3**).

An easement approximately 20m wide would be created the entire length of the pipeline and appropriate arrangements would be made with Dubbo City Council and DPI-C&L in relation to the placement of the pipeline below Toongi and Benolong Roads (and the unformed road reserves).

The water pipeline would be constructed using 20m lengths of 400mm to 450mm external diameter HDPE pipe[5]. All joins in the pipeline would be butt fusion welded and tests would be undertaken to ensure the integrity of each join before it is buried. The pipeline would be laid within a trench in accordance with the trench dimension and installation specifications provided by *AS/NZ 2566.2:2002 Buried Flexible Pipelines – Installation* (Standards Australia, 2002). **Inset 3** of **Figure 2.3** provides the minimum dimensions of the trench within which the pipeline would be laid. With the exception of each end of the pipeline and any valves that may be constructed along the pipeline route (initial design provides for five air valve, four scour valve and two to three isolation valve assemblies), the pipeline would be buried within a trench below surface.

As illustrated on **Figure 2.3**, the trench would be approximately 1.5m deep and 1.05m wide and would be excavated using trenchers, mini-excavators and/or backhoes. A small bulldozer, grader, ute-mounted HDPE welder and service truck (carrying pipeline lengths) would also be used during pipeline installation. All equipment would be selected to minimise the disturbance

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[3] The Applicant holds a call option to purchase the "Whychitella" and "Toongi Valley" properties should development consent be granted.

[4] The Applicant has negotiated with the owner of "Mia Mia" for access across this property as illustrated on **Figure 2.3**.

[5] AS/NZS 4130 Class 8.

footprint of the trench construction. With the exception of small sections in the vicinity of joins in the pipe, generally no more than 200m of the excavation would be open and unprotected at any one time. In the vicinity of joins in the pipe, small sections of the excavation would remain open to permit pressure testing of all joins in the pipe prior to commissioning of the pipeline. While this is occurring, all open sections of the trench would be fenced to prevent any unauthorised or accidental access by persons, livestock or native fauna and appropriately signposted. Once pressure testing is complete, the open sections of the trench would be backfilled and the area of disturbance rehabilitated as soon as practicable. Should other sections of the excavation be required to be left open for any purpose, they would also be fenced and signposted.

It is noted that the proposed water pipeline would cross beneath several unsealed local roads (Toongi Road and Benolong Road). While the preference would be for these roads to be temporarily closed or diverted around the construction zone during pipeline installation (with Dubbo City Council to be consulted prior to the commencement of installation), the Applicant could install the pipeline using horizontal drilling techniques (under-boring). This would be undertaken using a drill rig within a shallow excavation, at an appropriate set back, drilling near horizontally under the road (or rail or drainage line). The resulting drill hole would be cased to allow later placement of the water supply pipeline.

In addition, the proposed water pipeline would cross several ephemeral drainage lines which flow into Wambangalang Creek. The pipeline would be installed across these drainage lines by trench excavation during periods of no flow within the channels and in accordance with the Department of Primary Industries – NSW Office of Water guideline: *Controlled Activities On Waterfront Land Guidelines for laying pipes and cables in watercourses on waterfront land* (NOW, 2012)

2.2.2.2 Pumping Infrastructure

A conceptual design for the proposed pumping infrastructure has been prepared for the Proposal, based on an annual water requirement of 4.05GL, by Darling Irrigation (2013) (see **Appendix 5**) which considered the following design criteria.

1. Efficient point of uptake.
2. High reliability and a strong contingency in the case of equipment failure.
3. Ease of maintenance and efficient operating costs.
4. Environmental controls to minimise potential impact on fish and other aquatic biota.
5. Minimal sound and visual emissions for local landholders and recreational river users.
6. Cost effectiveness.

Inset 2 of **Figure 2.3** presents an example of an operating water pumping station equivalent to that to be constructed for the Proposal and **Inset 4** of **Figure 2.3** presents the conceptual design of a dual vertically mounted axial flow pump / wet well configuration which best satisfies these design criteria. A summary of the critical design features is as follows.

- The water inlets from the river would be at an elevation representing the lowest water level recorded in the past 20 years, i.e. approximately 1.5m below the surveyed water level on the day of the site inspection by Darling Irrigation. A low-suction velocity fish diversion screen, specifically designed to protect fish and other aquatic life, would be installed.
- Water from the inlets would be drawn from the river through to the wet wells via a horizontal suction line of at least 600mm in diameter. The wet well would be between 800mm and 1200mm in diameter to facilitate ease of pump removal. The wet end of the pump is 362mm in diameter in the concept design. The intake or 'bellmouth' of the vertical suction line within the wet well would also be fitted with a fish diversion screen.
- Water would be drawn from the wet wells to the pipeline by the pump motors located above the 1 in 100 year flood level, approximately 11.5m above the low water level elevation of the inlet valve.
- A small enclosure would be constructed around the motors, which would also house the variable speed motor controllers, to attenuate noise. The enclosure would be approximately 5m x 6m, adequate to enclose two adjoining wet wells, and constructed of Hebel panel or Coolroom style cladding. The roof is removable to allow a crane easy access to the pumps in order to remove for maintenance purposes. The enclosure and pump infrastructure would be constructed over a concrete foundation slab.

Construction and installation of the wet wells and pumping infrastructure would require the construction of a temporary dam within the Macquarie River channel of approximately 5m x 10m within which a drill rig or auger would be placed to bore a horizontal hole for the installation of an intake pipe. From the top of the bank, a void to intersect the horizontal pipeline would be excavated within which the wet wells and pumps would be placed. The area required for this excavation would not be greater than 50m x 50m, i.e. 2 500m^2. An assessment of the vegetation likely to be disturbed and potential impacts is provided in Section 4.7.6.3.

The location of the proposed pumping infrastructure would not be visible from vantage points on the "Mia Mia" property with no infrastructure visible in the water or up the river bank. Impacts on local visual amenity would be limited to power poles and lines proposed within the easement and a small enclosure to house the pump infrastructure which would be visible from the river and far bank only.

2.2.3 Natural Gas Pipeline

It is noted that Clause 53 of State Environmental Planning Policy (Infrastructure) 2007 ("the Infrastructure SEPP") states '"*Development for the purpose of a pipeline may be carried out by any person without consent on any land if the pipeline is subject to a licence under the*

Pipelines Act 1967 or a licence or authorisation under the Gas Supply Act 1996". It is further noted that Section 89K of the EP&A Act states that the granting of such a licence cannot be refused if it is necessary for carrying out State Significant Development that is authorised by a development consent and is to be substantially consistent with the consent. The level of detail provided in this section is therefore tailored to allow for the relevant authority to assess a subsequent application for licence (under Part 3 of the *Pipelines Act 1967*) as substantially consistent with any development consent issued for the Proposal.

The natural gas pipeline is proposed between the Central West Pipeline (operated by APA Group) Purvis Lane, Dubbo and the DZP Site. The pipeline would be developed as a spur line approximately 30km in length located within the easement of the Main Western Rail Line and Dubbo-Molong Rail Line (see **Figure 2.2**). The pipeline would require several public road crossings, property access road crossings, as well as crossings of the Macquarie River, Cumboogle Creek, Hyandra Creek and Wambangalang Creek.

The gas pipeline would be required to supply up to 970TJ/year and a maximum daily quantity of 3 300GJ/day of natural gas. Based on a natural gas energy content of 53.6MJ/kg the mass flow requirements would be approximately 2 565kg/hr with a minimum delivery pressure of 1 540kPa. To meet these supply requirements, a polyurethane or fibreglass pipeline with a diameter of 100mm would be required.

The construction and installation of the pipeline would be undertaken in accordance with all relevant codes and Australian Standards, including the AS2885 Pipelines - Gas and Liquid Petroleum series and the Australian Pipeline Industry Association (APIA) *Code of Environmental Practice 2005*.

General pipeline construction and installation activities would include the following.

- Surveying and marking of the pipeline corridor and any areas of environmental or safety significance required to be avoided. If required, temporary high visibility fencing would be erected.
- Clearing of any brush or shrubby vegetation above the areas to be trenched. If required, any unsafe working surfaces would also be graded.
- Trenching to a minimum depth of 750mm below the ground surface and, where required, placement of bedding material (such as sand or finer materials recovered during trenching) to provide a suitable base that won't damage the pipe. Soil material would be placed adjacent to the trench keeping the topsoil and subsoil material separate.
- Transportation of pipe lengths (approximately 20m long), laying of pipe lengths end to end ('stringing') beside the trench on raised timber skids, joining of pipes and lowering into the trench.
- Backfilling of soil material in the reverse order of removal, i.e. subsoil then topsoil and, where required, seeding of a stabilising cover crop to protect the soil surface from erosion.
- Testing of the pipeline integrity through hydrostatic methods (i.e. leak testing through pressurisation with water).
- Removal of the water used in hydrostatic testing via tanker and drying of pipeline.

Any necessary marker signage for buried pipelines would also be installed in accordance with the relevant Australian Standards.

Construction and installation of the pipeline would require a disturbance area of approximately 5m wide although temporary work and access areas adjacent to the corridor would also be required in some areas including road and watercourse crossings. Road crossings would involve horizontal drilling from an enlarged trench area beside the road and boring beneath the road (under-boring). Unsealed roads and tracks may alternatively be trenched, backfilled and compacted to required road standards.

Similarly, dry or shallow flow watercourse crossings would be trenched, the pipeline placed and the trench immediately backfilled. If required, upstream water would be temporarily dammed, such as through the use of sandbags, and pumped around the section to be trenched. The area to be trenched may also require ‘dewatering’ using strategically located sumps.

In the event that the creation of an enlarged trench is not feasible, horizontal directional drilling may be used. This method would involve drilling a hole at a shallow angle beneath the surface and pulling the pipe through. A drill pad may be required to be formed for the drill rig and a sump for the drill cuttings and drilling mud may be required at the entry and exit points. Any trenches or sumps required for under-boring or horizontal directional drilling would be backfilled following installation of the pipeline.

Like the water pipeline, generally no more than 200m of trench would be open and unprotected at any one time. Any sections of trench required to be left open and unattended would be fenced to prevent any unauthorised or accidental access. Equipment used during construction would also be similar to the water pipeline and include trenchers, mini-excavators and/or backhoes, a small bulldozer, boring machine / drill rig, grader and service trucks for delivery of pipe lengths and equipment.

Construction would occur over an approximately 2 month period pending weather conditions.

2.2.4 Toongi-Dubbo Rail Line and Rail Infrastructure

2.2.4.1 Introduction

The DZP Site adjoins the now disused Dubbo-Molong Rail Line. Given the bulk nature of many of the reagents required for the proposed processing operations (refer to Sections 2.6 and 2.7), the Applicant has identified the potential to reduce the volume of heavy vehicle movements on the roads of NSW by utilising this infrastructure. Whilst the Dubbo-Molong Rail Line is still technically an open rail line, it has not been operated since 1987[6] and has fallen into disrepair. Significant upgrade, and in most sections, complete reconstruction is required before the rail line could be used for the purposes of reagent delivery.

The following subsections provide information on:

- the rail line classification proposed and design features of this classification;
- the rail bridges to be upgraded or reconstructed and proposed works;

[6] A small section of the line remained open beyond the Dubbo East Junction interchange as a connection to the main line until January 1988

- the level crossings between the DZP Site at Toongi and the Dubbo Triangle where the Dubbo-Molong Rail Line joins the Main Western and Newcastle Rail Lines and proposed works; and
- upgrades to signalling within Dubbo to maximise the efficiency of rail movements through Dubbo.

2.2.4.2 Rail Line Classification, Design and Construction

The Applicant proposes to upgrade the rail line between Dubbo East Junction (see **Figure 2.2**) from Class 5 to Class 1 to allow for the mean gross wagon weight which can be carried by the line to be increased from 76t to 92t.

The line alignment would not deviate from the existing, with existing level and waterway crossings having been identified, inspected and upgrade requirements nominated (see Sections 2.2.4.3 and 2.2.4.4).

The following provides relevant information drawn from the concept design and cost estimate prepared for Toongi-Dubbo Rail Line by CR Rail (2012).

- Strip and reclaim existing track. All existing rails, turnouts and sleepers would be reclaimed and stacked inside the rail corridor by front-end loader for removal by road registered truck.
- Supply and delivery of the rail line in 530kg/110m length rail sections, the minimum size of rail required to obtain a Class 1 track, to the Dubbo East Junction end of the line. The rail sections would be sequentially laid down (from Dubbo East Junction to Toongi) and installed. A front-end loader would likely be used to move the rail sections into place for installation.
- Rail installation. The 110m rail sections would be installed at an average rate of 10 sections per day. It has been calculated that 491 rail sections would be delivered and installed.
- Continuous Welded Rail (CWR). Once the rails are installed, they would be welded to remove any joints in the track. This process, when correctly installed, reduces the risk of track breakaways and misalignments. CWR also reduces noise emissions (the ‘click-clack’ synonymous with rail operation). CWR creep pegs, sourced from the reclaimed 80lb (~36kg) rail, would be installed every 500m along each side of the corridor to monitor longitudinal rail movements.
- Sleeper supply, delivery and installation. Two types of steel sleepers would be installed.
  - i) Standard 53kg steel sleepers would be installed on the open track.
  - ii) Insulated 53kg steel sleepers would be installed within signalling areas around level crossings and turnouts that have electrical switches.
- All sleepers would be delivered by semi-trailer, unloaded and laid out in their required track sections using front-end loaders. All sleepers would be installed, on average 800 per day, using the side insertion technique. In total, approximately 45 000 sleepers would be installed.

- Turnout supply and construction. A requirement of the NSW State government, the owner of the main running line (Main Western Rail Line), is to install a 60kg turnout into the existing 53kg running line. The turnout to be installed would be a 60kg, 1 in 15 R500 Tangential turnout on timber bearers, complete with rodding and points operation. The turnout would be electrically operated, but could also be operated manually, if required.
- Fencing. The Applicant would provide for fencing as required by John Holland Rail (JHR). It is noted that some members of the local community have expressed a preference that the rail corridor adjacent to Margaret Crescent remain unfenced due to rural views and access to walking paths. Where fencing is 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. Survey would be completed to confirm the horizontal and vertical alignment of the rail meets the design specifications.
- Embankments and cuttings. Several embankments and cuttings would be widened and have the drains re-installed to prevent water from remaining within the confines of the track. In total, 2 170m of cutting would be widened and 500m of drainage works completed.
- Ballast delivery and installation. Bottom ballast (ballast under the sleepers) would be delivered by road. The ballast used for filling both shoulders and crib to standard would be delivered by rail along the line as it is installed. In total, 14 460t of ballast would be required.
- Resurfacing. A Turnout/Production Tamper and Ballast Regulator would be used to top and line the rail. Between three and five passes over the entire length would be required to ensure track stability.
- Level crossing upgrades. 26 level crossings occur between Toongi and Dubbo, seven of which are major crossings with the remaining 19 crossings varying from farm access crossings to cattle crossings. Section 2.2.4.4 reviews the proposed works.
- Fire breaks. Access roads, acting as fire breaks, would be graded on both sides of the track to maintain access for future maintenance works.

2.2.4.3 Rail Bridges

Between the Dubbo East Junction and DZP Site (Toongi), 44 rail bridges have been identified including:

- 19 steel underbridges;
- 3 timber bridges; and
- 19 culverts classified as either:
  - concrete arch;

– concrete pipe; or

– steel corrugated pipe.

Each bridge was inspected by Opus International Consultants (NSW) Pty Ltd (Opus, 2012) and the following provides the relevant details of this inspection, review of load rating[7] and summary of upgrade requirements to enable the construction and operation of a Class 1 rail line between Dubbo and Toongi. The locations of the bridges are provided on **Figure 2.2**.

Steel Underbridges

Of the 17 bridges inspected (two were not identified at the referenced location), only three currently display a load rating that would satisfy 92 tonne train on Class 1 rail line. With the exception of the Macquarie River Bridge, most of the bridges which failed the load rating assessment are of small size (1 to 2 spans and less than 6m in length) and low soffit height. One of the following remedial or reconstruction methods would be used for these bridges to enable construction and operation of the proposed Class 1 rail line.

1. Replace all steelwork and re-use acceptable concrete sub-structure.
2. Replace the complete structure with a pre-cast concrete culvert.
3. Replace all steelwork and concrete sub-structure with precast concrete pipes.

The Macquarie River Bridge is far larger (25 spans), with the majority of these spans found to provide an adequate load rating for a Class 1 rail line to carry 92t gross weight. The remaining two (final approach) spans are considered likely to be adequate by Opus (2012) on the basis that the following are undertaken.

- Rivet shear capacity is tested.
- All missing rivets are replaced and existing corroded rivets are made good.
- Holding down bolts, where excessively corroded or insufficient engagement, are repaired/replaced.
- Bracing rivet connections are tested and repaired, if required.
- Sub-structure investigations are undertaken to confirm concrete strength and reinforcement condition/detail at all piers and abutments.

The Applicant would complete these works for all spans of the Macquarie River Bridge.

Timber Bridges

All timber bridges require replacement which would be completed by one of the following methods.

1. Replace the timber structures with pre-cast concrete beams on the existing concrete abutments and piers.

[7] Load ratings were undertaken in accordance with AS 5100 to determine the live load capacity and load rating. Rating factors have been determined in accordance with AS 5100.7 and "As-Is" ratings were calculated on the basis of structural details identified during their inspections.

2. Replace all structures with pre-cast culvert boxes.
3. Replace all structures with pre-cast culvert pipes.

Culverts

All existing structures are adequate for 92t gross weight of a Class 1 rail line.

2.2.4.4 Level Crossings

There are 26 level crossings situated between Dubbo (East Junction) and the DZP Site at Toongi. Of the 26 crossings, 19 are either farm access or cattle crossings which do not require any major upgrade. These crossings would be upgraded to the required standard (unless any are deemed illegal crossings in which case no additional works would be undertaken and appropriate steps taken to close them).

UTS Rail Pty Ltd was commissioned by the Applicant to review the existing signalling arrangements and provide a concept proposal for modifications to be submitted to the rail network owners (ARTC) (UTS Rail, 2012). This concept proposal included information on the proposed junction at Dubbo East (**Plate 2.1**) and upgrade of the seven level crossings (four of which occur within Dubbo City limits) (see **Figure 2.2**) which are described in their current form below.

- Wingewarra Street (Dubbo). One lane each way, single track with formed pedestrian paths and traffic on either side of the road (see **Plate 2.2**).
- Cobra Street (Mitchell Highway) (Dubbo). One lane each way with traffic island, single track with formed pedestrian paths and traffic on either side of the road (see **Plate 2.3**).
- Boundary Road (Dubbo). One lane each way, single track with no formed pedestrian paths (see **Plate 2.4**).
- Macquarie Street. (Dubbo) One lane each way, single track with no formed pedestrian paths (see **Plate 2.5**).
- Obley Road (Cumboogle). One lane each way, single track with no formed pedestrian paths (see **Plate 2.6**).
- Obley Road (Glengerra). One lane each way, single track with no formed pedestrian paths (see **Plate 2.7**).
- Toongi Road (Toongi). One lane each way, single track with no formed pedestrian paths (see **Plate 2.8**).

Railway level crossings of Cumboogle and Bellevue Roads have also been identified. Both are unmarked single lane unsealed crossings with no formed pedestrian paths.

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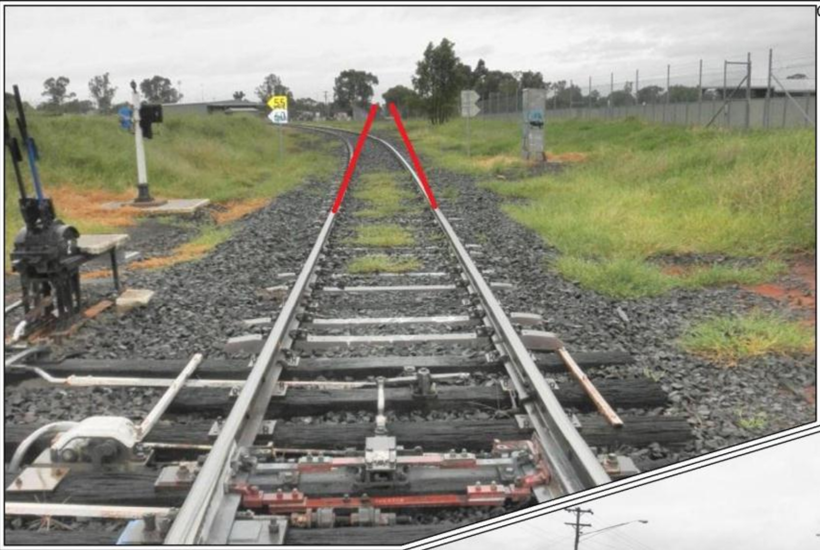

Plate 2.1: Dubbo East Junction
Ref: UTS Rail (2012) - Appendix A

Plate 2.2: Wingewarra Street Level Crossing
Ref: UTS Rail (2012) - Appendix A

Plate 2.3: Cobra Street (Mitchell Highway) Level Crossing
Ref: UTS Rail (2012) - Appendix A

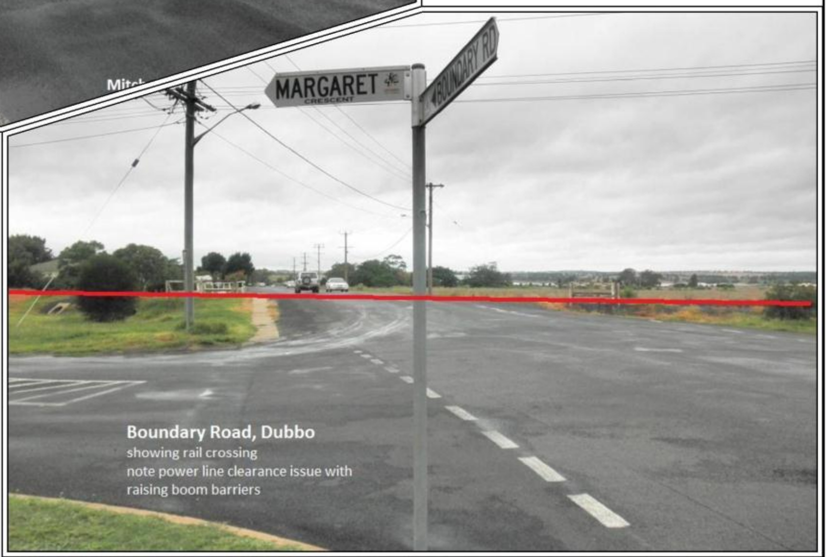

Plate 2.4: Boundary Road Level Crossing
Ref: UTS Rail (2012) - Appendix A

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Plate 2.5: Macquarie Street Level Crossing
Ref: UTS Rail (2012) - Appendix A

Plate 2.6: Cumboogle (Obley Road) Level Crossing
Ref: UTS Rail (2012) - Appendix A

Plate 2.7: Glengerra (Obley Road) Level Crossing
Ref: UTS Rail (2012) - Appendix A

Plate 2.8: Toongi Road Level Crossing
Ref: UTS Rail (2012) - Appendix A

In each case, the formation materials would be imported and laid down to raise the elevation of the road with bitumen laid over the reconstructed pavement. Guard rails and running rails would be installed and secured within concrete. The warning equipment proposed for installation at these crossings (UTS Rail, 2012) is as follows.

- Type F flashing lights and warning bells at each crossing. Boom barriers would be installed at the Dubbo crossings.
- Two boom posts and four-way LED lights at each crossing. Two centre island light posts would be installed at the Wingewarra Street and Mitchell Highway crossings.
- Three section axle counter rail detection would be installed at each crossing. This would be interfaced with track circuits and signals at Dubbo East Junction.
- At the Wingewarra Street and Mitchell Highway crossings, pedestrian crib fences and formed bitumen paths with 'Red Man' warning lights and sirens would be installed. At the other crossings, signs would be installed.

2.2.4.5 Rail Signalling / Interface

A track and signalling interface would be required to connect the Toongi-Dubbo Rail Line ('the branch line') to the Main Western Rail Line ('the main line') at Dubbo East Junction (see **Plate 2.1**). This connection would require a main line turnout and catch-points in the branch line. Additional signals, alteration to track circuits, and new and altered control circuitry for the operation of the existing active level crossings are required.

The Applicant proposes a new main line set of points which would connect the branch line to the operational network at Dubbo East Junction. Main line protection would be provided by a catch-point located at the clearance point between the branch and main lines. Signals would be installed at Dubbo East Junction to protect the mainline and branch line from opposing and following train movements, and to prove the points are safely set for the appropriate route.

In order to improve rail and road efficiencies, it is proposed to convert the existing mechanical ground frame points on the triangle track to remote controlled motor points. Additional signals would be required at the Cobborah Road (Golden Highway) Crossing location to protect the motorized points at that end of the triangle track (UTS, 2012).

2.2.5 Public Road Network

2.2.5.1 Introduction

The Proposal relies on the movement of reagents by road between the State Highway road network (Newell Highway) and the DZP Site. The roads that would be used, Obley Road and Toongi Road, are relatively lightly trafficked and the Applicant recognises these would require upgrading in order to accommodate the type and volume of traffic proposed.

The following subsections provide information on current road conditions and the upgrades proposed. The information presented is based on the inspections, detailed assessment and concept design work of Constructive Solutions Pty Limited (Constructive Solutions, 2013), however, it is noted that the designs presented and discussed represent conceptual treatments with final engineering designs to be prepared following approval of the Proposal. **Figure 2.4** provides the locations of proposed intersection upgrades, road widening, realignment and/or pavement upgrade, level crossing and major creek crossing upgrades.

2.2.5.2 Obley Road

Obley Road, which is aligned between the Newell Highway south of Dubbo and the Mitchell Highway at Molong, is a two lane, two way road with a central sealed carriageway varying in width from 9m down to 7.0m to 7.5m. Obley Road primarily services the existing properties along its length, however, it is also used as an alternate route to Dubbo from the south for vehicles choosing to avoid using the Mitchell Highway. Obley Road is currently designated as a B-Double route from the Newell Highway to Benolong Road according to the RMS's Restricted Access Vehicle maps.

Obley Road forms a T-intersection with the Newell Highway, which includes a channelised right turn (CHR) and an auxiliary left turn treatment (AUL) for movements into Obley Road (as defined within the Austroads publication: *Guide to Road Design – Part 4A: Unsignalised and Signalised Intersections* (Austroads, 2009) ("the Guide to Road Design"). Give way controls include a give way sign and a hold line on Obley Road.

There are three major creek crossings on Obley Road.

- Cumboogle Creek: a concrete bridge structure with 7m pavement (corresponding to the width of the bridge) elevated above the local flood plain.
- Hyandra Creek: a 12m span timber bridge providing a low flow crossing. Flood modelling completed by SEEC (2013) indicates that the elevation of the bridge is below the 1 in 5 ARI flood event.
- Twelve Mile Creek: a single 450mm reinforced concrete pipe low flow causeway. Flood modelling completed by SEEC (2013) indicates that the elevation of the causeway and the road for several hundred metres in either direction is below the 1 in 5 ARI flood event.

There are several existing intersections, and one proposed new intersection (to Taronga Western Plains Zoo opposite the Dundullimal Homestead), between the Newell Highway and The DZP Site, namely:

- Taronga Western Plains Zoo (existing);
- Hyandra Road;
- Oakdene Road;
- Bellevue Road;
- Benolong Road;
- Cumboogle Road;
- Belowrie Road;
- Camp Road; and
- Toongi Road.

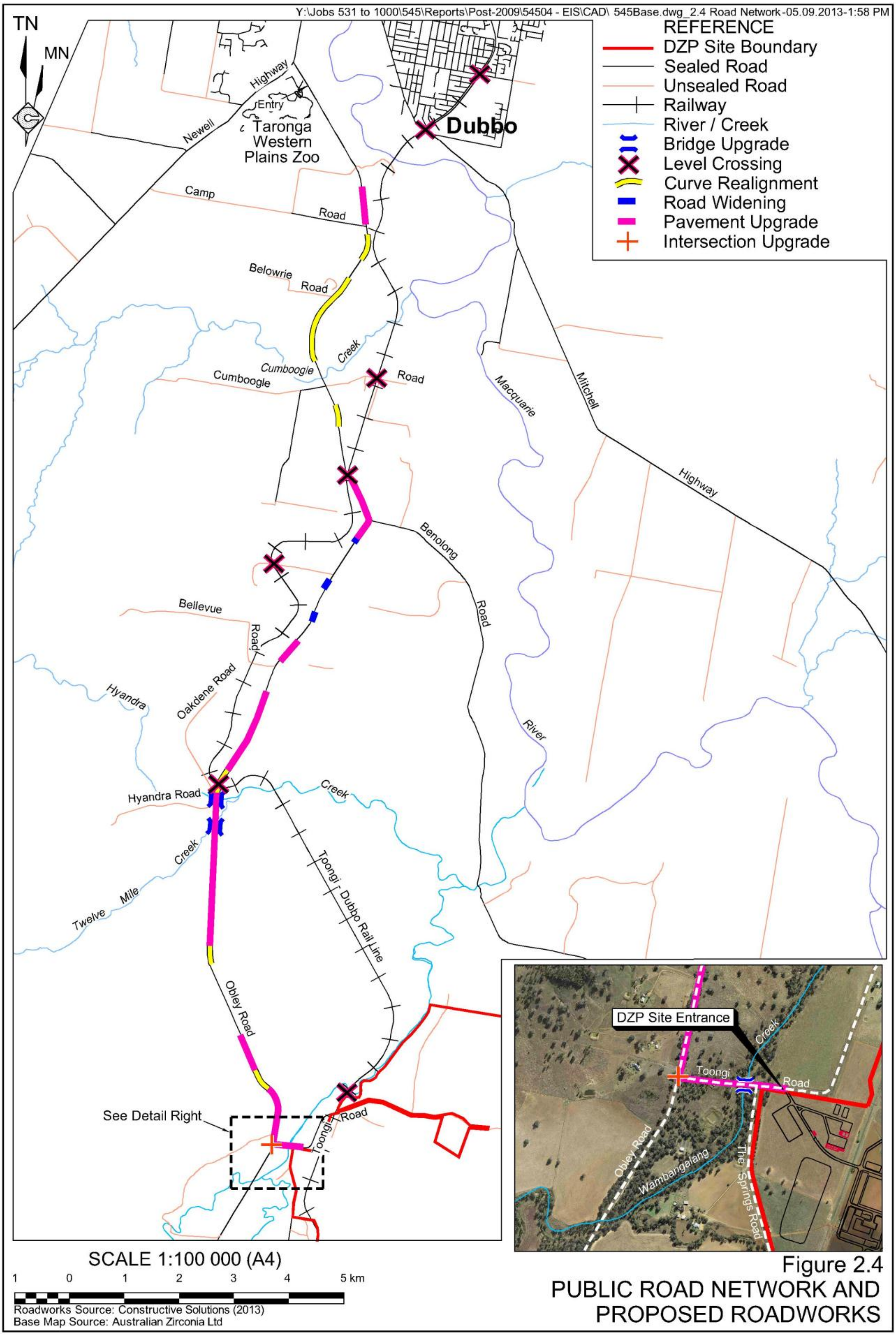


Figure 2.4
PUBLIC ROAD NETWORK AND PROPOSED ROADWORKS

Based on the site inspections and geotechnical investigations completed or commissioned by Constructive Solutions, it has been determined that the condition of the seal is variable and the alignment and marking sub-standard at points for the sign-posted speed limit of 100km/hr (Constructive Solutions, 2013). On the basis of this analysis of current conditions, and with reference to the proposed traffic to be generated by the Proposal over the life of the DZP and flood modelling provided by SEEC (2013) (refer to Section 4.5.2.2), the Applicant proposes to upgrade the road as follows.

- The pavement seal would be increased to 9m for the entire length of the road (except where bridge crossings prevent this).
- The alignment of the road would be modified to meet the standards provided by the *Guide to Road Design* for a 100km/hr speed limited road. In some locations, this would require the construction of an entirely new pavement whereas in others only widening of the existing pavement. **Figure 2.4** presents the locations of the proposed road realignments with the specific locations and modifications provided by Constructive Solutions (2013).
- The pavement formation and sub-formation would be increased where sampling and analysis have identified it as not adequate for the proposed volume of traffic for the 20 year life of the Proposal. Further detail of the proposed formation increases and locations are provided by Constructive Solutions (2013).
- All line markings and guide posts would be installed to meet current standards.
- The crossings of Hyandra Creek and Twelve Mile Creek would be upgraded to provide the following.
  - A 20m span bridge would be constructed over Hyandra Creek at an elevation slightly greater than the 1 in 20 ARI flood level (SEEC, 2013). Earthworks or additional spans would be required up to 50m on either approach to provide for an appropriate approach gradient of 2.4%.
  - Five 2400mm x 1500mm box culverts would replace the 450mm reinforced copper pipe at the Twelve Mile Creek crossing. Although the culverts would improve the flood immunity, the crossing would remain below local flood levels. The significant distance that the existing road remains below local flood levels makes further elevating of the crossing impractical.

  Constructive Solutions (2013) presents concept plans for both crossing upgrades.
- Each of the nominated intersections would be upgraded to meet the relevant *Guide to Road Design* standard. The specifics of each intersection are provided by Constructive Solutions (2013).

2.2.5.3 Toongi Road

Toongi Road is a two lane, two way road with a central sealed carriageway with a 4.5m seal width at the intersection with Obley Road, narrowing to 3.0m to 3.5m after The Springs Road intersection. Toongi Road is a no through road which services several rural properties along its length. Toongi Road ends at several property entrances after crossing the rail line at the locality of Toongi. The road alignment is good with the exception of two right angle bends which have no warning or speed advisory signage.

Toongi Road forms a T-intersection with Obley Road, which conforms with a basic left turn (BAL) / basic right turn (BAR) type intersection as defined within the *Guide to Road Design*. Toongi Road crosses Wambangalang Creek approximately 260m from the intersection, forms a T-intersection with The Springs Road a further 85m from Wambangalang Creek and forms a 90° bend to the north approximately 280m beyond The Springs Road.

In accordance with the recommended minimum road standard recommended by Roads and Maritime Services (RMS), Toongi Road would be widened between Obley Road and the DZP Site Entrance to provide for two sealed lanes at least 3m wide. This would eliminate the need for traffic to move onto the unsealed shoulder to accommodate oncoming traffic. In addition, there are no lane markings or guide posts on Toongi Road. In light of this, the Applicant would undertake the following.

- Mark the road with a broken central separation line.
- Install guide posts for improved delineation of the road.

The Wambangalang Creek crossing is currently a causeway of six reinforced concrete pipes approximately 1m in diameter for low flows. The seal narrows at the crossing and approaches have excessive grades. Investigations completed by SEEC (2013) have identified that the crossing elevation is below the 1 in 5 Average Recurrence Interval (ARI) flood level for Wambangalang Creek. The Applicant proposes to replace the culvert crossing with a bridge spanning 30m at the approximately 1 in 20 ARI flood level (refer to Constructive Solutions, 2013 - *Appendix D*). Minor earthworks would be required to raise the elevation of the approach either side of the 30m bridge span.

Finally, the Applicant would undertake a geotechnical investigation of pavement depths, materials and sub-grade conditions on Toongi Road. From this, it would be determined if the existing pavement has the required strength to accommodate the increase in traffic volumes or if the pavement requires modification and/or strengthening. Should pavement strengthening be required, the Applicant would initiate discussions with the road authority, namely Dubbo City Council, to identify the most appropriate measures to manage this issue.

2.2.6 DZP Site Entrance and Access Road

The Applicant would construct the DZP Site Entrance approximately 120m east of The Springs Road and 170m west of where Toongi Road makes a 90° turn to the north. The entrance would be secured with automatic lockable gates and an intercom to prevent unauthorised access.

The DZP Site Access Road intersection with Toongi Road would be designed and constructed to a BAL standard on the Site Access Road with dimensional adequacy for B-Doubles. Give way controls and a sightscreen would also be installed. The location of the DZP Site Entrance would achieve a sight distance of 160m. The intersection would be sealed, as would an approximately 50m length of Toongi Road to the east. The pavement seal of Toongi Road would be widened as described in Section 2.2.5.3 as part of the public road network upgrade.

The DZP Site Access Road would be an all-weather, sealed two lane road suitable for use by light and heavy vehicles and be sufficiently wide that two loaded semi-trailer trucks can pass safely. The sealing of the Site Access Road would prevent the tracking of mud onto Toongi Road. The road would be elevated approximately 0.3m above the natural ground surface and appropriate road-side drainage would be constructed in accordance with the requirements of *Managing Urban Stormwater – Soils and Construction – Volume 2C Unsealed Roads* published by the Department of Environment and Climate Change in 2008 (DECC, 2008a). The DZP Site Access Road provides access to the DZP Site Administration Area located to the west of the rail line and the Processing Plant Area on the eastern side of the rail line.

A heavy vehicle park-up area would be constructed between the DZP Site Entrance and the DZP Site Administration Area (see **Figure 2.1**) to allow for the temporary holding of trucks to assist in scheduling of entry to the Processing Plant Area or exit to the public road network.

2.2.7 Electricity Transmission Line Infrastructure

The Applicant would commission the construction of approximately 20km of 132kV ETL from an existing sub-station to the southwest of Geurie (see **Figure 1.1**) to a proposed High Voltage Switch Yard (incorporating a sub-station and transformer) to the north of the Processing Plant Area (see **Figure 2.1**) which would reduce the voltage from 132kV to 11kV for on-site operations. Power would be distributed to the processing plant, offices, workshops and other areas by a combination of overhead and underground power lines.

The location of the entry point of the 132kV ETL to the DZP Site and HV Switch Yard is provided on **Figure 2.5**, however, several options to traverse the DZP Site are still under consideration. **Figure 2.5** presents the proposed alignment options under consideration across the DZP Site.

The Applicant also proposes to construct an additional 11kV ETL to follow the alignment of the Macquarie River Water Pipeline and provide power to the pumps at the Macquarie River pump station (see **Figure 2.5**).

As noted in Section 2.1.2.1, the ETLs would be constructed under approval to be obtained in accordance with Part 5 of the EP&A Act. The Applicant will negotiate appropriate arrangements with the landowners, occupiers and relevant public authorities to establish the required electricity easement. The electricity transmission line would be constructed in accordance with Essential Energy's *High Voltage Connection Requirements* (CEPG8079 Issue 2). The sub-station and transformer would comply with Australian Standard AS 2067 - *Switch Gear Assemblies and Ancillary Equipment for Alternating Voltages above 1kV* and would be enclosed within a 2.5m high security fence with appropriate signage.

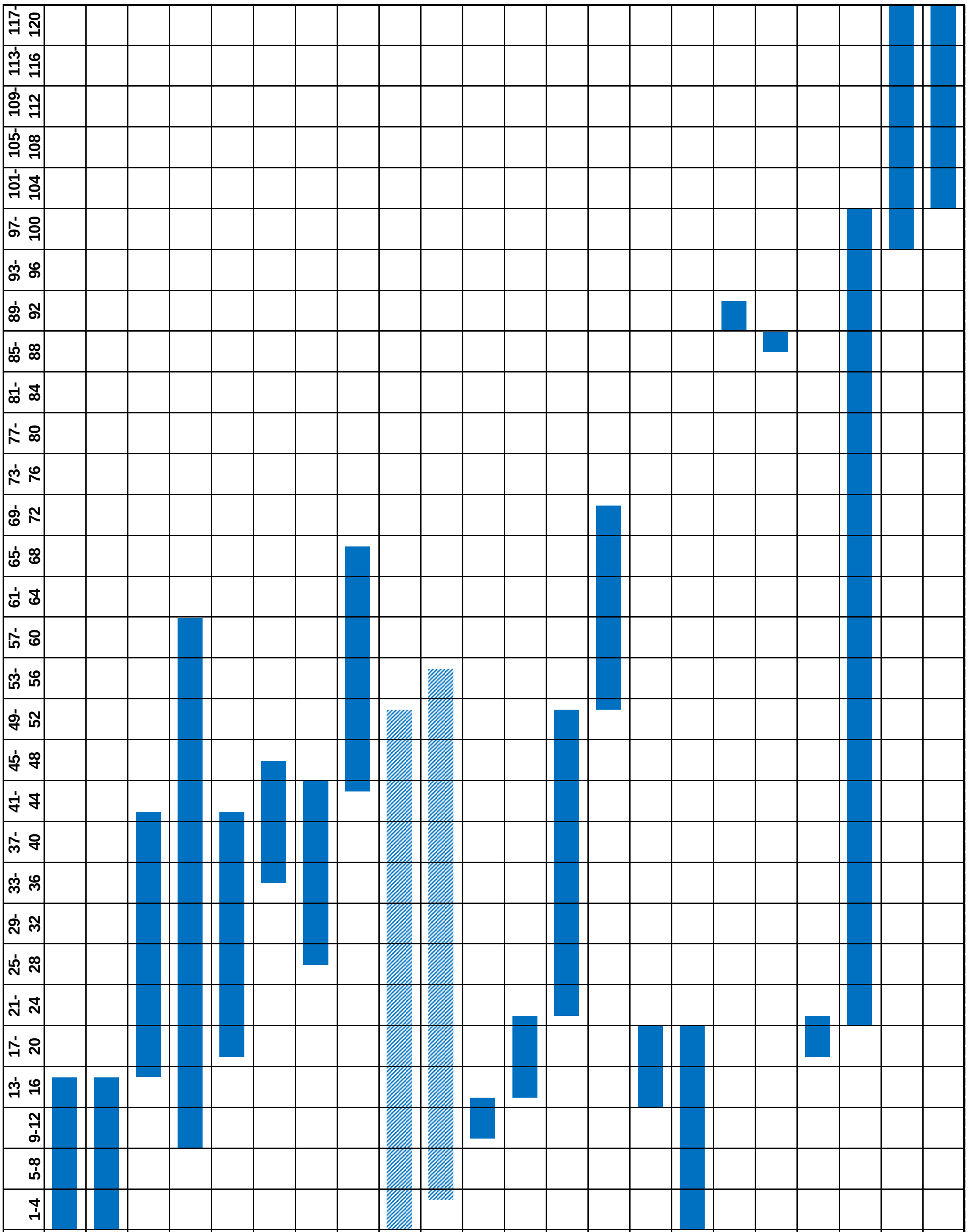
Following construction, ownership, operation and maintenance responsibilities for the proposed ETLs would pass to Essential Energy, under approval obtained under Part 5 of the EP&A Act. Essential Energy may continue to operate the lines beyond the life of the Proposal.

2.2.8 Site Establishment and Development Sequence

Chart 2.1 presents the indicative planning, construction and development sequence for the Proposal.

Chart 2.1
INDICATIVE CONSTRUCTION, DEVELOPMENT AND DZP COMMENCEMENT SEQUENCE

Task Name	Week / Duration
Upgrade Toongi Road	15 weeks
Upgrade Bridge over Wamgangalang Creek	15 weeks
Upgrade Obley Road (and associated bridges) 3-5km Sections	26 weeks
Construction of Rail Line (provisional)	52 weeks
Install New 132kV ETL	24 weeks
Install 11kV ETL to Macquarie River Pumping Infrastructure	12 weeks
Install Macquarie River Water Pipeline	18 weeks
Construction of Gas Pipeline	24 weeks
Vegetation Clearing over DZP Site	~ 3 week campaigns
Topsoil Clearing	~ 3-6 week campaigns
Construct DZP Site Administration Area	4 weeks
Process Water Dam Construction at Process Site	8 weeks
Construction of LRSF	30 weeks
Construction of SRSF	20 weeks
Site Security Fencing	8 weeks
Processing Plant Area Construction Bulk Earthworks	20 weeks
Construct Mine Haul Road	3 weeks
Open Cut Land Preparation	2 weeks
Construct Telecommunications (upgrade cell tower or fibre optic) to Site	4 weeks
Processing Plant Construction	80 weeks
Commence Mining and Delivery of Ore	Ongoing
Commence Processing and Product Despatch	Ongoing



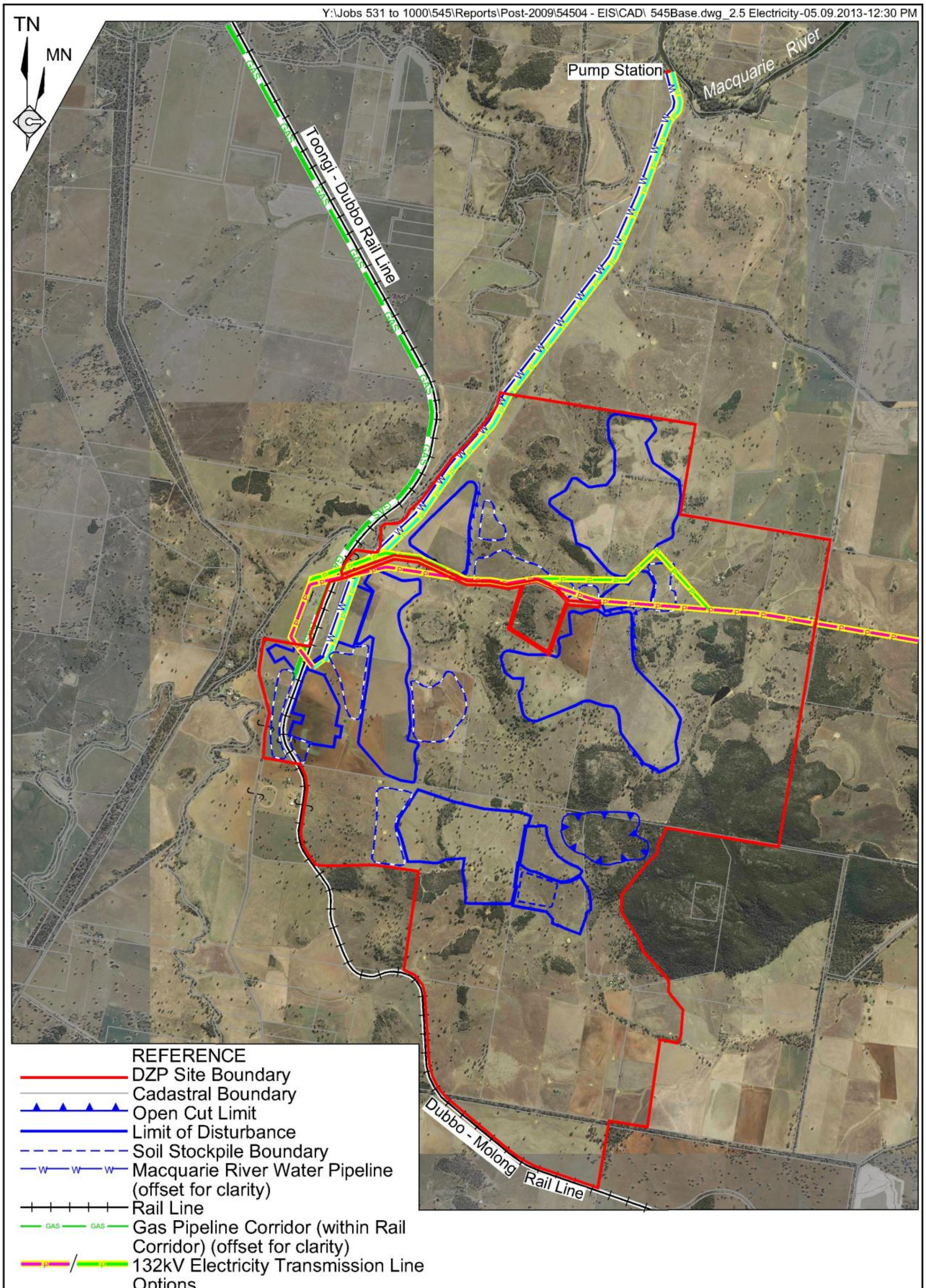


Figure 2.5
DZP SITE ELECTRICITY TRANSMISSION LINE OPTIONS AND INFRASTRUCTURE

2.3 DZP SITE PREPARATION

2.3.1 Introduction

This following subsections describe the activities that would be undertaken in preparation for mining operations, the construction of the processing plant and other DZP Site infrastructure and the construction and operation of the SRSF, LRSF and Salt Encapsulation Cell(s) (eventually). The activities would include:

- vegetation clearing;
- soil stripping; and
- soil stockpiling.

2.3.2 Vegetation Clearing

2.3.2.1 Vegetation Type

A large proportion of the DZP Site has been cleared of native vegetation and has been grazed or cropped over many years. Of the 807.7ha[8] of direct disturbance, approximately 322.8ha is considered cleared, grazed and/or cypress pine monoculture without remnant native vegetation. A further 414ha of disturbed vegetation is considered Derived Native Grasslands by OzArk (2013a) where a derived (or secondary) grassland is defined as *a native grassland*[9] *remaining after the removal or dieback of previous woody canopy vegetation (shrubs or trees), to a point where woody vegetation has less than 10% cover* (Benson, 1996)[10].

Of the remaining 70.9ha, three distinct remnant native vegetation communities have been identified within the DZP Site by OzArk (2013a).

- CW138: Fuzzy Box - Inland Grey Box on alluvial brown loam soils of the NSW South Western Slopes Bioregion and southern BBS Bioregion (Benson 201) - 0.1ha
- CW212: White Box - Tumbledown Gum woodland on fine-grained sediments on the NSW central western slopes (Benson 270) – 27.1ha.
- CW213: White Box - White Cypress Pine - Inland Grey Box woodland on the western slopes of NSW (Benson 267) – 43.7ha.

Further detail on these and other communities mapped on the DZP Site, including their classification, is provided in Section 4.7.4.1.1.

[8] This includes 129ha of land allocated to soil stockpiles beyond disturbance areas.

[9] Benson (1996) defines a native grassland as a community with <10% woody canopy cover and >50% of the vegetative ground cover composed of indigenous species of grasses and forbs, 50% of the number of species are native, and where the minimum standing vegetation ground cover, alive or dead, exceeds 10%.

[10] Benson (1996*). SEPP 46 Forum: What is a native grassland? Proceedings of the Eleventh Annual Conference of the Grassland Society of NSW, 1996, pp. 92-96*. National Herbarium of NSW, Royal Botanic Gardens, Mrs Macquaries Road, Sydney, NSW.

2.3.2.2 Larger Vegetation (Timber) Clearing and Management

During vegetation clearing operations, larger vegetation would be removed using a bulldozer with its blade positioned just above the surface. A *Vegetation Clearing Protocol* would be established to minimise the potential for resident native fauna to be injured during clearing campaigns. The critical features of the proposed *Vegetation Clearing Protocol* (which is implemented at the Tomingley Gold Mine operated by Tomingley Gold Operations Pty Ltd, a subsidiary of Alkane Resources Ltd) is presented in Section 4.7.5.4.1.

The majority of the areas to be disturbed have been cleared of larger vegetation, however, there is at least 70ha of remnant native vegetation communities containing woody vegetation of varying type, age and size (refer to Section 2.3.2.1). In addition, the reinstatement of grassy woodland vegetation types would be a key focus of habitat improvement on the DZP Site, in particular within a proposed Biodiversity Offset Area (BOA) to be established (refer to Section 2.17.8), and this would involve the 'thinning' (clearing) of canopy and mid-storey vegetation (mature and regrowth trees and shrubs).

While cleared vegetation would be an important resource in the rehabilitation of final landform (back to native vegetation), it is considered impractical to stockpile all the cleared woody material for this purpose for the following reasons.

- While the majority of the impact footprint on the DZP Site would be cleared within the first few years of operation, there would be only limited opportunity to progressively rehabilitate the DZP Site as most areas of disturbance would remain active for the life of the Proposal.
- It is proposed to rehabilitate significant areas of the DZP Site back to agricultural land (refer to Sections 2.17.4 and 2.17.5), on which it would be counter-productive to place previously cleared vegetation.
- Some tree species, e.g. White Cypress Pine, have an allelopathic effect (they inhibit the growth or survival), on other species as a result of chemicals released into the soil. Stockpiling these trees could therefore have a detrimental impact on surrounding vegetation.
- By leaving some felled trees following upper- and mid-storey clearing within the habitat enhancement areas, some protection of regenerating groundcover species from herbivory would be provided.
- Stockpiles would likely provide habitat for feral species.

In order to avoid the requirement to stockpile large volumes of vegetation on the DZP Site for extended periods, much of which would be of little value for the intended final land use and only increase local bush fire hazard and risk of vermin infestation, a more flexible approach to cleared timber management is proposed. This timber management would involve the development of a 'timber inventory' which would identify and classify all timber to be cleared on the basis of type (introduced vs. native), size (mature vs. regrowth), density, habitat features (e.g. hollows) and other uses (for milling, structural timber, etc.). The end use for the cleared timber would then be identified on the basis of satisfying the requirements of rehabilitation and habitat enhancement on the DZP Site and surrounds before other uses / management methods are implemented. The following provides a summary of the preferred uses of the timber (from highest to lowest value use).

- Whole trees retained for improving habitat complexity on the final landform designated for native vegetation re-establishment or improvement of habitats surrounding the DZP Site, e.g. re-snagging watercourses.
- Retention and re-hanging of tree hollows for habitat enhancement within the proposed Biodiversity Offset Area (refer to Section 2.17.8) or on the final landform designated for native vegetation re-establishment.
- Cutting and milling or sale of suitable species (White Cypress Pine, White Box, Ironbark), e.g. for fence posts, structural timber or floor boards.
- Chipping of crowns and limbs, following harvest of seed for use in rehabilitation, and either use on rehabilitated land or sale.
- Cutting and sale as firewood for community benefit/use.
- Pyrolysis to charcoal and use in soil amelioration.

2.3.2.3 Groundcover Clearing and Management

Groundcover vegetation would be removed with the topsoil to maximise the retention of the seed bank and nutrients within the soil, as well as to minimise opportunities for erosion and dust lift-off between removal of the larger vegetation and soil stripping.

2.3.3 Soil Stripping

2.3.3.1 Introduction

Soil materials within those sections of the DZP Site that would be disturbed have been assessed by Sustainable Soils Management (SSM). A full description of the soils assessment is provided in SSM (2013) (Part 10 of the *Specialist Consultant Studies Compendium*) and summarised in Section 4.11.2. The following sections identify the soil categories identified within and surrounding the DZP Site, the proposed maximum stripping depths, the volumes of soil that would be available for use during rehabilitation and the procedures that would be used during soil stripping and stockpiling operations.

Two important considerations have influenced the proposed soil stripping and management measures.

1. The total area of disturbance associated with the mining, processing, waste management and related activities on the DZP Site would be large (678ha) which would require significant volumes of soils to be stripped.

2. These soils would be retained in stockpiles for significant periods given a large proportion of proposed impact footprint would remain active for the life of the Proposal. As a result, the majority of the soils stripped would have to be retained in stockpiles for the life of the Proposal (20 years) creating two issues.

   i) Large areas for stockpiling the soil would be required (140ha has currently been allocated[11]) which would ultimately encroach upon either agricultural land or remnant native vegetation. Minimising disturbance to both these areas is an objective of the Applicant.

   ii) Extended retention of soil in stockpiles adversely impacts on the soil structure, organic levels, oxygen levels and microbial activity.

2.3.3.2 Soil Units, Stripping Depths and Inventory

2.3.3.2.1 Soil Landscape Units

SSM (2013) has used soil landscapes as the basis for categorising soil types over the DZP Site, as to define individual mapping units across a site with the size and geological diversity as the DZP Site would create enormous complexity. Ten Soil Landscape Units (SLUs) have been identified within the DZP Site as follows (**Figure 2.6**).

- Arthurville SLU.
- Bald Hill SLU.
- Ballimore SLU.
- Belowrie SLU.
- Dowd SLU.
- Mitchell Creek SLU.
- Nubingerie SLU.
- Splitters Hill SLU.
- Turkey Range SLU.
- Wongarbon SLU.

2.3.3.2.2 Soil Stripping Depths and Inventory

The volume of soil to be retained in stockpile has been established by identifying the final depths of topsoil and subsoil required to successfully rehabilitate the various areas of disturbance on the DZP Site. This would reduce the total area required to be disturbed for the purpose of soil stockpiling, as well as increase the effectiveness of soil management measures aimed at minimising the adverse effects of stockpiling on the soils as resources can be focused on fewer stockpiles.

Tables 2.1 and **2.2** present the proposed stripping depths and approximate volumes of soil from each SLU that would be stripped and available for rehabilitation operations based on recommendations provided in SSM (2013). It is noted that only topsoil would be stripped from some component disturbance areas of the DZP Site, namely the internal haul road and Processing Plant and DZP Site Administration Area, given that the material placed over the pre-disturbance topography would ultimately be removed as part of DZP Site decommissioning and rehabilitation (refer to Section 2.17.6). There would therefore be no need to replace subsoil material, rather provide for the appropriate reconditioning and coverage with topsoil.

[11] 11ha of this area occurs within the impact footprint of the Salt Encapsulation Cells.

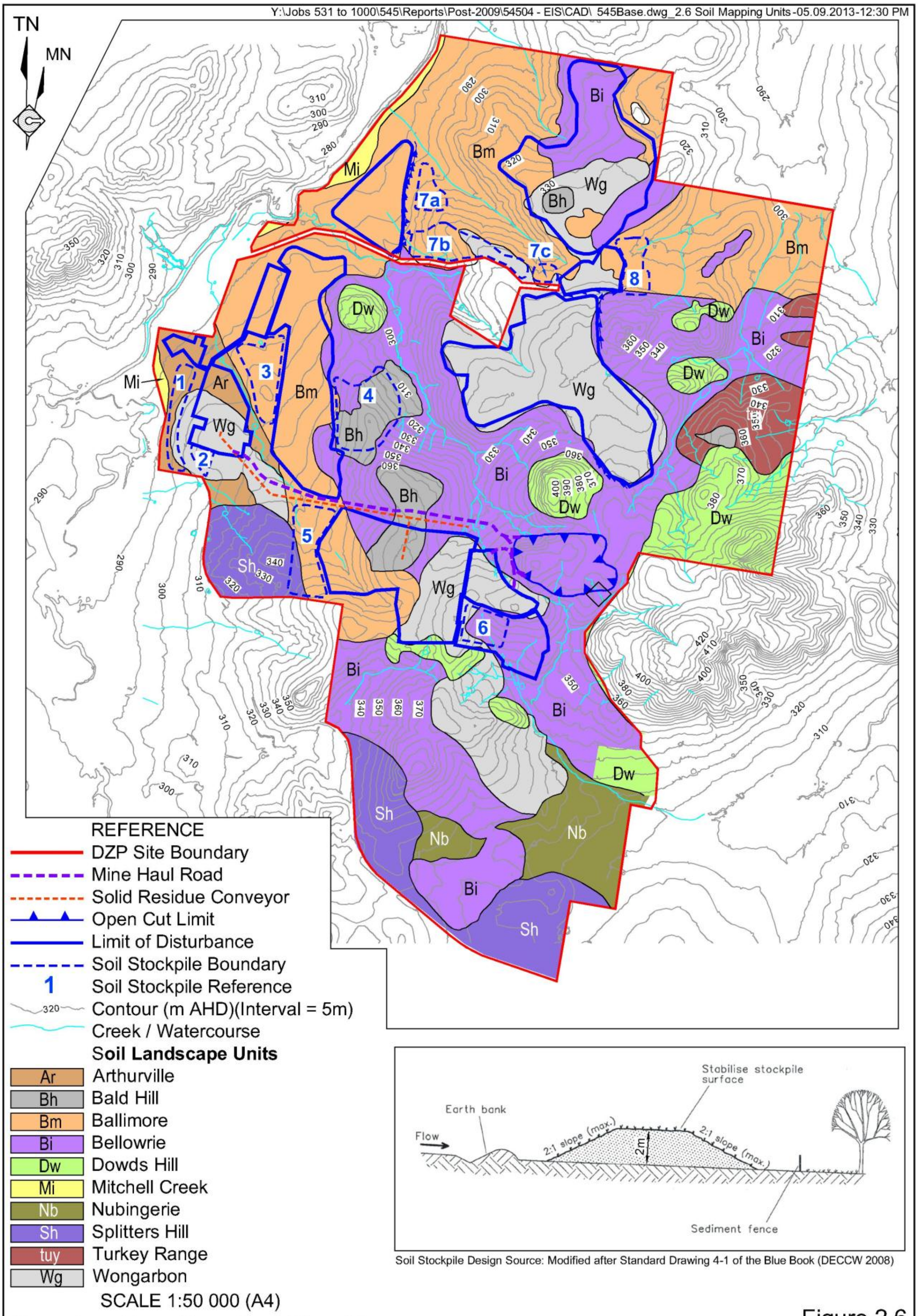


Figure 2.6
SOIL LANDSCAPE UNITS

The subsoil stripped from the LRSF would be preferentially stockpiled as the outer / upper 2m to 3m of the embankments to be constructed between the salt crystallisation cells of the LRSF, thereby reducing the overall area required for soil stockpiling (refer to Section 2.9.3).

Table 2.1
Indicative Topsoil Inventory

Component Disturbance Area	SLU	Area (ha)	Proportion Stripped	Thickness (m)	Volume (m^3)	Subtotal (m^3)
Open Cut	Belowrie	40.3	67%	0.15	40 300	40 300
Waste Rock Emplacement	Belowrie	1.9	100%	0.15	2 850	
	Wongarbon	18.5	100%	0.15	27 750	30 600
Solid Residue Storage Facility	Ballimore	35.1	100%	0.15	52 650	
	Belowrie	14.9	100%	0.1	14 900	
	Wongarbon	35.9	100%	0.15	53 850	
	Bald Hill	15.9	100%	0.15	23 850	
	Dowd	1	0%		0	145 250
Liquid Residue Storage Facility	Ballimore	152.7	100%	0.15	229 050	
	Belowrie	74.3	100%	0.15	111 450	
	Wongarbon	192.7	100%	0.15	289 050	
	Bald Hill	5.7	100%	0.15	8 550	638 100
Salt Encapsulation Cell	Belowrie	28.1	80%	0.15	33 720	
			20%	0.1	5 610	
	Wongarbon	5.9	50%	0.15	4 420	
			50%	0	0	
	Dowd	0.6	100%	0.1	600	44 350
Haul Road	Ballimore	0.9	100%	0.15	1 350	
	Belowrie	4.2	90%	0.15	5 670	
	Wongarbon	1.4	100%	0.15	2 100	
	Bald Hill	0.8	100%	0.15	1 200	10 320
ROM Pad	Wongarbon	4.2	100%	0.15	6 300	6 300
Processing Plant	Arthurville	15.9	100%	0.15	23 850	
	Ballimore	12.4	100%	0.15	18 600	
	Wongarbon	15.0	100%	0.15	22 650	65 100
Total		**678.3**				**980 320**

Source: Modified after SSM (2013) – Table 25

Table 2.2
Indicative Subsoil Inventory

Component Disturbance Area	SLU	Area (ha)	Proportion Stripped	Thickness (m)	Volume (m³)	Subtotal (m³)
Open Cut	Belowrie	40.3	67%	0.3	81 000	81 000
Waste Rock Emplacement	Belowrie	1.9	100%	0.2	4 000	
	Wongarbon	18.5	100%	0.35	65 000	69 000
Solid Residue Storage Facility	Ballimore	35.1	50%	0.6	105 000	
			50%	0.4	70 000	
	Belowrie	14.9	100%	0.15	22 350	
	Wongarbon	35.9	50%	0.6	107 700	
			50%	0.3	53 850	
	Bald Hill	15.9	50%	0.6	47 700	
			50%	0.2	15 900	
	Dowd	1.0	0%		0	422 500
Liquid Residue Storage Facility	Ballimore	152.7	100%	0.5	763 500	
	Belowrie	74.3	100%	0.5	371 500	
	Wongarbon	192.7	100%	0.6	1 156 000	
	Bald Hill	5.7	100%	0.6	34 000	2 325 000
Salt Encapsulation Cell	Belowrie	28.1	40%	0.4	45 000	
			40%	0.2	22 500	
			20%	0.0	0	
	Wongarbon	5.9	50%	0.5	15 000	
			50%	0.0	0	
	Dowd	0.6	100%	0.1	500	83 000
Total		**624**				**2 980 500**
Source: Modified after SSM (2013) – Table 26						

2.3.3.3 Soil Stripping Procedures

During soil stripping operations, the following procedures would be implemented.

- Strip soil material to the depths identified in Section 2.3.3.2 and **Tables 2.1** and **2.2**.
- Ensure that soil material to be stripped is maintained in a slightly moist condition during stripping. Material would not be stripped in either an excessively dry or wet condition.
- Grade or push soil into wind rows using graders or dozers for later collection by elevating scrapers or loading into trucks by front-end loaders to minimise compaction of soil materials.
- Use soil materials immediately in areas undergoing progressive rehabilitation, where practicable. Where this is not practicable, place soil transported by truck directly into storage or place soil transported by scrapers in thick “lifts” to minimise compaction.

2.3.3.4 Soil Stockpile Management

Figure 2.6 identifies eight soil stockpile areas within the DZP Site, referenced by the most proximal component activity.

1. To the south of the Site Administration Area and acting as a visual screen to vantage points to the west (11.1ha – up to 65 000m^3 topsoil).
2. To the south of the ROM Pad (3.1ha – up to 50 000m^3 topsoil or 70 000m^3 subsoil).
3. To the south of the Rail Container Laydown and Storage Area and west of LRSF – Area 3 (18.9ha – up to 300 000m^3 topsoil or 500 000m^3 subsoil).
4. To the east of LRSF – Area 3 (31.9ha – up to 500 000m^3 topsoil or 700 000m^3 subsoil).
5. To the west of the SRSF (22.2ha – up to 350 000m^3 topsoil or 500 000m^3 subsoil).
6. Temporary soil stockpile contained within impact footprint of the Salt Encapsulation Cells (11ha – up to 180 000m^3 topsoil or 250 000m^3 subsoil).
7. To the east of LRSF – Area 2:
   a) 7.6ha (up to 100 000m^3 topsoil or 150 000m^3 subsoil).
   b) 20.5ha (up to 320 000m^3 topsoil or 420 000m^3 subsoil).
   c) 3.1ha (up to 50 000m^3 topsoil or 70 000m^3 subsoil).
8. To the east of LRSF – Area 4 (10.9ha – up to 180 000m^3 topsoil or 250 000m^3 subsoil).

Through reference to **Tables 2.1** and **2.2**, it is confirmed that the stockpile area capacity of the eight areas combined is well in excess of that required. Providing for surplus area would allow the Applicant to optimise the location of soil stockpiles at the time of stripping giving consideration to haul distance, likely respreading location and soil type contained within other soil stockpile areas, i.e. it would enable similar soil types to be stockpiled together and close to the location of final use.

The following soil stockpile management procedures would be implemented.

- Construct the stockpiles as wind rows within each area, avoiding the construction of a single stockpile covering the entire area.
- Use bulldozers or other equipment to push soil placed by scrapers into stockpiles (to avoid tracking over previously laid soil by the scraper) whenever possible. If material is deposited directly by scrapers, it should be deposited in thick “lifts” to minimise compaction.
- Minimise, as far as practicable, the operation of machinery on soil stockpiles to minimise compaction.
- Ensure that soil stockpiles have a maximum height of 3m for subsoil and 2m for topsoil material.
- Leave the surface of the stockpile with an even but roughened surface to assist in erosion control and seed germination and emergence.

- If long term storage (>3 months) is planned, fertilise and establish an appropriate vegetative cover as soon as possible on all soil stockpiles to be retained for more than 3 months.
- Where practical and when conditions are suitable, allow occasional grazing on the vegetated stockpiles to encourage natural return of organic material, e.g. manure. When grazing livestock on stockpiles, livestock should be removed when the soil is wet enough that stock cause poaching of the soil. Livestock should also be removed when groundcover is less than 60% to encourage survival and growth of the pasture species.

The design of a typical topsoil stockpile, including erosion and sediment controls, is provided by the inset on **Figure 2.6**.

2.3.4 Pink-tailed Worm-lizard Habitat Management

The threatened Pink-tailed Worm-lizard (listed as vulnerable under both NSW *Threatened Species Conservation Act 1995* and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*) has been identified in several locations within the DZP Site (refer to Section 4.7.4.2.1). A detailed description of the habitat preferences of the Pink-tailed Worm-lizard, proposed impact management, species conservation measures and impact assessment is provided in Section 4.7.6.7.11. Furthermore, the Applicant has commissioned the preparation of a *Pink-tailed Worm-lizard Plan of Management* (PoM) (Biosphere, 2013) to provide guidance on management of this species prior to, during and following disturbance to confirmed or potential habitat. A copy of the preliminary *Pink-tailed Worm-lizard PoM* is provided as *Appendix 13* of *Part 6* of the *Specialist Consultant Studies Compendium* (OzArk, 2013a).

The following provides a summary of some of the critical safeguards, operational controls and management measures which would be implemented during land preparation activities to minimise or manage impacts on the following critical habitat parameters of the species.

- Open (native) grassland vegetation.
- Soils consisting of a friable sandy loam with moderate to high rock/gravel content.
- Surface rock beneath which ant nests (on which the lizard feeds) are constructed.

Prior to soil stripping within an area of confirmed or potential Pink-tailed Worm-lizard habitat, areas with surface rock the size generally utilised by the ant species favoured by the lizard to create nests would be identified.

These rocks would be turned prior to collection with any observed lizards captured for relocation to protected areas of confirmed, potential or artificially created habitat in accordance with Biosphere (2013).

The collected rocks would then be transferred for placement either on the surface of rehabilitated land, within the known populations of the lizard to be conserved and protected, or within areas designated for habitat augmentation, i.e. areas which display other key habitat features but which display little or no surface rock.

These activities would be undertaken together with a number of other management activities, to minimise, mitigate and offset any impact on the Pink-tailed Worm-lizard as nominated in the *Pink-tailed Worm-lizard PoM* (refer to Section 4.7.5.4.2 and *Appendix 13* of *Part 6* of the *Specialist Consultant Studies Compendium*).

2.4 MINING OPERATIONS

2.4.1 Introduction

Development consent is sought for the extraction of ore and waste rock from a single open pit. This subsection provides an overview of the layout of the mining area, a description of the proposed mining methods, mining rate and sequence and the equipment that would be used during mining operations.

2.4.2 Open Cut Design

Figure 2.7 presents an overview of the proposed development of the open cut and waste rock emplacement (WRE) at roughly five year intervals over the life of the Proposal.

The proposed open cut would be developed in two stages, each of approximately 10 years duration. During the first 10 years of operation, only the western half of the ore body would be mined (to minimise the initial impact of mining on the Pink-tailed Worm-lizard). The initial open cut would cover an area of approximately 20ha and would be excavated to a maximum depth of between 355m and 360m AHD. The depth of the open cut below the natural land surface would vary from only 5m at the northwestern entry point to the open cut to 32m below the most elevated point of the pre-mining topography (392m AHD). During the second 10 year period, the eastern half of the ore body would be mined to approximately 360m AHD, with the depth below the natural land surface varying from 15m to 32m.

At the end of the 20 years, the open cut would cover approximately 40ha with a long axis (east-west) of approximately 925m and a width (north-south) of approximately 550m. The Mine Haul Road would come to surface in the northwest where, once at natural surface, it would diverge into two roads, with one branch directed to the WRE and the other to the ROM pad approximately 3.5km to the west.

The open cut would be excavated in competent rock from surface. Pit walls would be constructed at a 55° batter slope with an 8m wide catch berm developed at 370m AHD, variably 8m to 16m below ground surface. All mining during the 20 year operation would remain above the groundwater table.

It is noted that the trachyte ore body continues at depth below the floor of the proposed open cut. Resource calculations indicate that at the proposed rate of mining, there are sufficient reserves for mining for a further 60 years beyond the proposed life of the current Proposal. Notably, the current design would not sterilise any of this future resource, which could continue to be mined in the same manner as proposed (subject to appropriate approvals) at greater depths.

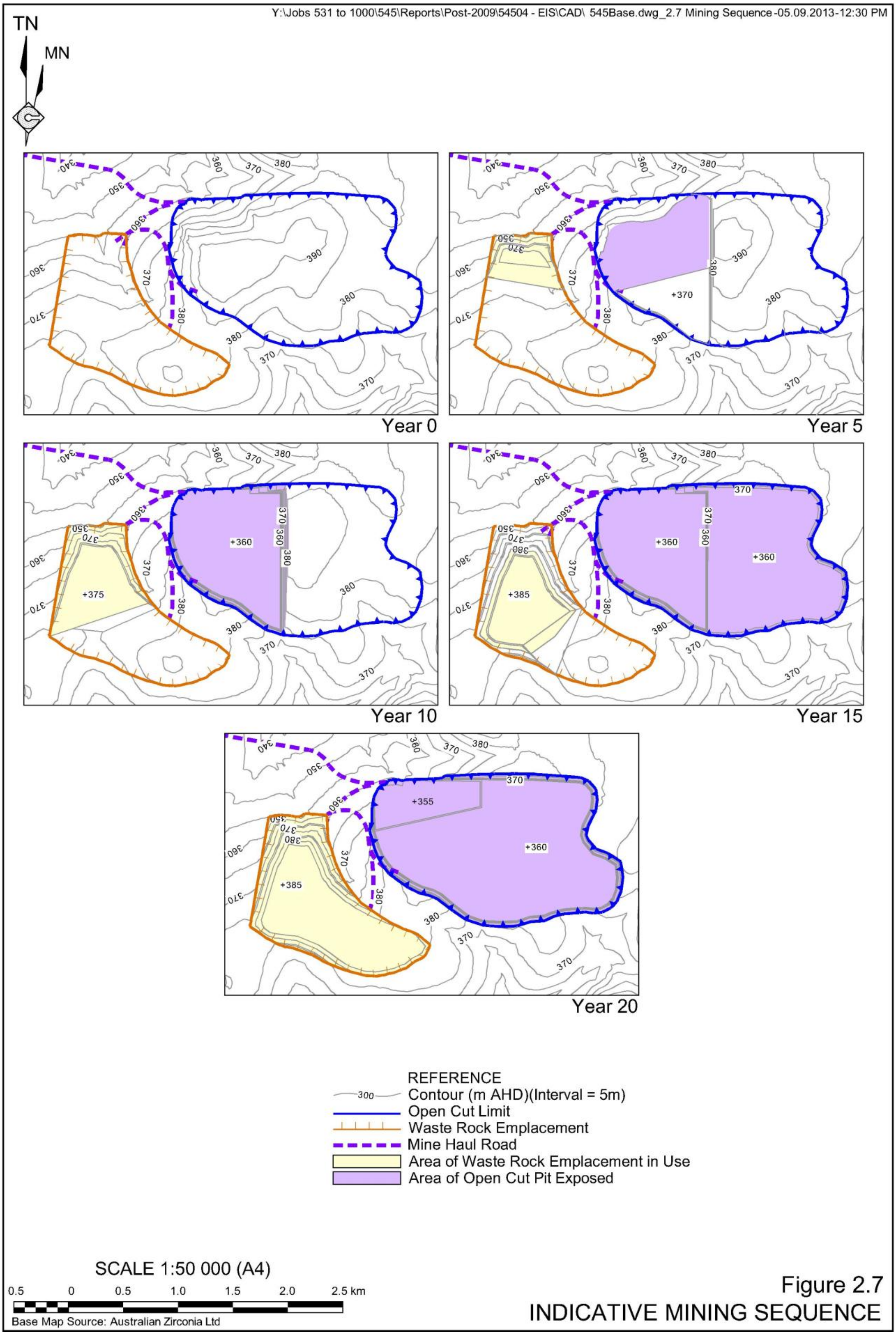


Figure 2.7
INDICATIVE MINING SEQUENCE

2.4.3 Mining Method

2.4.3.1 Introduction

This subsection provides a summary of the mining methods that would be employed. These methods are shown schematically in **Figure 2.8**.

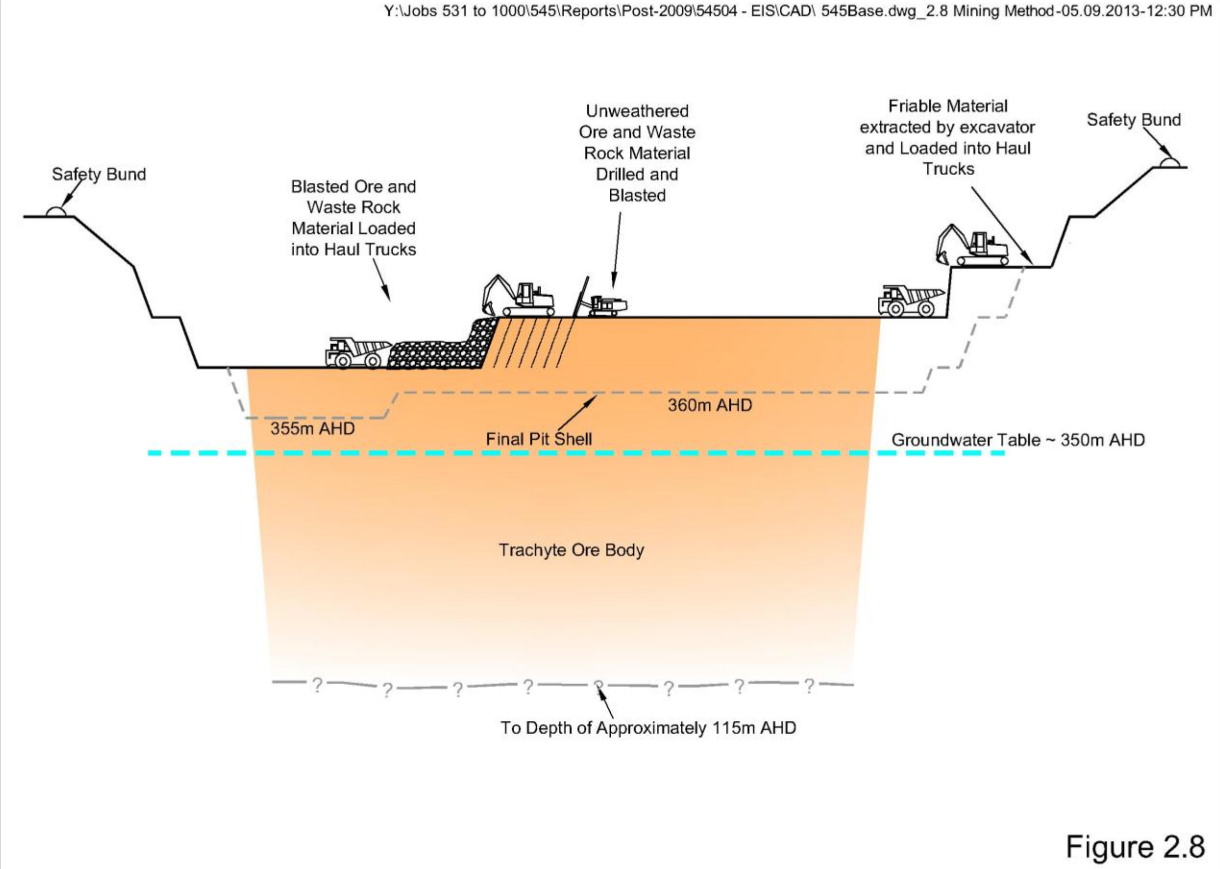


Figure 2.8
SCHEMATIC MINING METHOD

2.4.3.2 Grade Control Drilling

Grade control would be undertaken in all areas of the open cut by collecting samples from each of the holes drilled for blasting purposes. This sampling would be undertaken to more precisely define the boundary between ore and waste rock and allow for stockpiling of differing grades of ore at the ROM pad.

All grade control samples would be analysed at the laboratory located within the Processing Plant and DZP Site Administration Area.

2.4.3.3 Drill and Blast Operations

Drill and blast methods would be used to fragment the majority of material that is to be excavated from the open cut. All drill and blast operations would be supervised by a suitably qualified and experienced blasting engineer or shot-firer. Blast holes would be drilled using one or more hydraulic drill rigs equipped with dust and noise suppression equipment. **Table 2.3** outlines the indicative blast design parameters to be applied.

Table 2.3
Indicative Blast Design Parameters

Blast hole Diameter	89mm
Blast hole Depth	5.5m to 11m
Blast hole Spacing	2.6m x 2.5m
Depth of Stemming	1.9m
Area of Blast	700m^2 - 1 400m^2
Size of Blast	7 000bcm – 14 000bcm
Bulk Explosive Type	ANFO
Powder Factor	0.60kg/bcm
Maximum Instantaneous Charge (MIC)	Up to 68kg (generally 30kg)
Initiation System	Nonel
Note: bcm = bank cubic metre.	
Source: Alkane Resources Ltd	

The Applicant would ensure that all relevant noise and vibration criteria are achieved at surrounding residences and other sensitive receptors not owned by or under agreement for sale to the Applicant. Section 4.2.6.5 and *Part 1* of the *Specialist Consultants Studies Compendium* provide further detail on the management of blasts.

Detonators and boosters would be stored within magazines within a Magazine Area, located to the north of the open cut[12]. The Magazine 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 inspections by security personnel. The magazines would be likely to be transportable structures, which would be constructed, secured, maintained and permitted in accordance with Australia Standard *AS2187 – Explosives Storage, Transport and Use* and relevant guidelines.

Signs advising employees, contractors and visitors to the DZP Site of the date and time of the next blast would be positioned at the DZP Site Entrance and at other appropriate locations within and surrounding the DZP Site. The Applicant would consult with surrounding residents to determine the most appropriate method to notify them of blast times and would implement the agreed notification methods.

Based on a mining rate of approximately 1 000 000t of ore and 150 000t of waste rock (see **Table 2.4**) per year, ANFO usage would average 264tpa.

2.4.3.4 Load and Haul Operations

Following completion of each blast, boundaries between ore and waste rock would, if required, be identified and marked on the ground using paint, tape or similar materials. Fragmented material would then be loaded into haul trucks using a front-end loader or excavator and transported to the WRE or the ROM pad.

[12] For security reasons, the location of the explosives magazine has not been provided on report figures.

2.4.4 Mining Rate and Sequence

Table 2.4 presents the indicative mining rate based on the indicative mining sequence as presented in **Figure 2.7**.

Table 2.4
Indicative Mining Rate

Mining Year	Ore (t)	Waste Rock (t)	Total (t)	Strip Ratio (ore : waste rock)
Site Establishment	74 598	1 869	76 466	1 : 0.025
1	753 362	41 016	794 378	1 : 0.054
2	813 254	67 398	880 652	1 : 0.083
3	905 797	88 888	994 685	1 : 0.098
4	1 000 444	118 254	1 118 697	1 : 0.118
5	1 008 330	116 829	1 125 159	1 : 0.116
6	989 570	113 171	1 102 742	1 : 0.114
7	1 005 179	82 212	1 087 391	1 : 0.082
8	991 605	77 541	1 069 147	1 : 0.078
9	1 002 201	78 917	1 081 118	1 : 0.079
10	1 005 807	149 356	1 155 163	1 : 0.148
11	1 004 671	669 556	1 674 227	1 : 0.666
12	995 891	262 944	1 258 836	1 : 0.264
13	1 003 319	271 753	1 275 072	1 : 0.271
14	1 001 169	285 565	1 286 734	1 : 0.285
15	998 558	268 212	1 266 771	1 : 0.269
16	995 185	186 425	1 181 610	1 : 0.187
17	1 006 494	188 543	1 195 037	1 : 0.187
18	991 207	149 643	1 140 850	1 : 0.151
19	1 004 666	148 007	1 152 673	1 :0.147
20	904 566	92 642	997 208	1 :0.102
Total	**19 455 875**	**3 458 740**	**22 914 615**	**1 : 0.178**
Source: Alkane Resources Ltd				

2.4.5 Mining Equipment

Table 2.5 presents an overview of the indicative mining fleet that would be used during mining operations. In addition to the equipment identified in **Table 2.5**, a number of light and other vehicles would be used during mining operations.

Table 2.5
Indicative Mining Fleet

<table>
<tr><th>Equipment No</th><th>Indicative Number</th><th>Use</th><th>Proposed Hours of Operation</th></tr>
<tr><td colspan="4">Major Equipment – Open Cut Mining</td></tr>
<tr><td>Cat 980G Front-end Loader or equivalent</td><td>1</td><td>Extraction of ore material and waste rock</td><td rowspan="2">10 - 11 hours per day, 5 - 5.5 days per week, 48 weeks per year</td></tr>
<tr><td>Articulated Truck (Cat 740) 38t or equivalent</td><td>5</td><td>Transportation of ore material and waste rock</td></tr>
<tr><td colspan="4">Support Equipment</td></tr>
<tr><td>Cat D8R Dozer</td><td>1</td><td rowspan="2">Stripping soil, shaping of waste rock emplacement, clearing of benches, general site maintenance</td><td rowspan="5">10 - 11 hours per day, 5 - 5.5 days per week, 48 weeks per year</td></tr>
<tr><td>Cat 14H Grader</td><td>1</td></tr>
<tr><td>Service Truck</td><td>1</td><td>Equipment servicing and refuelling</td></tr>
<tr><td>Water cart</td><td>1</td><td>Dust suppression</td></tr>
<tr><td>Diesel Generators</td><td>variable</td><td>Power supply as required</td></tr>
<tr><td>Blast Hole Drill Rig</td><td>1</td><td>Drilling blast/grade control holes</td><td rowspan="2">10 - 11 hours per day, 5 – 5.5 days per week, 32 weeks per year</td></tr>
<tr><td>Explosives Delivery Vehicle</td><td>1</td><td>Explosives delivery (1 day per week)</td></tr>
<tr><td colspan="4">Source: Alkane Resources Ltd</td></tr>
</table>

2.5 WASTE ROCK MANAGEMENT

2.5.1 Introduction

During mining operations, material that is excavated to enable access to the defined ore or contains insufficient grades of the targeted rare metals and REEs to justify processing or stockpiling for later processing, would be placed within the WRE (see **Figure 2.7**). This subsection provides an overview of the characteristics of the waste rock material, as well as the design of the WRE and the procedures that would be implemented during construction of the WRE.

2.5.2 Waste Rock Characteristics

2.5.2.1 Composition

The waste rock would be generated from four main geological sources, namely:

- Colluvial surface clays and gravel (including clayey ‘saprolite’);
- Tuff, an igneous rock of consolidated volcanic ash ejected during a volcanic eruption;
- Siltstone and Sandstone of the bedrock Napperby Formation; and
- The highly siliceous rim (formed as the volcanic source material cooled against the source material for the Napperby Formation siltstone and sandstone) or lower grade extremities of the trachyte.

All geology of the local area contains detectable concentrations of radionuclides, uranium and thorium, however, these levels are more elevated in the igneous trachyte and tuff materials. **Table 2.6** provides a summary of the proportional representation of each waste rock type and average radionuclide concentration.

Table 2.6
Waste Rock Materials

Waste Rock Type	Proportion (%)	Radionuclide Concentration (ppm)	
		Uranium	Thorium
Clay & Gravel	5	36	133
Tuff	<5	63	295
Siltstone/Sandstone	50	30	126
Trachyte	40-45	85	369
Source: Australian Zirconia Ltd			

As the open cut is developed to lower elevation, the proportion of Napperby Formation siltstone and sandstone would increase and the proportion of the other waste rock types would decrease, lowering the overall concentration of radionuclides. This notwithstanding, the specific composition of the waste rock would be regularly reviewed to assess any specific issues associated with radionuclide concentration or other potential contaminants. Furthermore, the Applicant has committed to containing all runoff from the WRE up to and above the 1 in 100 ARI rainfall event. This is discussed in greater detail in Sections 4.5.4.2 and 4.5.5.4.

2.5.2.2 Acid Rock Drainage

Five outcrop samples of waste material were collected from around the proposed open cut perimeter and analysed for net acid generation potential by ALS Laboratory Group. Each of the samples returned a negative acid generation potential, indicating that the waste rock from the open cut would not generate an acidic leachate once placed within the WRE.

2.5.3 Waste Rock Emplacement Design

Figure 2.7 presents the layout and development of the WRE over the 20 year life of the Proposal based on the indicative design features listed in **Table 2.7**.

Table 2.7
Indicative Waste Rock Emplacement Design Features

Feature	Design
Area (ha)	20
Maximum Height (m above current ground level)	43
Lift heights (m)	10
Number of lifts	4
Berm widths (m)	5
Final Slope (V:H)	1:3
Final Design Volume (m^3)	3 000 000
Anticipated Volume Required (m^3)	2 000 000
Source: Alkane Resources Ltd	

The WRE layout and design features presented in **Figure 2.7** and **Table 2.7** has been designed with a capacity in excess of the $3Mm^3$, i.e. approximately 50% greater than the anticipated volume of waste rock to be generated from the open cut. By 'over-designing' the WRE, the possibility that the volume of waste rock is greater than initially anticipated is accounted for. This also accounts for the potential continuation of mining beyond the nominated life of the Proposal (subject to a further development consent) which would result in the generation of additional waste rock. It is likely that should the actual volume of waste rock correspond to that anticipated, the upper lift or lifts of the WRE would not be constructed.

Water management structures would be constructed during shaping of the emplacement to reduce the risk of erosion on the constructed landform. In summary, these structures would comprise low slope sections with slopes of approximately 1:100 (V:H) and, where required, engineered high slope sections or 'drop structures' to transfer surface water from the emplacement to the dirty water management system or, following completion of rehabilitation operations, to natural drainage.

2.5.4 Waste Rock Emplacement Procedures

Waste rock would be transported using off-road haul trucks to either the WRE or, subject to review of radionuclide and other potential contaminant composition, alternatively used to construct other infrastructure within the DZP Site, including the SRSF and Salt Encapsulation Cell walls and/or capping, ROM pad, surface water diversion structures and haul roads.

Figure 2.7 presents the progressive development of the WRE with an overview of the methods that would be employed during construction of the WRE as follows. Following the removal of the topsoil and subsoil, the waste rock would initially be 'paddock dumped,' commencing along the northern edge of the proposed footprint of the WRE. The piles of waste rock would be pushed flat using a bulldozer prior to construction of the next layer. Subsequent layers would be constructed by establishing a tip head on the active emplacement face and collectively form a lift within the WRE. The WRE would be constructed in three 10m lifts, typically from the outer margins of the emplacement towards the centre, allowing for the final face angle for each lift of 1:3 (V:H). Between each lift, a 5m wide berm with a 1:20 (V:H) or 5% back slope and a 1:200 (V:H) or 0.5% longitudinal grade would be constructed. The WRE would be compacted during construction by heavy vehicles travelling across the surface of the emplacement.

Following completion of construction of the outer section of each lift, the outer face of the WRE would be shaped, spread with previously stockpiled subsoil and topsoil and progressively rehabilitated. Rehabilitation operations are described more fully in Section 2.13.

2.6 PROCESSING OPERATIONS

2.6.1 Introduction

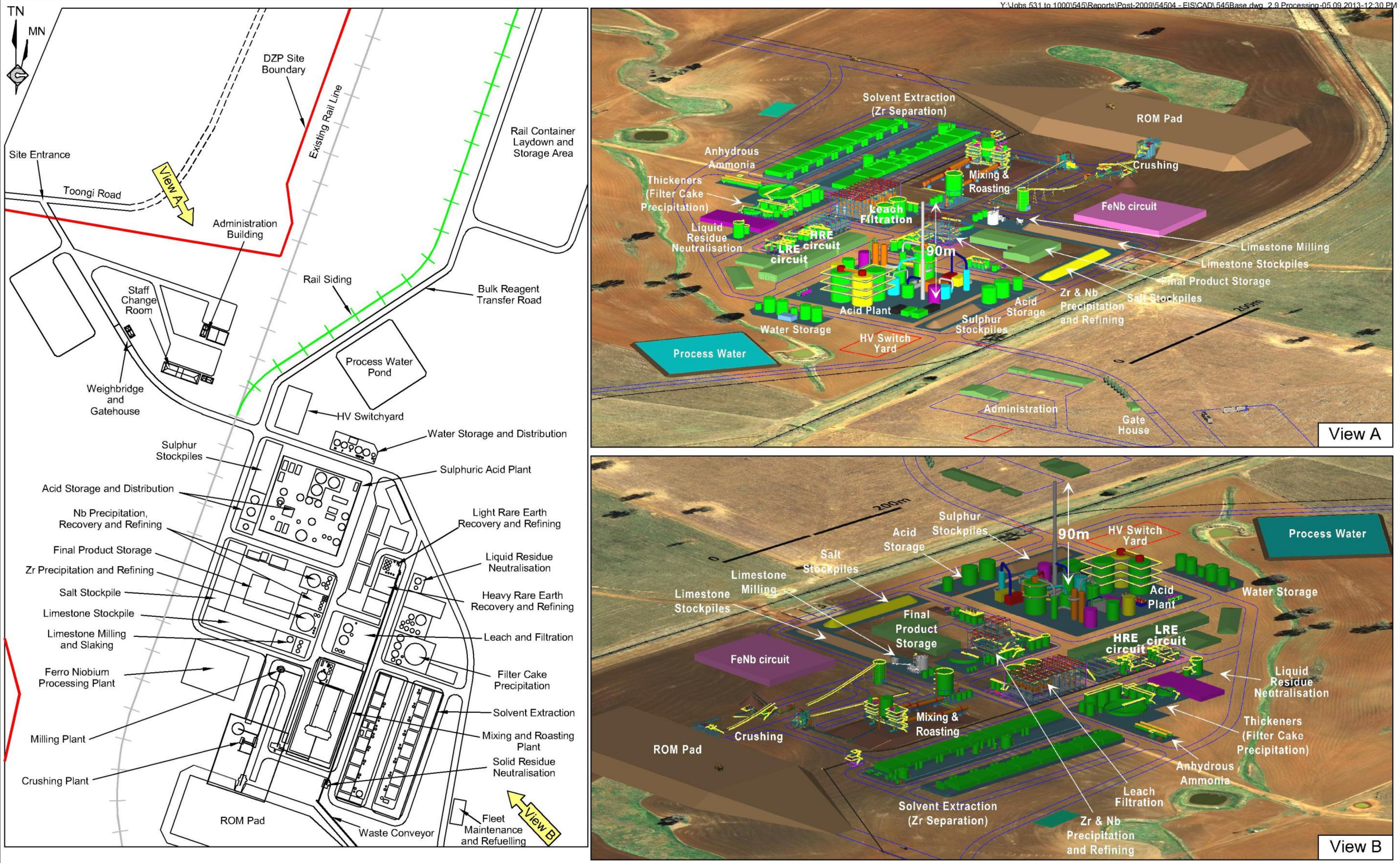
Ore material would be processed within the on-site processing plant. This subsection provides a description of the layout of the processing plant, together with the ROM stockpiling, crushing and grinding, and various rare metal and REE processing methods to produce Zirconia (ZrO_2), Zirconium hydroxide (ZrOH), Zirconium Basic Sulphate (ZBS), Niobium pentoxide concentrate (Nb_2O_5), ferro-niobium (FeNb), a Light Rare Earth concentrate and a Heavy Rare Earth concentrate. Material Safety Data Sheets for each of these products are presented in **Appendix 11**.

The processing methods to be implemented by the Applicant have been developed over 15 years at a demonstration pilot plant developed at commercial laboratories and the ANSTO (Minerals) facility at Lucas Heights. The methods developed are commercially sensitive and as such the detail contained within the EIS is restricted.

2.6.2 Processing Plant and DZP Site Administration Area Layout

Figure 2.9 presents the layout of the Processing Plant and DZP Site Administration Area which can be further categorised into three separate areas.

1. DZP Site Administration Area: located on the western side of the rail line and includes the following component areas.
   - Gatehouse and weighbridge.
   - Administration building including offices and lunch rooms.
   - Change rooms, wash house and ablutions.
   - Staff and visitor parking. Allowance has been made for 160 parking bays in the two allocated parking areas.
   - Truck park-up bays providing for up to 30 trucks.
2. Rail Container Laydown and Storage Area: located on the eastern side of the rail line north of a tributary of Wambangalang Creek, this area provides a location for the unloading of reagents from the train away from the active processing operations. This bunded concrete pad area would be separated into an open area and three bays for temporary storage of the three bulk reagents delivered by train: sulphur, sodium hydroxide and hydrochloric acid.
3. Processing Plant Area: located on the eastern side of the rail line and connected to the DZP Site Administration Area and Rail Container Laydown and Storage Area by the DZP Site Access Road and Reagent Haulage Road respectively and includes the following component areas.
   - ROM pad and crushing circuit.
   - Dry grinding (ball) mill.
   - Sulphur stockpiles and sulphuric acid plant.
   - Acid mixing & roasting circuit (roasting kilns).
   - Leach filtration circuit.
   - Solid residue precipitation circuit.
   - Solid residue neutralisation area.
   - Solvent extraction, precipitation and product handling circuits.
   - Refining and metal / rare earths recovery circuits.
   - Major reagent storage and stockpile areas.
   - Minor reagents stores.
   - Limestone stockpiles, (wet) mill and slurry tank.
   - Neutralised waste stockpile.
   - Water storage & treatment facilities.
   - Process water pond.
   - Final product storage.
   - Laboratory and control room.



SCALE 1:6 000 (A3)
100 0 100 200m
Source: EPMS

Note: Columns are provided only to allow for identification of different facilities

Figure 2.9
PROCESSING PLANT AND DZP SITE ADMINISTRATION AREA

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The nature of the site preparation for each nominated area is provided by **Figure 2.10**, i.e. bunded concrete pad, fully enclosed building with concrete floor or packed gravel.

2.6.3 Process Description Overview

The following provides an overview of the key features of the proposed processing operations, with a flow chart of the processing operations supplied as **Figure 2.11**. The description is provided in sufficient detail to provide the reader with an understanding of the various processes, transfer points and waste streams.

- The mined ore would be loaded from the ROM Pad into a primary crusher where it would be reduced in size. From the primary crusher, the ore would be transferred to secondary and tertiary crushing stations to reduce the size of the ore such that 80% is less than 6mm (P_{80}).
- From the crushing station, the 6mm material would be transferred to a dry grinding circuit to reduce the feed size to 75µm (P_{80}).
- As part of a separate but concurrent process, sulphur would be taken from stockpiles and transferred to the sulphuric acid plant where it would be heated (by steam coils) and burnt to produce sulphur dioxide gas [$S + O_2(g) \rightarrow SO_2(g)$]. The sulphur dioxide would then be oxidised using oxygen with vanadium oxide as a catalyst to produce sulphur trioxide [$2SO_2 + O_2 \rightarrow 2SO_3$]. The sulphur trioxide would then be absorbed into 98% H_2SO_4 forming oleum [$H_2SO_4(l) + SO_3(g) \rightarrow H_2S_2O_7$], which is diluted with water to form concentrated sulphuric acid [$H_2S_2O_7(l) + H_2O(l) \rightarrow 2H_2SO_4(l)$].
- The concentrated sulphuric acid would then be added to the ground ore feed within the roasting circuit. The ore acid mixture would be heated to convert the contained metals and REEs to sulphates ('sulphated ore').
- The acidic gases generated by the production of the sulphated ore would be cooled and scrubbed prior to discharge from the roasting circuit. The scrubber would use recovered water to cool the gas to less than 50°C and absorb SO_3 to form a dilute acid which would be used in the metal and heavy REE leaching circuit. The remaining gas would be scrubbed with limestone slurry to capture sulphuric acid mists and any low level radionuclide particulates and hydrofluoric gases. A centrifugal fan would then induce the scrubbed (clean) gas flow through the 10m high stack.
- The sulphated ore would then be transferred to roaster coolers and be cooled by water directed over the drums. This water would be collected and reused for heating elsewhere within the plant.
- From the coolers, the sulphated ore would be transferred to leach tanks where chilled water would be added to dissolve the sulphate compounds of the sulphated ore.

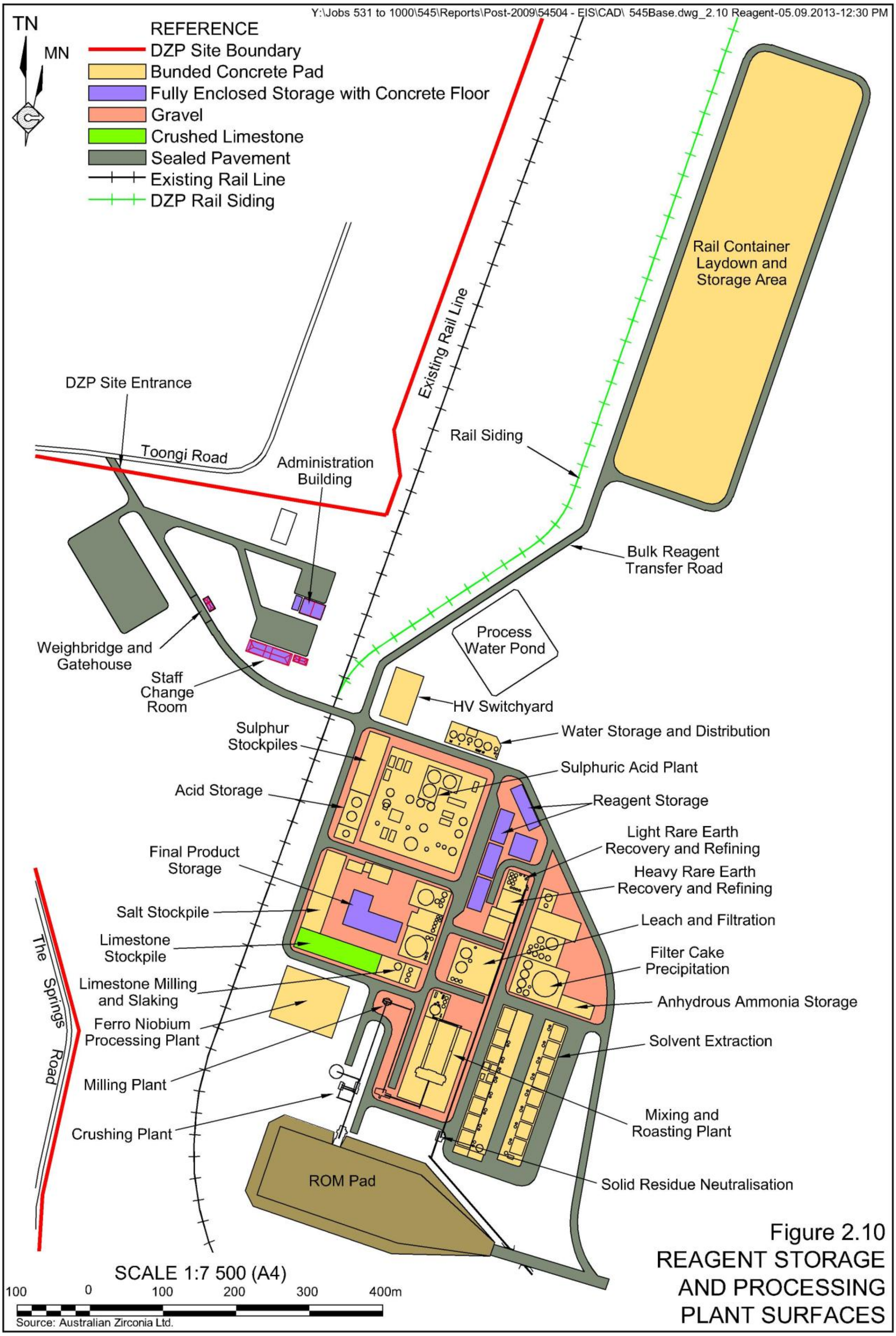

Figure 2.10
REAGENT STORAGE AND PROCESSING PLANT SURFACES

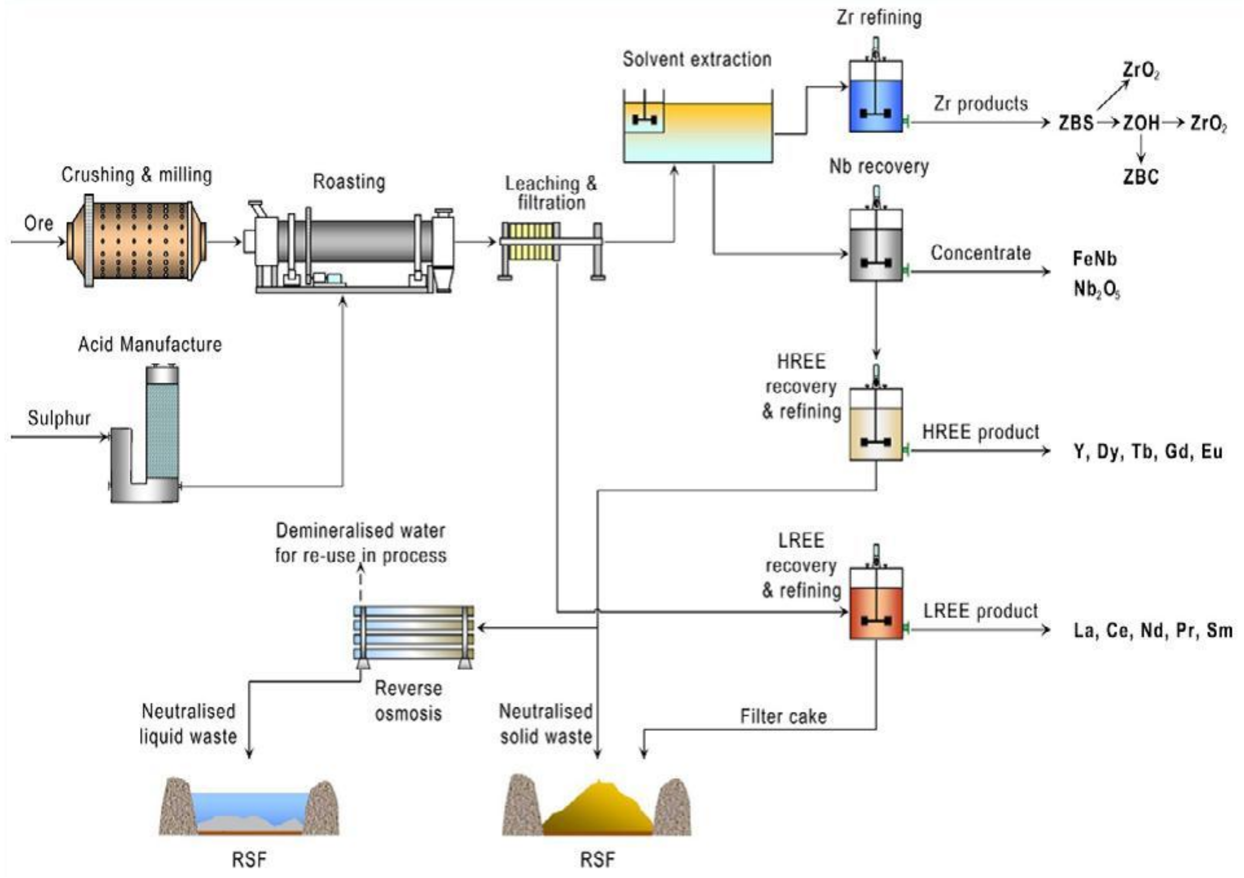

Figure 2.11
PROCESS FLOW PATH

Source: AZL

- The slurry would be filtered to separate the pregnant leach solution (PLS) from the residue solids, maximising the recovery of the soluble species. The filter cake would first be washed with the recovered acid from the roaster scrubber to recover the dissolved zirconium species. The liquor would be a highly acidic, iron rich solution containing zirconium (Zr), hafnium (Hf), niobium (Nb), tantalum (Ta), yttrium (Y) and heavy REEs.
- Prior to discharge, the filter cake would be washed a second time with water (sourced from waste water from the solvent extraction wash and fresh water) to recover the low solubility light REE. The solid residue filter cake would be transferred to a stabilisation area for neutralisation and disposal to the SRSF. The light REEs would be precipitated and thickened, while the waste liquor would be recovered for reuse by reverse osmosis.
- The filtered PLS would be delivered to the solvent extraction (SX) cycle for the recovery of zirconium and hafnium. The solution would be neutralised and zirconium and hafnium selectively precipitated. Small amounts of trace materials, including uranium, would be removed from the precipitated zirconium oxide for disposal as a solid residue. Notably, the concentration of uranium would be very low and diluted significantly as part of the liquid residue stream.

- The raffinate from the first SX cycle would then be heated to recover a crude niobium-tantalum precipitate which would be further refined to produce niobium concentrate pellets that would be smelted to produce the final ferro-niobium (FeNb) product. Iron, aluminium and thorium would remain within the PLS transferred to the Yttrium-Heavy REE circuit. The SX organic chemicals would be regenerated for reuse.
- The remaining PLS would be delivered to the Yttrium-Heavy REE circuit for precipitation from solution. The liquid residue (containing iron, aluminium and thorium) would have a pH close to neutral, with adjustments made by dosing with lime slurry or diverting residue from the sulphate light REE liquid as required, and would be recovered for reuse by reverse osmosis with the concentrate being pumped to the LRSF for disposal. The solid residue removed at this point, which would be acidic, would be transferred to a stabilisation area along with the solid residues generated by the other processes.
- The various solid residues would be delivered to the solid residue neutralisation area via a long waste conveyor. Lime slurry, produced by the crushing and hydration of quicklime within a limestone milling and slaking plant, would be added within an online paddle type mixer in sufficient quantities to result in a blended neutral pH cake. A conveyor from the solid residue neutralisation area would deliver the solid residue to the SRSF. A sump pump would return any leachate to the LRSF.

As outlined above, but with specific reference to the radionuclides within the process streams following the initial sulphation roast and leaching, the uranium and thorium that remains in solution would be progressively excluded from the product streams and be retained in the waste (predominantly liquid) residues. The residues would be neutralised through addition of lime slurry before being discharged to the LRSF or SRSF. Notably, the average uranium and thorium concentration in the residue storage facility would be less than that in the ore. Section 2.9 provides further discussion on the management of uranium and thorium within the solid and liquid residues.

The volume of water required per tonne of ore processed would be minimised (4.05kL/t) by the construction and operation of two reverse osmosis plants. Of this input, water would exit the process by three main methods:

1. 0.72kL/t would be lost as steam from the various processing plant cooling towers;
2. 0.84kL/t would be incorporated into the solid residue stream reporting to the SRSF; and
3. the bulk of the remaining (2.49kL/t) would be discharged as liquid residue.

A small proportion of the water would also leave the DZP Site within the REE solution product.