ATTACHMENT 2

WONNERUP NORTH MINERAL SANDS PROJECT - ENVIRONMENTAL REFERRAL DOCUMENT

WONNERUP NORTH MINERAL SANDS PROJECT
ENVIRONMENTAL REFERRAL DOCUMENT

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PREPARED BY
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APRIL 2014
Project No. CMA-13-01
Document No. 00588354

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EXECUTIVE SUMMARY

Cristal Mining Australia Ltd (Cristal) is seeking environmental approval for the Wonnerup North Mineral Sands Project (the Project), which is located approximately 44 kilometres (km) south of Bunbury and 10 km east of Busselton in the south-west of Western Australia. The Project is situated within Cristal's mining tenements M70/360 and M70/569.

Conventional dry sand mining methods are proposed to be used to extract heavy minerals from the Wonnerup North deposit at a nominal rate of 2.3 million tonnes per annum over an eight year mine life. The mining method, mining rate and overall operation would be very similar to Cristal's existing Wonnerup Mineral Sands Mine, which is located immediately to the west. In fact, the Project is scheduled to commence once operations at the Wonnerup Mineral Sands Mine cease (in approximately 2018) and it is therefore expected that the majority of the mobile equipment, workforce, mineral separation plant and associated infrastructure would be transferred across and used at the Project.

The Project is expected to disturb approximately 517.5 hectares of land. The majority of the proposed disturbance area (i.e. approximately 89%) has been cleared of all native vegetation and is currently used for cattle grazing.

Initial processing of the mineral sands ore at the Project would be conducted on-site in a wet separation plant to produce approximately 683,000 tonnes of heavy mineral concentrate over the life of the mine. The heavy mineral concentrate would be transported by road to Cristal's Mineral Separation Plant at Bunbury for further processing and would then be dispatched to domestic and overseas customers. The road haulage operation would be the same as the existing Wonnerup Mineral Sands Mine (i.e. 60 tonne trucks operating between the hours of 7.00 am and 7.00 pm).

The Wonnerup North orebody is typically 1.5 to 3.5 metres (m) thick and has no overburden. In some areas it can extend as deep as 5 to 6 m from the surface. The natural groundwater table typically occurs within 3.5 m of the surface.

Sand residues generated through the on-site wet processing of the ore would be placed behind the active mining area and would be progressively rehabilitated during the mine life. It is expected that the final rehabilitated land surface would be the same or very similar to the pre-mining topography. The final land use would be determined in consultation with the relevant Government agencies and landowners; however it is expected to be predominately agricultural, with some areas of native vegetation.

Environmental management of the Project would be designed and implemented based on the findings of the environmental studies conducted within the Project area and surrounds, as well as the experience gained through the operation of the adjacent Wonnerup Mineral Sands Mine.

Cristal has consulted with local landholders and members of the Aboriginal community, the City of Busselton, Office of the Environmental Protection Authority, Department of Mines and Petroleum, Department of Environment and Regulation, Department of Water, Department of Aboriginal Affairs and the Department of Parks and Wildlife in regards to the Project.

Environmental factors relevant to the Project are:

- hydrological processes;
- flora and vegetation;
- terrestrial environmental quality;
- terrestrial fauna;

- amenity;
- heritage; and
- rehabilitation and closure.

Cristal has considered the Environmental Protection Authority (EPA)'s Significance Framework for determining the likely significance of impacts in relation to a proposal (i.e. Environmental Assessment Guideline No. 9) as part of the preparation of this Environmental Referral Document. This included an evaluation of each of the above environmental factors and whether or not the Project is likely to meet the EPA's environmental objectives for each factor. Cristal believes that the Project can meet all of the EPA's objectives.

1 INTRODUCTION

1.1 PURPOSE OF THIS DOCUMENT

Cristal Mining Australia Pty Ltd (Cristal) is seeking environmental approval to develop the Wonnerup North Mineral Sands Project (the Project), which is located approximately 44 kilometres (km) south of Bunbury in the south-west of Western Australia (WA) (Figure 1-1).

Part IV Division 1 of the WA *Environmental Protection Act, 1986* (EP Act) provides for the referral and environmental impact assessment (EIA) of proposals likely, if implemented, to have a significant effect on the environment. In order to determine whether the Project will be assessed under Part IV of the EP Act, Cristal has lodged a Project Referral Form with the WA Environmental Protection Authority (EPA) in accordance with section 38(1) of the EP Act and the EPA's *General Guide on Referral of Proposals* (EPA, 2010).

As per section 39A of the EP Act, the EPA will decide whether or not to assess the Project. The EPA will make its decision based on the potential impacts of the proposal on the environment, with reference to information in the Referral Form, any public comments on the referral information, and any additional information it obtains from Cristal, other relevant Government agencies (i.e. Decision Making Authorities [DMAs]), or any other person. The EPA has 28 days to advise both the proponent and the DMAs of its decision on whether or not to assess the proposal, once all requests for information have been met to the EPA's satisfaction.

This Environmental Referral Document (ERD) is the key supporting document to the Project Referral Form. It provides details of the proposed Project in accordance with the EPA's Environmental Assessment Guideline No. 1 (EAG#1) *Defining the Key Characteristics of a Proposal* (EPA, 2012). It also provides a preliminary assessment of relevant environmental factors and identifies the EPA's objectives for each factor.

In preparing this ERD, Cristal has considered the EPA's Environmental Assessment Guideline No. 9 (EAG#9) *Application of a Significance Framework in the Environmental Impact Assessment Process* (EPA, 2013a). Cristal has evaluated the likely significance of Project-related impacts, and whether the EPA's environmental objectives can be achieved for each environmental factor.

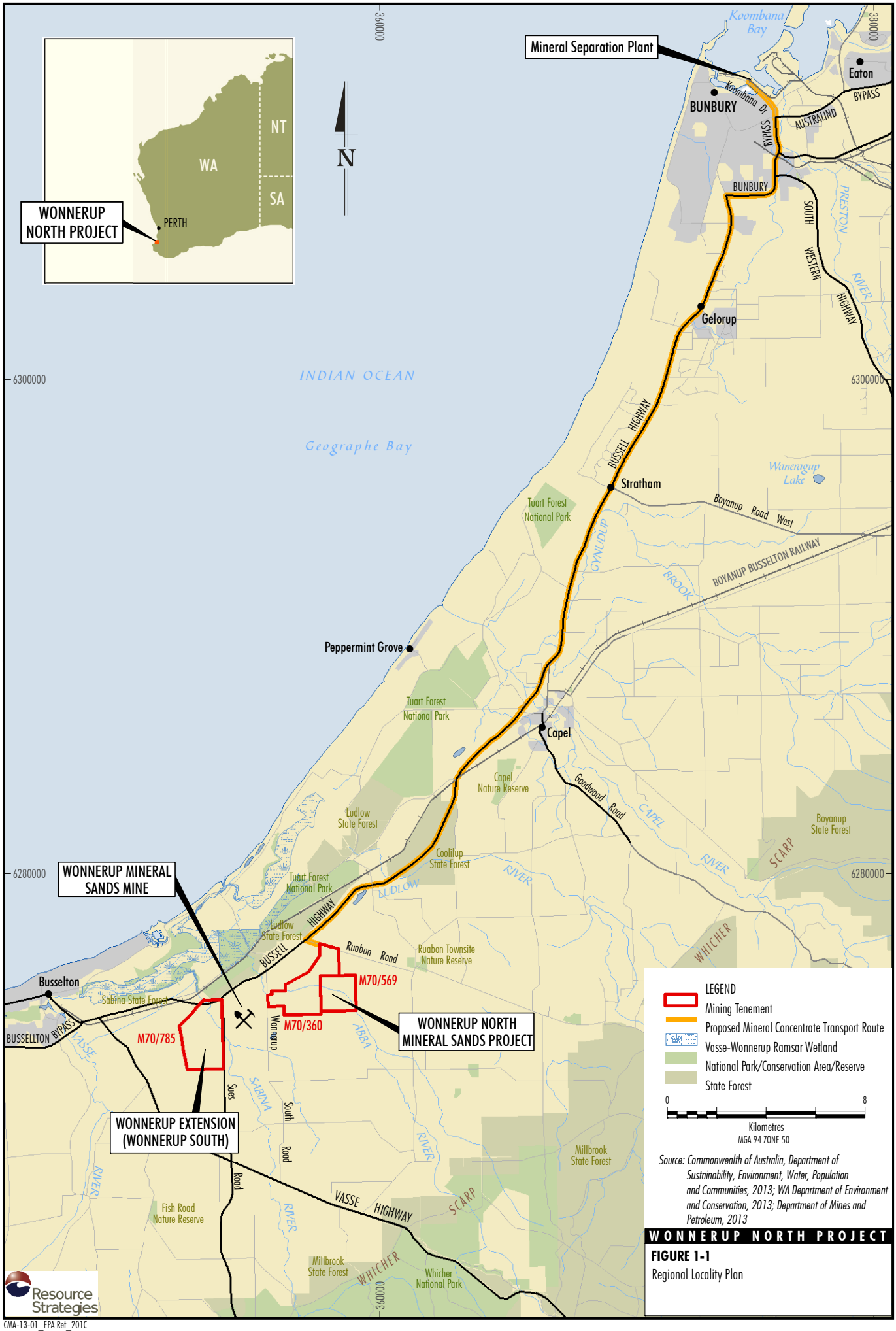
1.2 PROPONENT DETAILS

Cristal is the proponent for the Project. Cristal is one of Australia's premier mineral sands companies and is headquartered in Perth. It is ranked in the top ten of global sands-producing companies based on production volume. Cristal's current mining operations in WA include the Wonnerup Mineral Sands Mine, which is located to the immediate west of the Project and a Mineral Separation Plant (MSP) located in Bunbury (herein referred to as the Bunbury MSP) (Figure 1-1). Cristal also has several exploration tenements and former mine sites undergoing rehabilitation and closure in south-west WA (e.g. Gwindinup and Ludlow).

1.3 PROJECT LOCATION, TENURE AND LAND USE

Figures 1-1, 1-2a and 1-2b show the location of the Project in a regional and local context. The Project area includes the entirety of mining tenements M70/360 and M70/569 plus a 500 metre (m) long section of Ruabon Road, which would provide the main access to the Project. Figure 1-3 shows the proposed maximum disturbance footprint of the Project.

Mining tenements M70/360 and M70/569 are both held exclusively by Cable Sands (WA) Pty Ltd, which is a wholly owned subsidiary of Cristal.

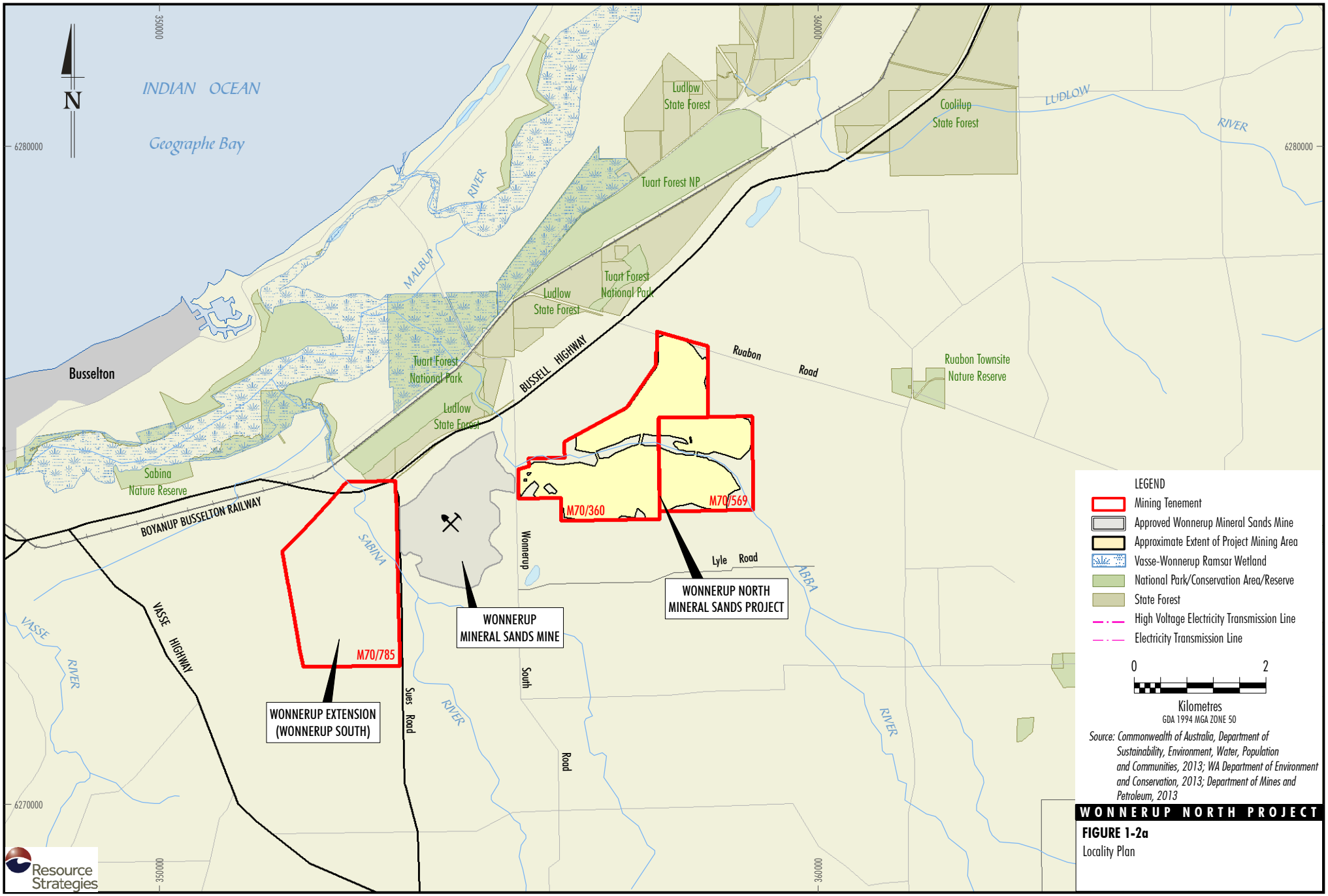


WONNERUP NORTH PROJECT

FIGURE 1-1

Regional Locality Plan

CMA-13-01_EPA Ref_201C

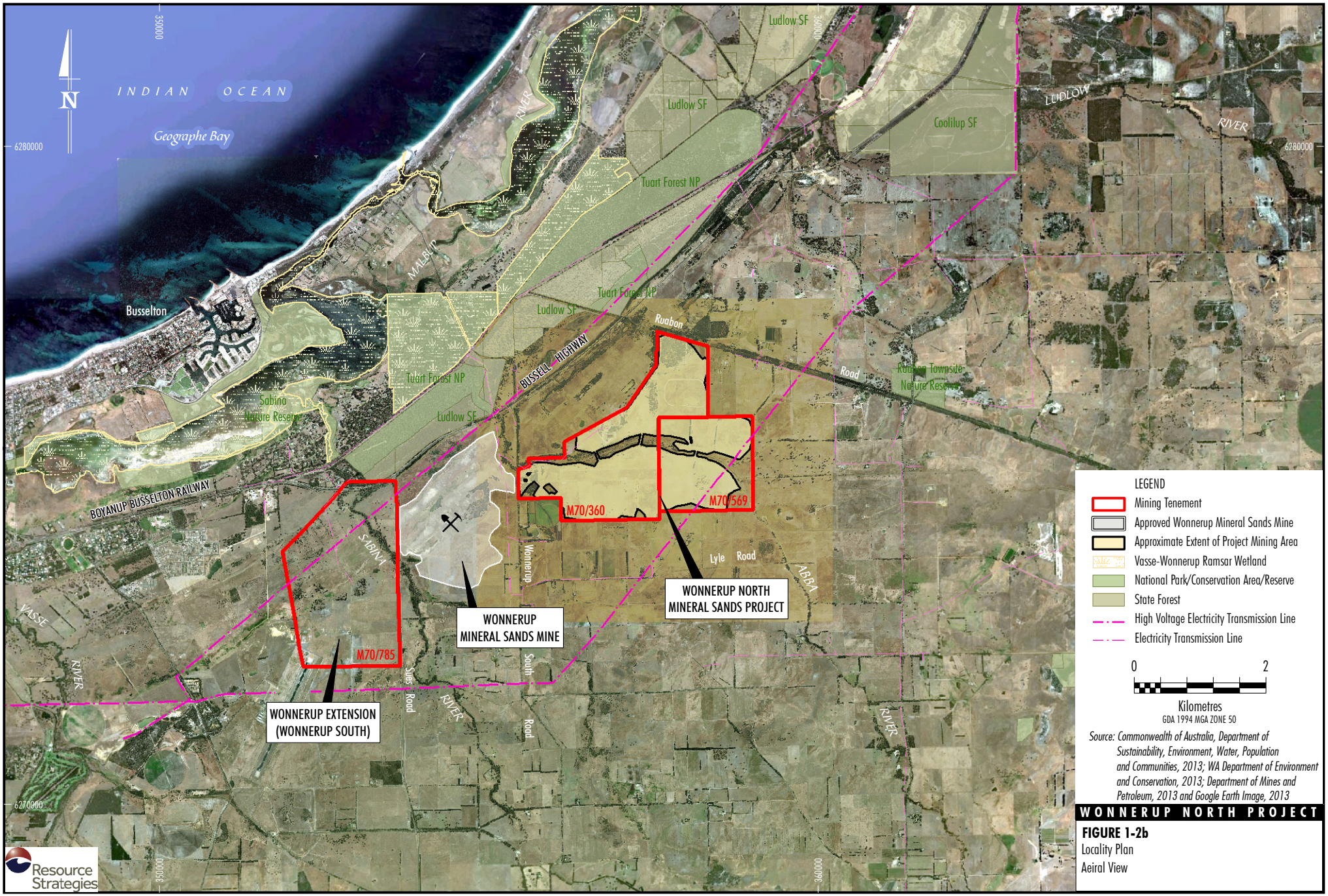


WONNERUP NORTH PROJECT

FIGURE 1-2a

Locality Plan

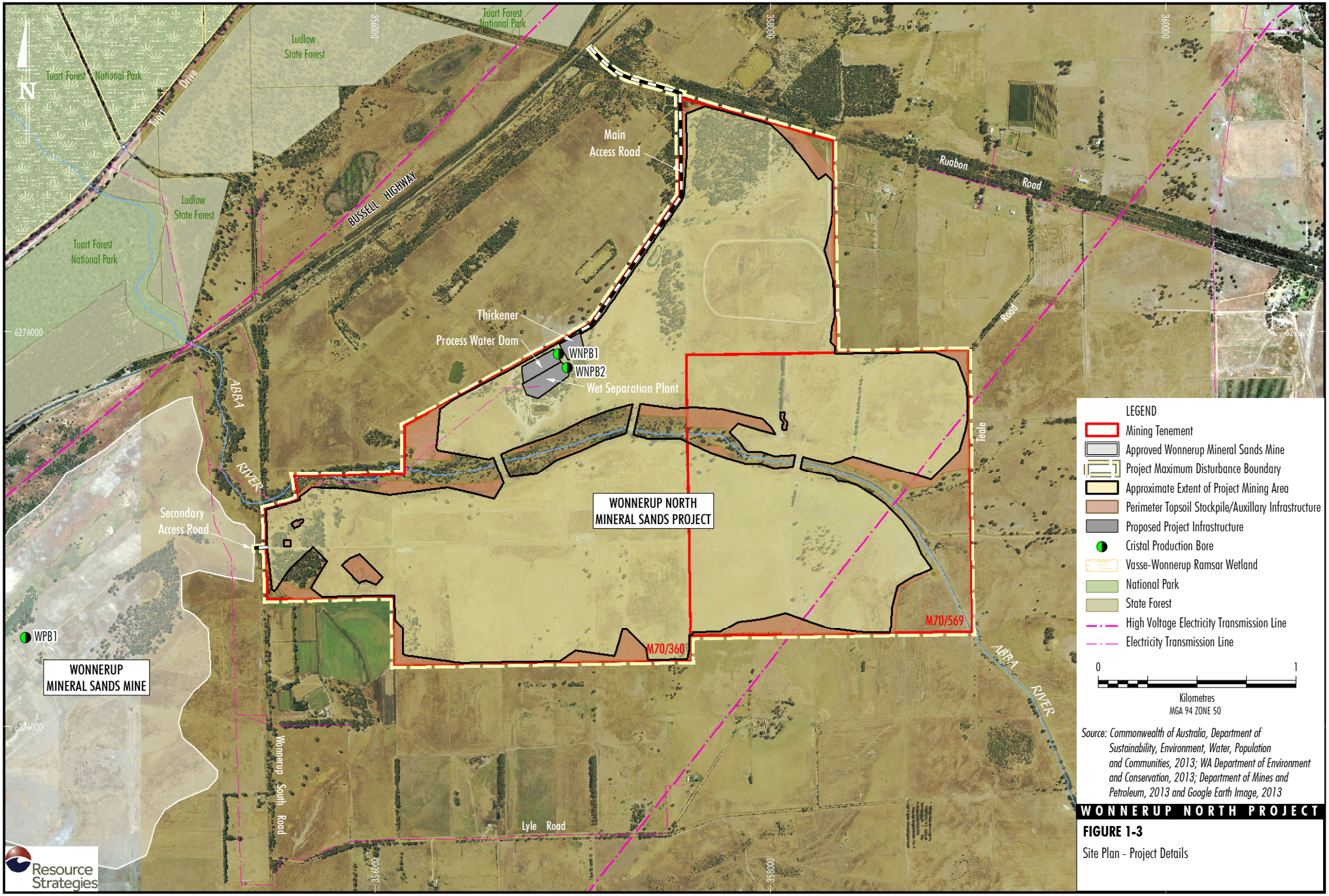
CMA-13-01_EPA Ref_212A



WONNERUP NORTH PROJECT

FIGURE 1-2b
Locality Plan
Aeiral View

CMA-13-01_EPA Ref_203E



WONNERUP NORTH PROJECT

FIGURE 1-3

Site Plan - Project Details

CMA-13-01_EPA Ref_2026

Figure 1-4 shows the relevant mining tenements as well as the underlying land tenure in the Project area, which is predominantly privately-owned freehold land. Cristal (via its subsidiary Cable Sands [WA] Pty Ltd) currently owns Lot 6 on D88371, Lot 10 on DP37187, Lot 1124 on P81921 and Lot 850 on P134119 within the Project area, and has entered into access agreements with the owners of the remaining lots.

The land encompassed by M70/360 and M70/569 is predominantly cleared of native vegetation and consists of pasture with occasional individual paddock trees and small patches of native vegetation. The understorey of most of the remnant vegetation that occurs within the Project area is in a degraded or completely degraded condition. The land use within the Project area is primarily cattle grazing on improved pastures.

1.4 PROJECT OVERVIEW

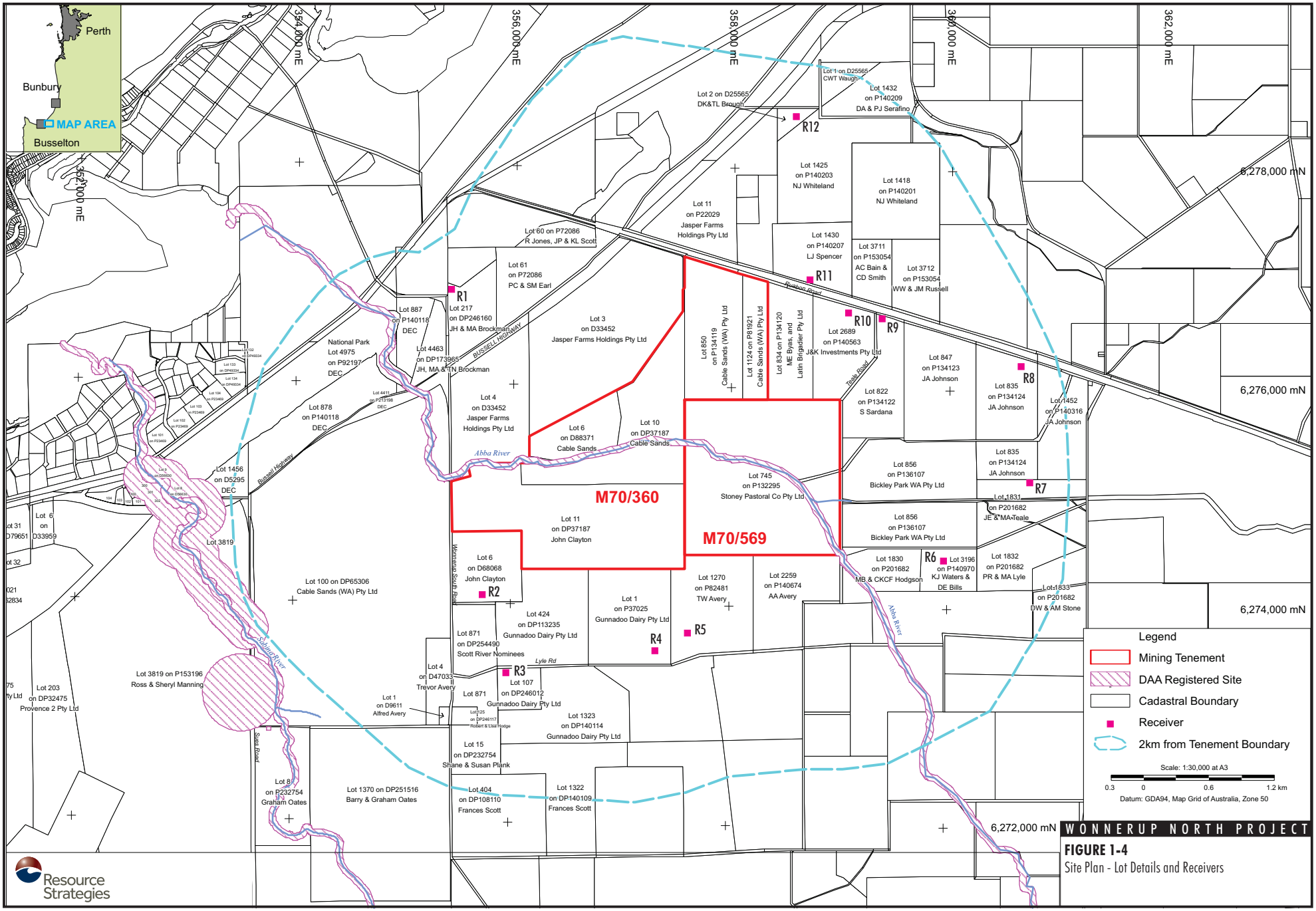
The main Project components and activities are as follows;

- dry mining of mineral sands using conventional mobile equipment at a production rate of up to approximately 2.3 million tonnes per annum (Mtpa);
- vegetation clearing and topsoil stripping above the mineral sands deposit;
- construction and use of administration/office buildings and car parking facilities, workshop and stores, services corridors and laydown areas;
- construction and use of mineral processing and related infrastructure (including a wet processing plant, thickener, pumps and pipelines, towers and stackers for stockpiling heavy mineral concentrates [HMC]);
- backfilling of mined-out areas with sand residues (clays, sands and coarse rejects) generated by the processing of ore at the on-site wet processing plant;
- construction and use of water supply infrastructure including a groundwater bore, process water dam, supply pipelines from the groundwater bore, return water lines and process water pumps;
- construction of on-path solar evaporation ponds and decant water pipelines/drains and sumps;
- installation of an electrical sub-station, connection of it to existing high voltage electricity transmission lines (ETLs), and relocation of existing ETLs around mine disturbance areas;
- construction of internal haul/access roads, including up to three crossings of the Abba River;
- widening of the section of Ruabon Road between M70/360 and the Bussell Highway, and construction of appropriate intersections with the Bussell Highway and at the entrance to M70/360;
- haulage of HMC from the mine site to the Bunbury MSP via the Bussell Highway using 60 tonne (t) trucks between the hours of 7.00 am and 7.00 pm six days per week (Monday to Saturday) excluding public holidays; and
- back-loading of tailings generated during the processing of Project HMC at the Bunbury MSP to the Project site and disposal of the tailings within the mined-out areas of the pit.

A more detailed description of the Project is provided in Section 2 of this ERD.

1.5 CONSULTATION

Cristal has consulted with local landholders and members of the Aboriginal community, the City of Busselton, Office of the Environmental Protection Authority (OEPA), Department of Mines and Petroleum (DMP), Department of Environment Regulation (DER), Department of Water (DoW), Department of Aboriginal Affairs (DAA) and the Department of Parks and Wildlife (DPaW) in regards to the Project.



WONNERUP NORTH PROJECT

FIGURE 1-4

Site Plan - Lot Details and Receivers

Table 1-1 summarises the consultation activities undertaken to date.

Table 1-1
Summary of Project Consultation Activities

Stakeholder	Timing	Consultation Topics
Local landholders	2013, 2014	Land access agreements; exploration drilling programs; environmental surveys and monitoring equipment installation.
Aboriginal Groups/Community	May-June 2013 October-November 2013	Proposed approach to Aboriginal cultural heritage assessment; identification of relevant Aboriginal stakeholders; Project surveys.
City of Busselton	2013 February 2014	Initial Project briefing and proposed use and widening of Ruabon Road for mine access.
OEPA	February 2014	Initial Project briefing; approval process discussion; overview of key environmental factors and EPA objectives.
DMP	February 2014	Initial Project briefing and approval process discussion.
DER	February 2014	Initial Project briefing; preliminary noise assessment findings.
DoW	September 2013 February 2014	Initial Project briefing; conceptual hydrogeological model and proposed approach to numerical groundwater modelling.
DAA	May 2013	Proposed approach to Aboriginal cultural heritage assessment; identification of relevant Aboriginal stakeholders and archaeological consultants.
DPaW	January 2014 February 2014	Initial Project briefing and preliminary flora and fauna survey findings.

Cristal will continue to consult with the above stakeholders and other interested parties during the EIA of the Project. Cristal will also consult with the Commonwealth Department of the Environment (DotE) with regard to matters of national environmental significance and application of the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act).

1.6 STRUCTURE OF THIS DOCUMENT

The structure and overall content of this document is as follows:

Section 1 Describes the purpose of this document, provides details of the proponent, describes the Project location and land tenure, provides a brief Project overview and summarises consultation undertaken by Cristal.

Section 2 Provides a summary of the proposal, including a Key Proposal Characteristics Table.

Section 3 Identifies and describes the relevant environmental factors and EPA objectives, including a description of the existing environment, potential Project-related impacts and proposed management and mitigation measures.

Section 4 Provides a conclusion and discussion of how the EPA's significance framework could be applied to the Project.

Section 5 Lists references contained within the ERD.

2 SUMMARY OF THE PROPOSAL

2.1 KEY PROPOSAL CHARACTERISTICS

The key characteristics of the proposal have been identified in accordance with the EPA's EAG#1 *Defining the Key Characteristics of a Proposal* (EPA, 2012) and are presented in Table 2-1.

Table 2-1
Key Proposal Characteristics

Summary of the Proposal		
Proposal Title	Wonnerup North Mineral Sands Project.	
Proponent Name	Cristal Mining Australia Pty Ltd.	
Short Description	This proposal is to mine and concentrate mineral sands from mining tenements M70/360 and M70/569. The mine is to be located approximately 44 km south of the town of Bunbury in WA and will include the construction and use of associated mine infrastructure (wet separation plant, offices, workshop, roads), road transportation of heavy mineral concentrate to the Bunbury MSP and back-loading of tailings from the Bunbury MSP to the Project for disposal.	
Physical Elements		
Element	**Location**	**Proposed Extent**
1. Mine	Mining tenements M70/360 and M70/569. Refer to Figure 1-4.	Clearing of no more than 475 ha within a 575 ha development envelope.
2. Associated Infrastructure	Mining tenements M70/360 and M70/569, and mine access road. Refer to Figure 1-4.	Clearing of no more than 42 ha within a 575 ha development envelope.
Operational Elements		
Element	**Location**	**Proposed Extent**
1. Mineral Sand Extraction	Mining tenements M70/360 and M70/569.	Mining tenements M70/360 and M70/569.
2. Ore Processing (waste)	Mining tenements M70/360 and M70/569.	Disposal of no more than 44,000 t per annum of back-loaded tailings from the Bunbury MSP in the mined-out Project pits.

The following subsections provide a written summary of the proposal, including the key development actions, activities and processes Cristal intends to undertake as part of the Project.

2.2 MINING OPERATIONS

The Project would extract approximately 16.4 million tonnes (Mt) of mineral sands ore from the Wonnerup North deposit at a rate of approximately 2.3 Mtpa.

Mining is expected to commence in the fourth quarter of 2018, following a six to nine month construction period. The initial open pit excavation would be situated immediately west of the proposed mine infrastructure area (i.e. to the north of the Abba River). Mining would then continue in the western portion of M70/360 (south of the Abba River) and would progress in a counter-clockwise direction though M70/569 and back into the northern part of M70/360 during the eight year mine life. The mining operations would be set back from the Abba River so that it could flow interrupted through the mine site. The undisturbed corridor would be approximately 40 to 175 m wide (Figure 1-3).

The general sequence of mining operations would be as follows:

1. vegetation clearing and topsoil stripping;
2. extraction of mineral sands ore and placement using conventional dry mining equipment (e.g. dozers and loaders);
3. placement of sand residues (i.e. fine residues [clays], sandy residues, coarse rejects [oversize] and tailings from the Bunbury MSP) following mineral processing to either the active mining area (behind the advancing ore extraction area) or in solar evaporation ponds; and
4. progressive rehabilitation behind the advancing mining operation.

Mining operations would be conducted 24 hours per day seven days per week.

2.3 ORE PROCESSING AND TRANSPORT

Mined ore would be screened in a trommel located in the active mining area. Water would be added and it would then be pumped as a slurry to the wet separation plant. The ore slurry feed material would be approximately 30% solids comprising heavy mineral, unconsolidated sands, fine residues and minor amounts of coarse reject material.

At the wet separation plant, the heavy minerals would be separated from the sand residues to produce HMC. Approximately 683,000 t of HMC would be produced over the life of the mine. The HMC would be comprised of approximately 90 to 95% valuable heavy minerals (principally ilmenite, leucoxene, zircon, rutile and monazite) on a dry weight basis.

The majority of the ore processing infrastructure would remain fixed for the duration of the mine life, with the exception of the mining trommel in the active pit, and the pumps and pipelines used to manage water and slurries. The pump and pipeline systems would be constructed progressively within services corridors throughout the mine life and would be used to convey sand residues and HMC to the required disposal or stockpile areas. The majority of pipelines would be located on the surface so they can be relocated easily as the mine progresses.

The HMC would be transported to the Bunbury MSP using 60 t trucks between the hours of 7.00 am and 7.00 pm six days per week (Monday to Saturday) excluding public holidays. The haulage route is shown on Figure 1-1 and would comprise the following public roads:

- Ruabon Road;
- Bussell Highway;
- Bunbury Bypass; and
- Koombana Drive.

Up to approximately 44,000 tpa of tailings generated through the processing of Project HMC at the Bunbury MSP would be back-loaded to the Project and would be buried within the mined-out areas of the pit.

Ruabon Road, which bounds the northern side of M70/360, would be widened up to a maximum of 3.2 m, or 1.6 m on either side on average, to provide the main access to the Project and to accommodate the increase in traffic generated by the HMC haulage (Figure 1-3). The intersection between Ruabon Road and the Bussell Highway and the entrance to M70/360 would be upgraded as necessary in accordance with the City of Bussellton and Main Roads Western Australia approval and requirements.

A secondary mine access point would also be established on the western side of the Project and across Wonnerup South Road (Figure 1-3) to enable access between the Project and the Wonnerup Mineral Sands Mine. During construction, this secondary access point would be used to relocate processing plant and infrastructure from the Wonnerup Mineral Sands Mine to the Project site.

Three internal haul/access road crossings of the Abba River would be constructed during the mine life. These would be designed to minimise disturbance and maintain flows in the Abba River. The river crossings are expected to be constructed as a box culvert or spiral pipe design.

2.4 WATER SUPPLY AND MINE WATER MANAGEMENT

The mineralisation at the Wonnerup North deposit occurs within the Bassendean Sands. It is typically 1.5 to 3.5 m thick and occurs at the surface, but can extend as deep as 5 to 6 m below the surface. The natural groundwater level within the Bassendean Sand superficial aquifer at the Project area is typically within 3.5 m of the surface. As a result, some dewatering of the open pit mining area is expected to be required. Groundwater inflows and incident rainfall that collects in the open pits (i.e. mine water) would be collected via sumps and would be preferentially used in the mine water system to meet the Project water demand (i.e. use in the wet separation plant and for dust suppression).

Water would also drain from the areas within the Project area where partially saturated sand residues and HMC are stored/deposited. Where possible this water would be captured and preferentially used to meet the mine water demand.

During periods where the amount of mine water generated/captured is less than the Project water demand, Cristal would extract make-up water from a licensed bore within the deeper Yaragadee aquifer. Cristal's has an existing *Rights in Water and Irrigation Act, 1914* (RIWI Act) licence (i.e. GWL161841[7]) for the Yarragadee South Water Resource which has a total annual water entitlement of 3.9 gigalitres (GL) and includes the current production bore at the Wonnerup Mineral Sands Mine (i.e. WPB1 – Figure 1.3), as well as various bores at Cristal's Gwindinup, Ludlow and North Shore sites in south-west WA . Cristal intends to fit-out one or two of the existing bores located within the Project area (i.e. WNPB1 and WNPB2 - Figure 1-3) and would seek to include them as nominated extraction points in its existing groundwater extraction licence.

The Project water supply bore(s) would be used to extract up to approximately 1.6 GL per annum to meet the Project make-up water demand. Water extracted from the Yarragadee aquifer would be transferred to the process water dam (located in the mine infrastructure area) then reticulated by pumps and pipeline systems via service corridors to processing infrastructure such as the dry mining units and wet separation plant. The location of pump and pipeline systems would be adjusted as necessary during the mine life as the active mining area advances.

Cristal would implement an on-site water management system which would be used to keep uncontaminated water separate from contaminated water or potentially contaminated storm water. As per the existing Part V EP Act licence for the Wonnerup Mineral Sands Mine (L8739/2013/1), Cristal would manage SEPs, tailings dams and water management dams so that minimum freeboard heights are retained. The licence would specify the relevant freeboard/criteria.

In the event that there is excess water in the Project water management system (e.g. groundwater inflows exceed Project make-up water requirements), Cristal would dispose of it through controlled release into the Abba River (i.e. as is the case at the existing Wonnerup Mineral Sands Mine). Cristal anticipates that the Part V EP Act licence issued for the Project would include conditions specific to this activity (i.e. approved release point location, and target and maximum criteria for key water quality parameters).

2.5 POWER SUPPLY

Power would be sourced from the existing power supply infrastructure located within the Project area (Figure 1-3). The infrastructure would be upgraded to an approved mine site supply switch yard and internal ETLs.

The existing ETLs that cross the proposed mine path would either be de-energised and removed (if no longer required), mined under (i.e. poles left on an undisturbed 15 m to 20 m wide 'island'), or relocated around the planned disturbance areas.

2.6 WASTE MANAGEMENT AND STORAGE OF CONSUMABLES

Waste materials generated by the Project would include:

- Sand residues generated on-site from the wet processing plant and tailings back-loaded from the Bunbury MSP;
- recyclable and non-recyclable general wastes; and
- other wastes from mining operations and workshop activities (e.g. used tyres, scrap metal, waste hydrocarbons and oil filters).

With the exception of the sand residues and MSP tailings, no waste would be disposed of on-site.

General waste minimisation principles (i.e. reduce, re-use and recycle) would be applied at the Project.

All general domestic waste and general recyclable products would be collected from the Project by an appropriately licensed contractor.

Waste tyres would be stockpiled (and/or re-used as delineators on-site), prior to collection by contractors and removal from site. Scrap metal produced at the workshops during the life of the mine would be collected by a scrap metal merchant for recycling.

Waste hydrocarbons and oil filters would be collected by licensed contractors. Workshop hydrocarbon spills and leaks, and truck washdown areas would be contained by purpose-built oil/water separator systems which would be inspected and maintained regularly.

Liquid wastes from hydrocarbon/chemical spills and leaks, and truck wash down areas would be contained in purpose-built oil/water separator systems which would be inspected and maintained regularly.

As per the existing Part V EP Act licence for the Wonnerup Mineral Sands Mine, all substances classified as dangerous goods or hazardous substances would be stored at the Project in accordance with the DMP's Code of Practice for the Storage and Handling of Dangerous Goods.

2.7 DUST SUPRESSION

The following management measures would be implemented to minimise dust emissions:

- water carts would be used for dust suppression on haul roads;
- open areas and stockpiles subject to wind erosion would be stabilised using clay fines or other additives, and
- mine voids would be progressively rehabilitated.

2.8 PROGRESSIVE REHABILITATION AND MINE CLOSURE

Sand residues generated at the wet processing plant would be placed behind the active mining area and would be progressively rehabilitated during the mine life. It is expected that the final rehabilitated land surface would be the same or very similar to the pre-mining topography. The final land use would be determined in consultation with the relevant Government agencies and landowners; however it is expected to be predominately agricultural, with some areas of native vegetation. As is the case at the existing Wonnerup Mineral Sands Mine, local provenance seeds and propogating material would be used in areas rehabilitated to native vegetation communities.

2.9 PROJECT SCHEDULE AND WORKFORCE

Subject to Cristal obtaining all necessary approvals, the construction phase is expected to commence in the first quarter of 2018, and would be approximately six to nine months in length. The proposed life of the Project is approximately eight years, with mining assumed to commence in the fourth quarter of 2018. Mine closure works would occur over the period from 2025 to 2027 based on the proposed mining rate and current heavy mineral reserve.

The construction workforce is expected to be approximately 50 employees, and the operational workforce would be approximately 80 employees. It is expected that many of the existing employees would transfer across to the Project from the Wonnerup Mineral Sands Mine when it ceases operation in 2017/2018. The majority of the mobile and fixed equipment (i.e. most of the mining fleet and wet separation plant) currently used at the Wonnerup Mineral Sands Mine would also be transferred across and used at the Project.

2.10 CRISTAL'S EXISTING ENVIRONMENTAL MANAGEMENT FRAMEWORK

Cristal has an Environmental Management System (EMS) certified to ISO 14001. The core of the EMS is the company's Environmental Policy, which has been approved and signed by Cristal's Operations Manager.

Cristal's EMS has been implemented at the Wonnerup Mineral Sands Mine, and various environmental management plans and monitoring programs have been developed in accordance with the mine's approval requirements. The EMS would be used to help implement best practice environmental management during all phases of the Project. The EMS is complemented by a certified Quality Management System (AS/NZS ISO 9001) and a certified Safety Management System (OHSAS 18001 and AS 4801).

The EMS designates the responsibilities of the various staff positions and/or levels, as summarised in Table 2-2.

Table 2-2
Responsibilities Prescribed by the Cristal EMS

Role	Responsibility
Operations Manager	Responsibilities include ensuring that all Cristal activities conform to the Environmental Policy.
Safety Health and Environmental Manager (SHE)	Responsibilities include ensuring systems implemented meet statutory and other requirements, including an effective and adequate mechanism for liaising with the local community regarding environmental and amenity issues.
Mining Manager	Responsibilities include ensuring that the mine is designed, developed and operated in accordance with company policies, approvals, permits and other undertakings.
Senior Environmental Officer – Operations and Compliance	Responsibilities include monitoring compliance with relevant environmental legislation and regulations, managing the EMS, maintaining documents and records to demonstrate conformance, and identification of non-conformances with the EMS.
All employees	Responsibilities include ensuring that all operations are carried out in accordance with specified procedures and work practices.

An overview of the key components of the EMS (i.e. hazard identification, communication, community consultation and complaints procedures, monitoring, auditing, reviewing and reporting) is provided below.

Hazard Identification

Environmental aspects, which are at risk of being impacted upon by the mining operations, are identified using the procedures set out in internal EMS and standard operating procedures.

Communication

The EMS contains procedures for managing internal and external communications of environmental matters. Environmental hazards and incidents are reported using an incident report system (CD018). All external complaints automatically generate an incident report that is forwarded to and dealt with by Cristal's Environment Department.

Community Consultation and Complaint Procedures

Cristal consults with residents and other interested stakeholders with the purpose of informing the community about environmental issues, including noise, or to obtain community feedback and attitudes towards its operations and performance.

Environmental complaints are systematically processed through the Cristal EMS. Responsibility for action lies with Cristal's SHE Manager. Cristal's Environment Department reports complaints and other non-conformances that are related to environmental approvals or permits to the appropriate government regulator.

Monitoring

In addition to collecting baseline data, monitoring is undertaken to verify impact predictions, assess the effectiveness of management measures and drive continual improvement. Monitoring is coordinated by Cristal's Senior Environmental Officer and is conducted in accordance with the appropriate procedures.

Auditing

Cristal routinely conducts internal audits to assess the compliance with, and effectiveness of the various components of its EMS. In addition, the entire EMS is audited externally every year, with a full re-certification audit every three years. Audit findings are reviewed by the Integrated Management Systems Committee, including Cristal's Operations Manager, and acted upon by Cristal's Senior Environmental Officer, through the EMS.

Review and Reporting

Monitoring results and performance and compliance assessments are reported each year to the relevant Government agencies and can be made available to relevant stakeholders on request.

Wonnerup Mineral Sands Mine Environmental Management Plans and Monitoring Programs

Environmental management measures, plans and monitoring programs developed and implemented at Cristal's nearby Wonnerup Mineral Sands Mine include the following:

- Water Management Plan (requirement of the EPBC Act Approval [EPBC 2010/5403]);
- Acid Sulphate Soils Management Plan (requirement of the EPBC Act Approval);
- Western Ringtail Possum Management Plan (requirement of the EP Act Clearing Permit [3984/2] and the EPBC Act Approval);
- Cockatoo habitat identification and management measures (requirement of the EP Act Clearing Permit);
- Traffic Management Plan for Wonnerup South Road (requirement under the Planning Consent issued by the City of Busselton [DA/0320]);
- Rehabilitation Plan (requirement under the Planning Consent issued by the City of Busselton);
- Operating Strategy for Yarragadee Production Bores, GWL 161841 (requirement under the RIWI Act Licence to Take Water [GWL161841]); and
- routine groundwater, surface water, meteorology and noise monitoring programs.

Cristal prepares annual environmental performance reports and/or provides monitoring data to DoW, DotE, and DER as per the requirements of the environmental approvals for the Wonnerup Mineral Sands Mine.

This ERD includes references to management measures and monitoring programs contained in the above plans and programs. It is envisaged that the EMS and relevant plans and monitoring programs would be extended to the Project where relevant.

3 ENVIRONMENTAL FACTORS

Environmental factors relevant to the Project have been identified in consultation with the OEPA, DMAs and in accordance with the EPA's Environmental Assessment Guideline No. 8 (EAG#8) *Environmental Assessment Guideline for Environmental Factors and Objectives* (EPA, 2013b). The relevant factors are:

- hydrological processes (Section 3.1);
- flora and vegetation (Section 3.2);
- terrestrial environmental quality (Section 3.3);
- terrestrial fauna (Section 3.4);
- amenity (Section 3.5);
- heritage (Section 3.6); and
- rehabilitation and closure (Section 3.7).

For each of the above, the following aspects are addressed in this ERD:

- relevant environmental objectives;
- a description of the existing environment in the local area and region based on available survey and assessment information;
- potential impacts of the Project (including direct, indirect and cumulative impacts where relevant); and
- management measures that would be adopted in order to minimise potential impacts.

Section 4 provides a conclusion regarding the overall potential impacts of the Project, including a review of each environmental factor in terms of the EPA's significance framework (EPA, 2013a).

3.1 HYDROLOGICAL PROCESSES

3.1.1 EPA Objective for Hydrological Processes

The EPA's objective for hydrological processes is:

- *To maintain the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance, are protected.*

3.1.2 Existing Environment

Project mining tenements M70/360 and M70/569 are located on the Swan Coastal Plain less than 5 km from the current coastline and approximately 7 km from the Whicher Scarp and adjoining Blackwood Plateau (Figure 1-1). The elevation across the Project area generally ranges between 5 m Australian Height Datum (AHD) and 10 m AHD. The Project area slopes gently in a north-westerly direction towards the coastline.

The Project is situated within the Abba River catchment, which occupies an area of approximately 128 km^2 at the Abba River gauging station (610016) which is located near the Bussell Highway (Figure 3-1). The Abba River enters the Project area in the south-east corner of M70/569 and bends to flow in a westerly direction through the majority of the site to the M70/360 western boundary (Figure 3-1), before discharging into the Vasse-Wonnerup Wetland System located approximately 2 km downstream (Figure 1-2b). The Vasse-Wonnerup Wetland System is listed under the RAMSAR convention as a wetland of international importance.

The Abba River within the Project area is ephemeral, with flows typically only occurring during the winter months. The available data from the Abba River gauging station shows a mean annual flow in the order of 15 gigalitres per annum (GL/annum) (equivalent to 41 megalitres per day [ML/day]), but a median flow of just 2 ML/day.

The main channel of the Abba River varies from a few metres wide (up to 10 m) and is typically 1 m deep within the Project area. Its banks are typically 2 m to 3 m high in the western downstream portion of the site, but become shallower and less able to be distinguished in the upstream parts of the Project area. The Abba River is used for stock watering within the Project area when there is flow or pools of suitable quality.

Cristal has commissioned RPS Australia East Pty Ltd (RPS) to undertake a groundwater impact assessment of the Project, including a literature review, hydrogeological investigation program, development of a conceptual hydrogeological model and a groundwater impact assessment using a regional numerical groundwater model.

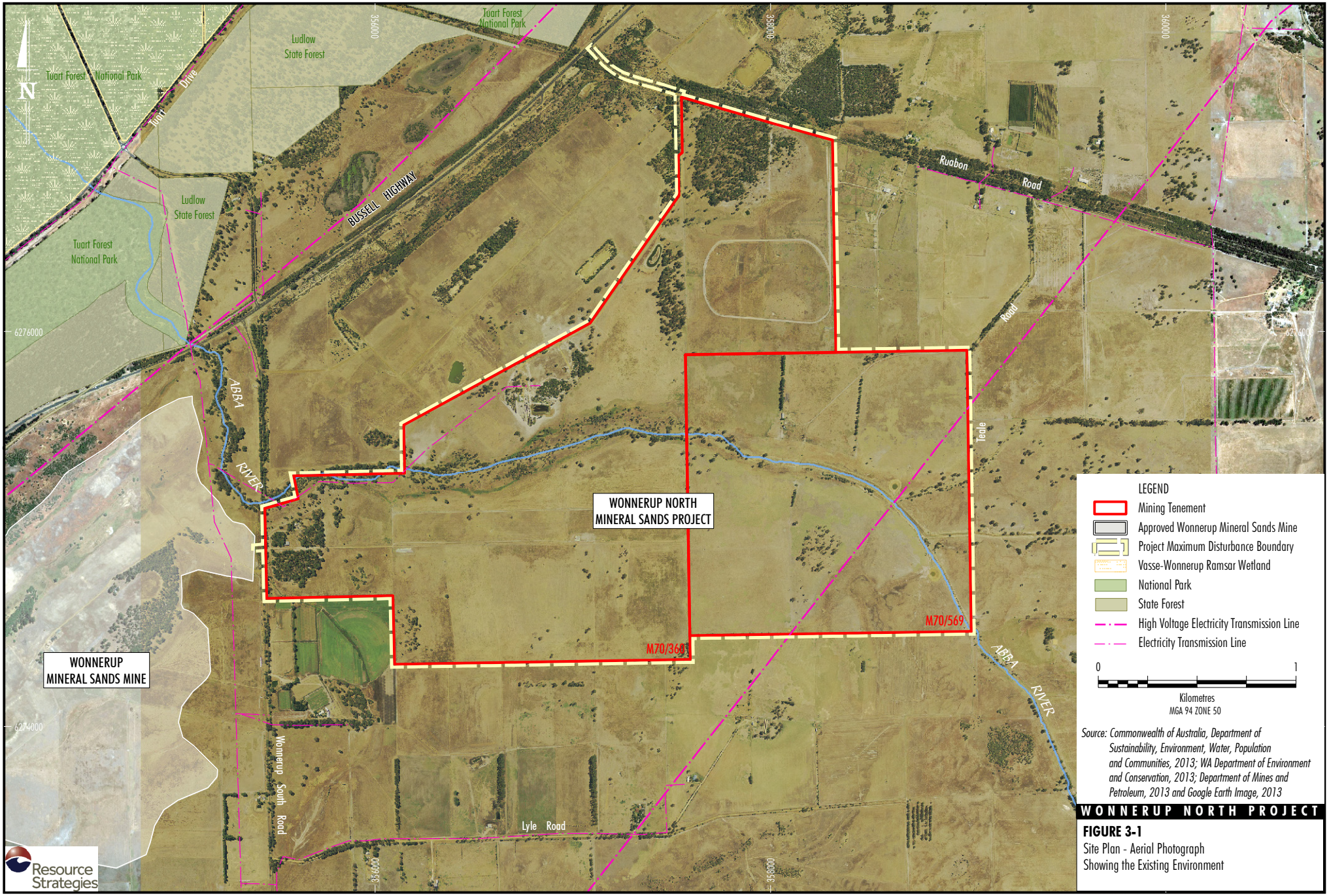
There is a significant body of work on the hydrogeology of the Swan Coastal Plain. The conceptual hydrogeological model of the Project area has been based on a review of this work by RPS, as well as the findings of the Project-specific hydrogeological investigation program. Figure 3-2 illustrates the conceptual hydrogeological model.

The conceptual hydrogeological model proposed for the site by RPS is that the Project would involve excavation into a thin, low permeability aquifer system, underlain by clays and mudstones which separate the upper superficial aquifer (Bassendean Sands) from the deeper and more permeable aquifer systems (Leederville Sands and Yarragadee Formations).

The Project hydrogeological investigation program was undertaken in June and July 2013 and included the drilling, construction, and hydraulic testing (i.e. slug and pumping tests) of ten monitoring bores in the Project area. The locations of the ten bores are shown on Figure 3-3.

The investigation program identified that the superficial aquifer which occurs within the Project area is perched locally on coffee rock or clays/mudstones. It is generally less than 4 m thick and has a water table that is typically up to 3.5 m below ground level. The water table generally shows a seasonal fluctuation of approximately 1 m.

Recharge of groundwater to the superficial aquifer is mostly from rainfall. Groundwater is discharged from the aquifer to the ocean and the coastal swamps, and to surface drainage channels such as the Abba River. There is only a minor component of leakage to the underlying Leederville Formation.



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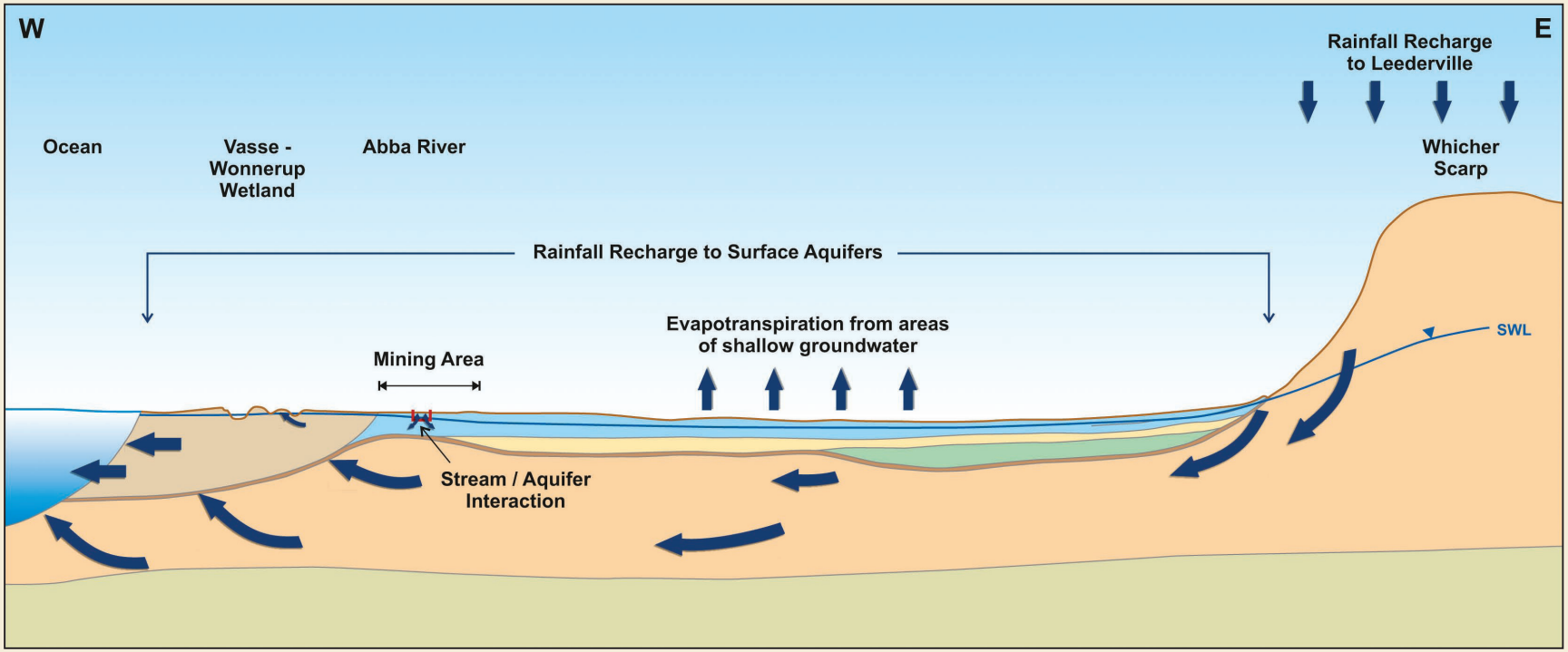


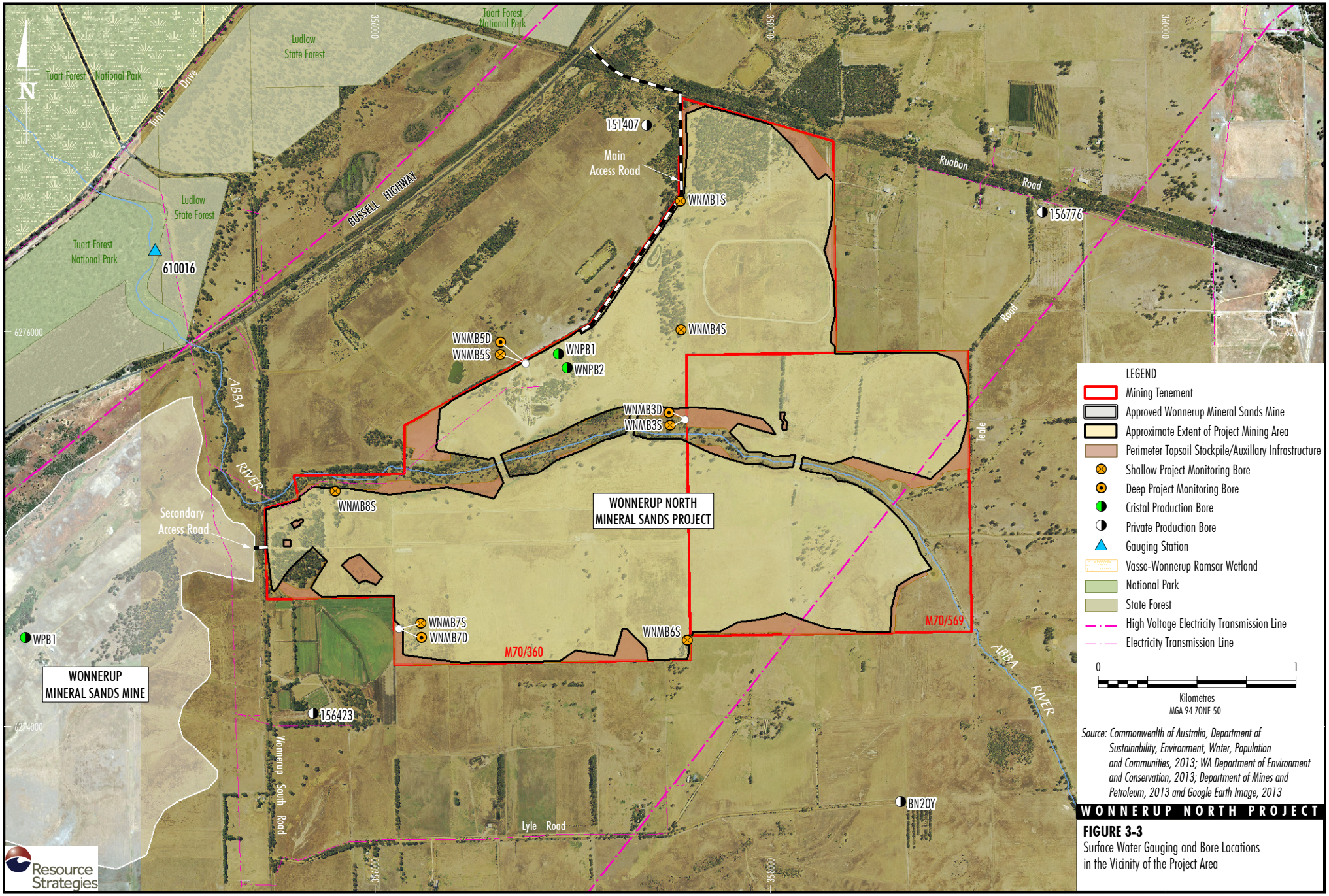
LEGEND

- Basendeen
- Guildford
- Tamala
- Yoganup
- Leederville mudstones/clays
- Leederville
- Yarragadee
- Approximate Water Table
- River

WONNERUP NORTH PROJECT

FIGURE 3-2
Conceptual Hydrogeological Model

CMA-13-01 EPA Ref_002A



WONNERUP NORTH PROJECT

FIGURE 3-3
Surface Water Gauging and Bore Locations in the Vicinity of the Project Area

When the superficial groundwater at the Project area was sampled by RPS in July 2013, it was found to be of a sodium chloride, and fresh to mildly brackish with salinity (Total Dissolved Solids – TDS) ranging from 620 milligrams per litre (mg/L) to 2,600 mg/L. Water in the Abba River was found to be similar in composition to the shallow bores, but had a TDS to chloride ratio similar to the deeper bores suggesting that there may be vertical leakage from the deeper (i.e. Leederville) aquifer upwards to the River. The superficial aquifer is regarded by Hirschberg (1989) as being of relatively minor importance to the region because of its limited thickness, predominantly clayey nature of the superficial formations, and because it is commonly too saline for domestic use.

The Leederville Formation and its associated aquifer underlies the superficial deposits across a large portion of the Swan Coastal Plain. The aquifer can be up to 200 m thick in places, but is normally less than 100 m thick. In broad terms, the Leederville aquifer receives recharge from an area near the Whicher Scarp and discharges towards the coast. Groundwater in the Leederville aquifer is also of a sodium chloride type, with the Total Dissolved Solids (TDS) concentration typically less than 500 milligrams per litre (mg/L). Dissolved iron within the Leederville aquifer is typically high (Hirschberg, 1989). The Leederville aquifer is widely used on the Swan Coastal Plain for town water supply, industrial use and horticulture.

The Yarragadee Formation and its associated aquifer underlie the Leederville Formation. It is up to 500 m to 600 m thick in the Busselton area. The Yaragadee aquifer receives recharge through surface recharge and by downward leakage from the Leederville Formation, especially in the inland areas around the Whicher Scarp where downward heads prevail. Groundwater flow in the aquifer is from the higher ground and recharge areas of the Blackwood Plateau towards the coast. The water quality of the Yarragadee aquifer is considered to be fresh, with the TDS typically ranging from 230 to 900 mg/L. The relative proportions of major ions are similar to those in the Leederville Formation, suggesting a close relationship between the two aquifers in the Project area.

The Yarragadee aquifer is regionally significant as a source of groundwater due to its large extent, thickness and good water quality. Groundwater uses include mining, industrial, town water supply and irrigation.

RPS has identified groundwater users in the vicinity of the Project area with existing licensed bores in the Yarragadee aquifer. Figure 3-3 shows the location of these registered bores. The figure also shows the two existing bores located within the Project area (i.e. WNPB1 and WNPB2), which Cristal intends to use to meet the make-up water demand (Section 2.4).

The largest nearby users of the Yarragadee aquifer are the turf farm located to the south-west (i.e. GWL 156423) and the planned avocado farm situated to the north (i.e. GWL 151407). These farms use (or propose to use) the groundwater for irrigation and currently have allocations of 0.4 GL/annum and 2.8 GL/annum, respectively.

3.1.3 Potential Impacts

Key hydrological regimes within the Project area and surrounds are:

- the Abba River;
- the Vasse-Wonnerup Wetland System;
- the superficial groundwater aquifer; and
- the Leederville and Yarragadee aquifers.

Potential Project-related impacts on the existing use of these resources include the following:

- erosion and sedimentation from Project disturbance areas adversely affecting water quality in the Abba River;
- changes to stream flow in the Abba River at the site of the proposed internal haul/access road crossings;
- localised changes to the groundwater levels in the superficial aquifer (i.e. drawdown and mounding) and changes to baseflow amounts in the Abba River, as a result of the excavation of the orebody and replacement of sand residues in the mine void;
- drawdown of the deeper Leederville and/or Yarragadee aquifers due to abstraction from the Project water supply bore to meet the Project water demand; and
- controlled release of excess water into the Abba River.

3.1.4 Proposed Management and Potential Impacts

Cristal has commissioned RPS to conduct a surface water and groundwater assessment of the Project. The study is currently being conducted and includes a review of the available literature and monitoring data, collection of additional hydrogeological information, identification and modelling of potential surface water and groundwater impacts, and development of suitable management strategies to minimise impacts on hydrological regimes.

A summary of the above Project-related impacts and how they would be managed by Cristal is provided below based on the preliminary findings of the RPS studies.

Erosion and Sedimentation

The proposal would require the disturbance of approximately 517.5 ha within the Project area. The majority of this area would be required to mine the Wonnerup North deposit and would be cleared in stages, backfilled with sand residues, and progressively rehabilitated as the mine develops. Some disturbance areas would remain in use for the life of the Project (e.g. the mine infrastructure area and mine access road).

As described in Section 2.2, the mining operations would be set back from the Abba River leaving an undisturbed buffer of no less than 40 m (Figure 1-3). This would provide the main control to prevent erosion and sedimentation from Project disturbance areas adversely affecting water quality in the Abba River. Notwithstanding, Cristal would install erosion and sediment control measures around active mine areas in order to minimise potential impacts. These measures would include, but would not necessarily be restricted to, minor diversion channels and bunds, silt traps, sediment dams and rapid surface stabilisation techniques (e.g. hydromulching, surface glues, seeding).

Rehabilitation of disturbed areas would be conducted as soon as possible after they have been mined and are otherwise no longer required.

Changes to Stream Flow in the Abba River

The Project would require the construction of up to three haul/access roads across the Abba River in order for mining equipment to pass from one side of the Project area to the other. As described in Section 2.3, these crossings would be designed to minimise disturbance and maintain flows in the Abba River. The river crossings are expected to be constructed as a box culvert or spiral pipe design, and would be designed to maintain access during small to medium-sized flow events. During larger flood flow events the crossings may be temporarily impassable, with access to be provided by the main access and secondary access roads until flood flows recede.

Flood protection bunds or similar would be installed immediately adjacent to the mine disturbance areas in order to prevent flood waters from the Abba River inundating the Project area. These bunds would be designed to accommodate the appropriate Annual Recurrence Interval flow event, and would be removed once the adjoining area has been mined, rehabilitated and is no longer required.

Localised Changes to Groundwater levels in the Superficial Aquifer

RPS has developed a regional numerical groundwater model in order to assess the potential impacts of the Project mining activities on groundwater resources. The model covers a 20 x 17 km area bounded by the Ludlow River (to the north-east), the Sabina River (to the south-west), the coastline (to the north-west) and a nominated boundary parallel to the Whicher Scarp (to the south-east). The model comprises five layers, including the superficial aquifer, and underlying aquitards and aquifers (i.e. Leederville and Yarragadee).

The preliminary results of the groundwater modelling indicate that the localised drawdown effect of the Project on the superficial aquifer would be very similar to Cristal's existing Wonnerup Mineral Sands Mine. The predicted maximum drawdown within the Project area is 4.5 m after four years of mining in the immediate pit area, with a drawdown of 1 m not predicted to extend more than 100 m past the mining tenement boundaries. The drawdown effects would be temporary (i.e. they would occur when mining is occurring in a particular area, but would rapidly diminish once mining progresses to the next area).

Placement of saturated sand residues behind the active mining area would result in localised groundwater mounding. A maximum water level increase of 3.5 m is predicted in the immediate pit area, with an increase in water level of 1 m not predicted to extend more than 50 m past the mining tenement boundaries. The predicted mounding effects would also be temporary, with groundwater levels generally expected to recede back to the pre-mining range within six to twelve months of any particular area being mined.

During periods when mining activities would be closest to the Abba River, the reduced water levels close to the river are predicted to result in greater recharge to the underlying aquifer from surface flows. During these short periods of around six months, the recharge is predicted to increase by approximately 150 kilolitres per day (kL/day). As a counter to this effect, backfilling the pits with saturated sand residues from the wet processing plant is predicted to lead to short-term mounding of groundwater beneath each actively backfilled pit. In the areas closest to the Abba River, this would result in a temporary increase in recharge to the river (i.e. baseflow) by up to 100 kL/day.

Nil to negligible groundwater drawdown in the superficial aquifer is predicted to extend to the Ludlow State Forest (i.e. greater than 625 m past the mining tenement boundary), Tuart Forest National Park (i.e. greater than 875 m past the mining tenement boundary) and the Vasse-Wonnerup Wetland System (i.e. greater than 1,750 m past the mining tenement boundary).

The above findings indicate that the potential impacts of the Project on the superficial aquifer would be localised, temporary in duration, and relatively small. Notwithstanding, Cristal would adopt the following management measures in order to meet the EPA's objective of maintaining the superficial aquifer's existing and potential beneficial uses, including ecosystem maintenance *viz.*:

- Where possible, the parts of the Wonnerup North deposit located immediately adjacent to the parts of the Abba River with stands of remnant native vegetation would be mined during the wetter months in the middle of the year in order to minimise the effect of increased recharge to the superficial aquifer from the Abba River. This management approach would also be used to minimise the potential impact of Project-related drawdown on the riparian vegetation adjacent to the Abba River.
- The Project groundwater monitoring program would be used to assess the predicted verses actual changes to water levels in the superficial aquifer within the Project area and surrounds.
- In the event monitoring indicates that water level changes are greater than predicted, or are likely to be if no action is taken, Cristal would implement appropriate mitigation strategies or contingency measures. These may include, but would not necessarily be limited to: adjustments to the mining operations to minimise drawdown or mounding effects; use of water-filled trenches or spears to locally raise groundwater levels near riparian vegetation; and provision of alternative water supplies to other users if required.
- The numerical groundwater model would be periodically reviewed and revised as necessary based on the monitoring results and operational experience.

Drawdown of the Deeper Leederville and Yarragadee Aquifers

The Project would not involve abstraction from the Leederville aquifer. As a result, no significant drawdown effects on this aquifer are predicted to occur.

The Project would require abstraction of up to 1.6 GL/annum of make-up water from the Yarragadee aquifer (Section 2.4). This water would be abstracted from one of two existing bores (i.e. WNPB1 and WNPB2) located within the Project area (Figure 3-3).

Cristal has commissioned RPS to model the impact of the proposed extraction from WNPB1 and/or WNPB2 on groundwater levels in the Yarragadee aquifer, and in particular, the effect on other licensed Yarragadee bores in the vicinity of the Project (Figure 3-3). The preliminary results indicate that pumping at a rate of 1.6 GL/annum over the life of the Project would result in maximum predicted drawdowns at non-Cristal owned Yarragadee production bores of 1.4 m at GWL 156776, approximately 2 m at GWL 156423 and BN20Y, and approximately 3 m at GWL 151407.

Management measures that would be adopted to minimise the potential impacts of the Project on the Yarragadee aquifer and its beneficial uses are listed below:

- All water abstraction would be conducted in accordance with the conditions of Cristal's groundwater licence and attendant Groundwater Operating Strategy.
- The Project groundwater monitoring program would be used to assess the predicted verses actual changes to water levels in the Yarragadee aquifer.
- In the event that the monitoring indicates that water level changes are greater than predicted, or are likely to be if no action is taken, Cristal would implement appropriate mitigation strategies or contingency measures. These may include, but would not necessarily be limited to: reducing the volume of abstraction from WNPB1 or WNPB2 to minimise drawdown effects; and enactment of appropriate compensatory measures for other users if required.

- The numerical groundwater model would be periodically reviewed and revised as necessary based on the monitoring results and operational experience.

Controlled Release of Excess Water into the Abba River

The surface water impact assessment of the Project by RPS has included evaluation of the site water balance. The preliminary results show that for the majority of the mine life there would be a water deficit, which would be met through extraction from the Yarragadee production bore(s). However, two peaks in groundwater inflow to the open pit were predicted in Q1 2019 and Q3 2022. If these peaks eventuate, the amount of water that drains to the open pit may exceed the Project demand, in which case controlled discharge to the environment would be required. The neighbouring Wonnerup Mineral Sands Mine has a similar situation, with the controlled discharge being conducted in accordance with Cristal's existing Part V EP Act licence (L8739/2013/1).

Cristal anticipates that the Part V EP Act licence issued for the Project would include specific conditions pertaining to controlled discharge (i.e. approved release point location and target and maximum criteria for key water quality parameters). Cristal would manage its mining operations during the predicted mine inflow peak periods in Q1 2019 and Q3 2022 to minimise the potential for excess water discharge being required.

3.2 FLORA AND VEGETATION

3.2.1 EPA Objective for Flora and Vegetation

The EPA's objective for flora and vegetation is:

- *To maintain representation, diversity, viability and ecological function at the species, population and assemblage level.*

3.2.2 Existing Environment

Astron Environmental Services (Astron) has been commissioned by Cristal to survey and describe the existing flora and native vegetation remnants occurring within the Project area and surrounds and to conduct an assessment of the potential impacts on flora and vegetation.

A desktop assessment has been completed that included database searches of the Department of Environment and Conservation (DEC [now DPaW]) databases, and the Commonwealth Protected Matters search tool to identify occurring and potentially occurring threatened ecological communities and flora species listed under the WA *Wildlife Conservation Act, 1950* (WC Act) and/or the EPBC Act. These searches also identified occurring and potentially occurring priority ecological communities and priority flora species recognised by DPaW.

The desktop assessment revealed that 25 plant taxa listed as rare flora under the WC Act (all of which were also listed as threatened under the EPBC Act) are located within a 10 km radius of the Project area. In addition, two priority one (P1), five priority two (P2), ten priority three (P3) and eleven priority four (P4) taxa have been recorded within the same search radius. Astron notes, however, that many of these conservation listed taxa are restricted to particular habitats not found within the Project area (e.g. Whicher Scarp and Busselton ironstone) and are therefore not likely to occur.

Following the desktop review, Astron conducted a two-phase Level 2 flora and vegetation survey. The first phase was conducted in June 2013 and the second phase was conducted in October 2013. The surveys were undertaken in accordance with the EPA's *Position Statement 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA, 2002) and the EPA's *Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA, 2004a).

Five vegetation complexes have been previously mapped across the Project area (Mattiske and Havel, 1998) and each of these units is described with the more recent assessment of reservation and pre-European status (Havel and Mattiske, 2002). They include:

- Abba complexes (AB, AF, Ad, and Aw); and.
- the Ludlow complex (Lw).

In order to maintain consistency with the previous vegetation mapping, the vegetation within the Project area was assigned to one of the pre-defined complexes already mapped by Astron. The previous vegetation mapping was, however, undertaken at a broader scale (1:50,000) than the Astron survey (1:5,000) so the boundaries of the broader mapping were refined following ground-truthing. The vegetation units mapped are herein referred to as vegetation communities. Figure 3-4 shows the vegetation communities mapped by Astron.

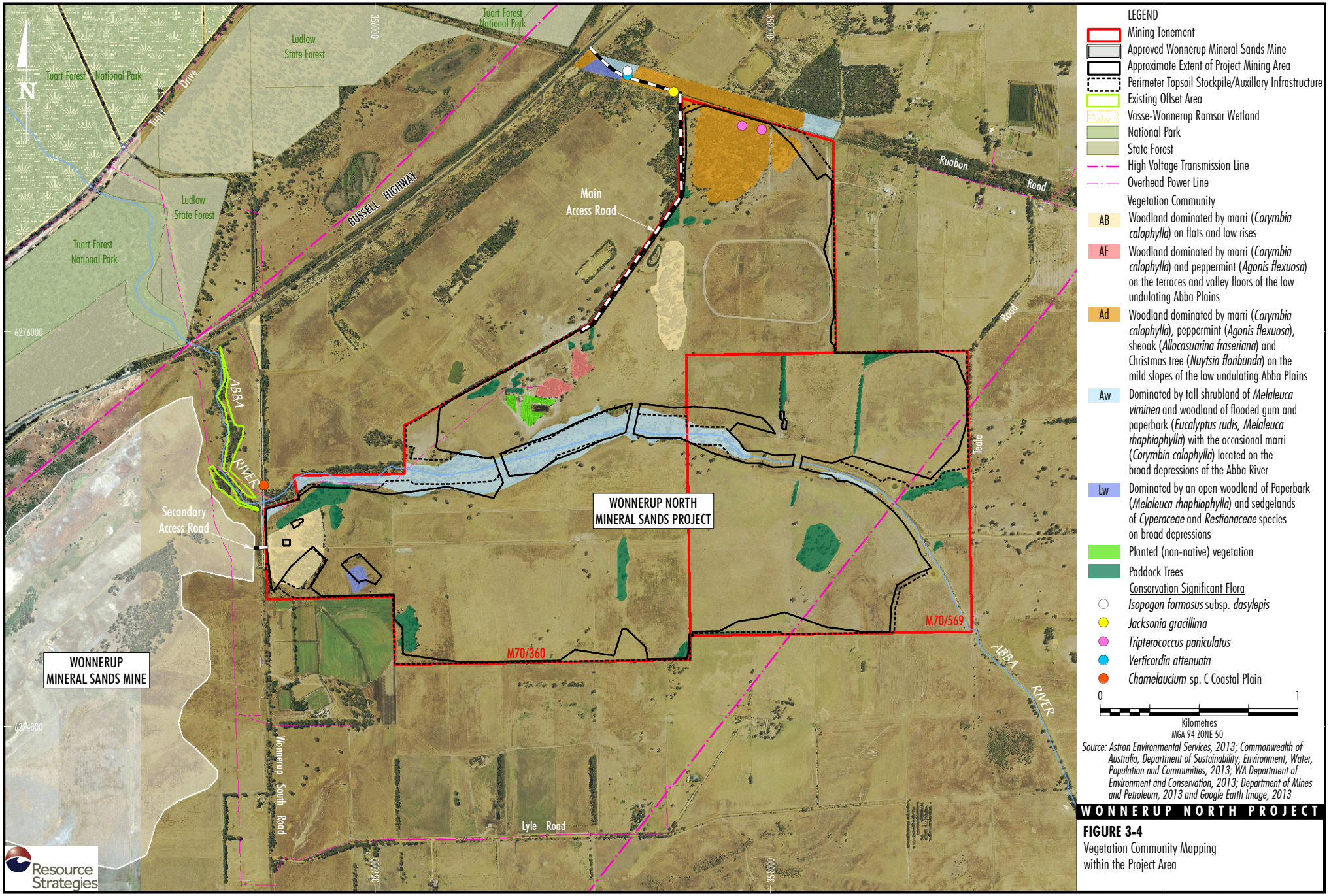
The understorey of most of the remnant vegetation that occurs within the Project area was found to be in a degraded or completely degraded condition (Figure 3-5). Small areas of remnant vegetation that are less degraded ('Degraded to Good' condition) occur in the northern part of M70/569 near Ruabon Road (Figure 3-5).

The only intact remnant vegetation within the area surveyed was found in the road reserves along both sides of Wonnerup South Road and Ruabon Road (Figure 3-5). The vegetation on the east side of Wonnerup South Road was found to have a fine mosaic of condition ranging from good to degraded condition to completely degraded condition (Figure 3-5). The west side of the road ranged from degraded condition to completely degraded (with some areas completely cleared of remnant vegetation) (Figure 3-5). The Project would involve minimal disturbance to the vegetation within the Wonnerup South Road reserve (i.e. less than 0.1 ha).

The road reserve along Ruabon Road retained reasonable stands of intact vegetation that is considered by Astron to be in excellent condition. In addition, two seasonally inundated areas exist near the Bussell Highway intersection, which remain in relatively good to very good condition despite past disturbance (Figure 3-5). As described in Section 2.3, Ruabon Road would be widened up to a maximum of 3.2 m, or 1.6 m on either side on average, to provide the main access to the Project.

A total of 201 vascular flora species representing 49 plant families and 130 genera were recorded during the surveys. A total of 38 weed species were recorded in the Project area, four of which are listed as declared plants under the WA *Biosecurity and Agriculture Management Act, 2007* (i.e. the Bridal Creeper [*Asparagus asparagoides*]; Narrowleaf Cotton Bush [*Gomphocarpus fruticosus*], Apple of Sodom [*Solanum linnaeanum*] and Arum Lily [*Zantedeschia aethiopica*].

The Atlas of Groundwater Dependent Ecosystems (BoM, 2014) indicates the potential occurrence of groundwater dependent ecosystems in the locality. Some of the existing vegetation in the Project area is likely to be at least partially groundwater dependent, in particular the riparian vegetation adjacent to the Abba River outside of the Project area.



Source: Astron Environmental Services, 2013; Commonwealth of Australia, Department of Sustainability, Environment, Water, Population and Communities, 2013; WA Department of Environment and Conservation, 2013; Department of Mines and Petroleum, 2013 and Google Earth Image, 2013

WONNERUP NORTH PROJECT

FIGURE 3-4
Vegetation Community Mapping within the Project Area

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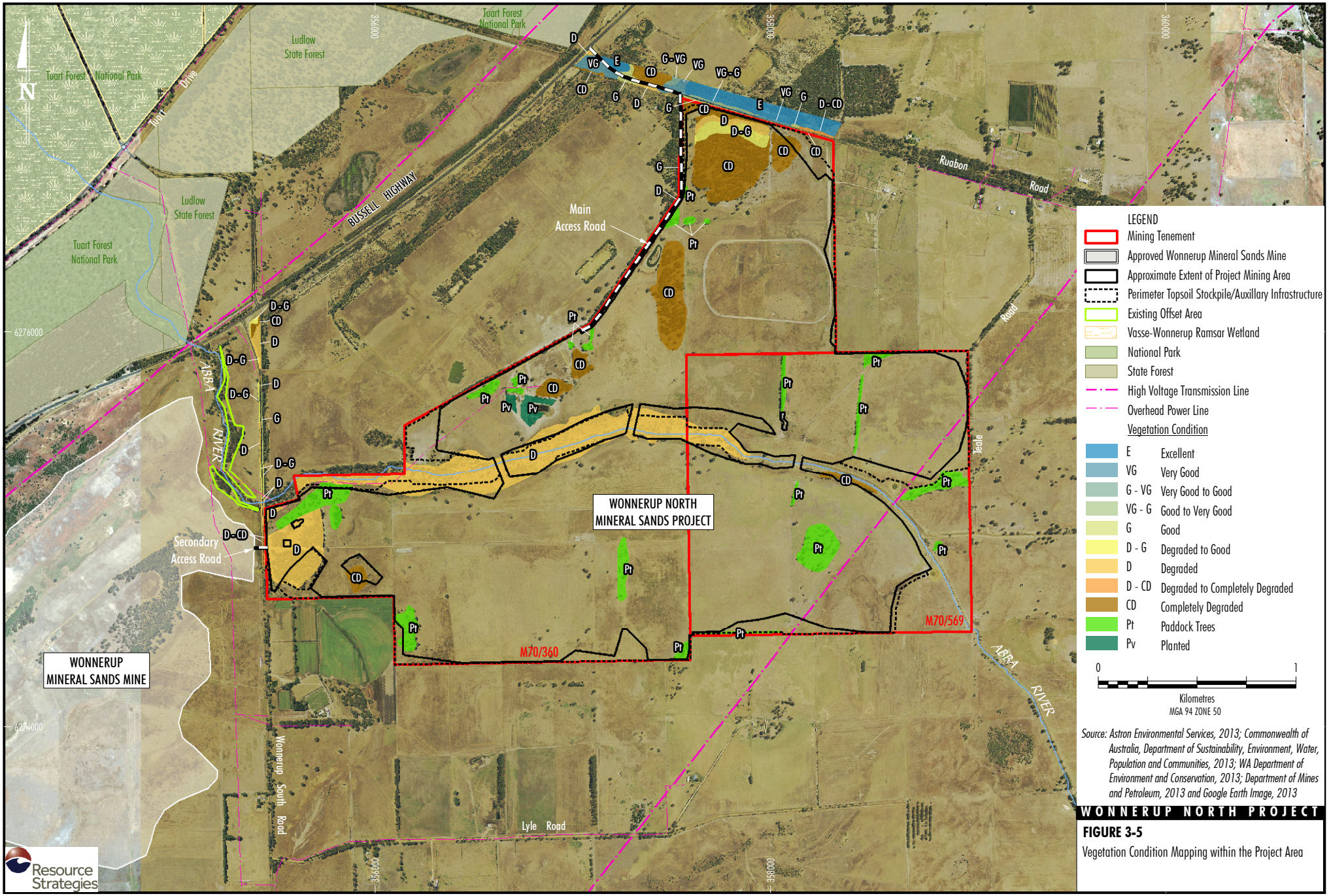

WONNERUP NORTH PROJECT

FIGURE 3-5

Vegetation Condition Mapping within the Project Area

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Conservation Significant Flora and Vegetation

Astron recorded the Declared Rare Flora (DRF) species *Chamelaucium* sp. C Coastal Plain adjacent to Wonnerup South Road near to where it crosses the Abba River. This species is also listed as Vulnerable under the Commonwealth EPBC Act. The Project does not involve disturbance to this area.

The remnant vegetation along Ruabon Road is considered by Astron to be significant in that it contains intact vegetation complexes that have critically low representation remaining (Lw – >0% remaining; Aw – 2% remaining; Ad – 14% remaining) (Havel and Mattiske, 2002). In addition, it contains some conservation significant flora and provides a corridor or linkage from the Vasse-Wonnerup Wetland System and the Tuart Forest National Park to the Whicher Scarp.

Figure 3-4 shows the location of the recorded conservation significant flora. Three priority flora species were recorded within the Ruabon Road verges in the vicinity of the proposed section of road that would be widened. These included:

- *Isopogon formosus* subsp. *dasylepis,* which is listed as P3 by the DPaW;
- *Jacksonia gracillima,* which is listed as P3 by the DPaW; and
- *Verticordia attenuate,* which is listed as P3 by the DPaW.

A fourth priority species, *Tripterococcus paniculatus* (listed as P4 by the DPaW), occurs in the northern extent of the Project mining area.

No priority or threatened ecological communities were recorded in the Project area.

3.2.3 Potential Impacts

The main potential adverse impacts on the flora and vegetation due to the Project include:

- clearing of patches of remnant native vegetation and paddock trees within the Project mining area;
- clearing along a portion of Ruabon Road (for widening of the road – less than 0.5 ha) resulting in a reduction in the width of the vegetation corridor;
- lowering and raising the superficial watertable leading to potential adverse impacts on groundwater dependent vegetation;
- potential introduction and/or spread of weed species; and
- potential increased fire risk.

3.2.4 Proposed Management of Potential Impacts

A description of the main potential adverse impacts on flora and vegetation and how they would be managed by Cristal is provided below.

Vegetation Clearing within the Project Area

As indicated in Table 3-1 and illustrated in Figure 3-4, the Project predominantly occurs in already cleared pasture (approximately 89% of the total Project disturbance area). The majority of the remnant vegetation that would be cleared is in a degraded condition due to a long history of agricultural land use.

The Project would require the clearing of approximately 38 ha of native vegetation communities within the mining area, plus approximately 7 ha associated with the widening of the access road, the perimeter topsoil stockpiles and auxiliary infrastructure (i.e. total of approximately 45 ha of native vegetation communities would be cleared for the Project [Table 3-1]). A total of 16 ha of paddock trees would also be cleared.

Table 3-1 presents the approximate amount and percentage of each of the mapped vegetation types that would be cleared.

Table 3-1
Approximate Vegetation Areas to be Cleared by the Project

Vegetation	Approximate Area (ha)[1]	Percentage of Total Project Area
AB (Abba) – located on the flats and low rises of the Abba Plains, dominated by woodland and open forest of Marri (*Corymbia calophylla*).	14	3.0
AF (Abba) – located on the terraces and valley floors of the low undulating Abba Plains, dominated by woodland of Marri (*Corymbia calophylla*) – Peppermint (*Agonis flexuosa*) and a tall shrubland of Myrtaceae – Proteaceae species.	2.5	0.5
Ad (Abba) – located on the mild slopes of the low undulating Abba Plains, dominated by woodland of Marri (*Corymbia calophylla*) – Peppermint (*Agonis flexuosa*) – sheoak (*Allocasuarina fraseriana*) – Christmas tree (*Nuytsia floribunda*).	18	3.5
Aw (Abba) – located on the broad depressions of the low undulating Abba Plains, dominated by tall shrubland of *Melaleuca viminea* and woodland of flooded gum and paperbark (*Eucalyptus rudis – Melaleuca rhaphiophylla*) with the occasional Marri (*Corymbia calophylla*).	9.5	2
Lw (Ludlow) – located on the fringes of the RFA area, near Ludlow. The vegetation complex is dominated by an open woodland of paperbark (*Melaleuca rhaphiophylla*) and sedgelands of Cyperaceae and Restionaceae species on broad depressions.	1	0.2
SUBTOTAL	**45**	**9.2**
Paddock Trees	16	3.0
Non-native planted vegetation	2.0	0.3
Cleared Pasture	454.5	87.5

[1] Based on mapping provided by Astron.

The Project has been designed to stand-off the Abba River (Section 2.2), which would minimise the amount of the Abba (Aw) vegetation that would be cleared (Figure 3-4). In addition, the planned mining area in the south-west corner of M70/360 has been adjusted and approximately half of the remnant of Abba (AB) vegetation that occurs in this area would be retained.

Cristal would conduct clearing activities progressively during the mine life (i.e. the area cleared at any one time would be restricted to the practical minimum). Cleared vegetation would be retained and stockpiled for later use in rehabilitation (e.g. as habitat resources) where practicable, or burnt. Larger trees with harvestable timber would be felled and removed from the site for sale to nearby sawmills.

Cristal would undertake enhancement works in and adjacent to the riparian vegetation along the Abba River in the areas that would not be disturbed by the Project. These works would include planting of tubestock, seeding, fencing and removal of weeds. The native plant species used in the regeneration activities would be selected in consultation with DPaW.

Tripterococcus paniculatus (P4) individuals have been recorded within degraded remnant vegetation in the Project mining area, and clearing would result in the loss of two individuals. The status of these taxa would not be affected given the wide distribution of this species across WA. The Project would not disturb the recorded locations of *Chamelaucium* sp. C Coastal Plain along Wonnerup South Road.

Vegetation Clearing Associated with the Widening of Ruabon Road

As described in Section 2.3, Ruabon Road would be widened up to a maximum of 3.2 m, or 1.6 m on either side on average, to provide the main access to the Project. The intersection between Ruabon Road and the Bussell Highway and the entrance to M70/360 would also be upgraded in accordance with the City of Busselton and Main Roads Western Australia requirements.

The planned road works would require disturbance to less than 0.5 ha of vegetation immediately adjacent to the existing Ruabon Road. Where possible this clearing would occur on the southern side of Ruabon Road, which has generally been mapped as being more degraded than the northern side of the road.

Astron's preliminary assessment of the potential impacts of the Project on priority flora recorded in the Ruabon Road corridor is summarised as follows:

- *Isopogon formosus* subsp. *dasylepis* (P3) and *Verticordia attenuate* (P3) – potential adverse impacts are unlikely, given the locations of these taxa are outside the mining tenements and are not likely to be removed due to the widening of Ruabon Road.
- *Jacksonia gracillima* (P3) – the Project would have a low potential impact on this species. The widening of Ruabon Road may require the removal of the recorded individuals. However, the status of these taxa would not be affected given the wide distribution of this species across WA.

Impacts Associated with Changes to Groundwater Levels

As described in Section 3.1, the potential impacts of the Project on the superficial groundwater aquifer are predicted to be localised, temporary in duration, and relatively small. Notwithstanding, there are three main areas where the proposed mining area would be adjacent to remnant vegetation that could use groundwater due to the presence of trees that are known elsewhere to use groundwater. These areas are:

- the tall shrubland and woodland (Aw) fringing the Abba River;
- vegetation growing in association with wetlands or seasonal damplands (Lw); and
- the woodland patch (AB) in the south-western extent of the project mining area (approximately 5.8 ha of the 8 ha patch).

In order to minimise the potential impacts of the Project on these areas, Cristal would implement the following management measures:

- Where possible, the parts of the deposit located immediately adjacent to the Abba River, and the other remnants described above, would be mined during the wetter months in the middle of the year in order to minimise the effect of Project-related drawdown on the vegetation.
- The Project groundwater monitoring program would be used to assess the predicted verses actual changes to water levels in the superficial aquifer within the Project area and surrounds. Cristal would also monitor the overall health of the vegetation in riparian vegetation located adjacent to the Abba River, as well as the other two adjoining remnants described above. In the event that the monitoring indicates that the condition of the adjoining remnant vegetation is adversely affected, or is likely to be if no action is taken, Cristal would implement appropriate mitigation strategies or contingency measures. These may include, but would not necessarily be limited to: adjustments to the mining operations to minimise drawdown or mounding effects; and use of water-filled trenches or spears to locally raise groundwater levels near riparian vegetation.

Weeds

Management measures that would be undertaken to minimise the potential for the spread of weed species would include, but would not necessarily be limited to, the following:

- mobile machinery and equipment would be brought to site clean;
- regular inspections for the presence of weeds within areas of disturbance would be conducted; and
- seasonal weed control programs would be implemented as necessary.

If new weed species are recorded during the life of the Project, the environmental risks would be considered and weed management procedures reviewed.

Fire Risk

Control measures to minimise the potential for fire would include the following:

- fire hazard awareness and management training would be provided to Cristal personnel and contractors, as required;
- fire-fighting equipment would be provided in work areas according to fire hazard; and
- fire-fighting equipment would be regularly inspected and maintained.

3.3 TERRESTRIAL ENVIRONMENTAL QUALITY

3.3.1 EPA Objective for Terrestrial Environmental Quality

The EPA's objective for terrestrial environmental quality is:

- *To maintain the quality of land and soils so that the environmental values, both ecological and social, are protected.*

3.3.2 Existing Environment

As described in Section 3.1.2, the Wonnerup North deposit is located on the Swan Coastal Plain less than 5 km from the current coastline. The elevation across the Project area is relatively flat (i.e. generally ranges between 5 m AHD and 10 m AHD).

The dominant surface geology within the Project area is Bassendean Sand Unit S_8. This particular Bassendean Sand unit is described in the Busselton Environmental Geology Sheet (Belford, 1987) as being *very light grey at surface, yellow at depth, fine to medium-grained, sub-rounded quartz, moderately well-sorted, of aeolian origin*, and hosts local accumulations of heavy minerals such as ilmenite and rutile. Cristal's analysis of soil samples from the resource definition drilling indicates that the orebody comprises approximately 4.3% heavy minerals and 13.8% clay.

The Project area is also mapped by Belford (1987) as including Unit M_{SC1},Clayey Sandy Silt alluvium deposits of Quaternary age, which are associated with the Abba River channel. Unit M_{SC1} is mapped in an area approximately 20 to 30 m wide along the 3 to 4 km stretch of the Abba River running through the Project area. The unit is described by Belford (1987) as Clayey Sandy Silt alluvium deposits of Quaternary age comprising *pale brown, angular to rounded sand, with low cohesion and of alluvial origin*.

Due to the Project's proximity to the coast and geological setting, Aurora Environmental (Aurora) was engaged by Cristal to conduct an acid sulphate soil (ASS) investigation for the Project, in accordance with the DER ASS guideline for mineral sands mining *viz*. *Investigation and Management of Acid Sulphate Soils Hazards Associated with Silica and Heavy Mineral Sands Operations* (DEC, 2012).

As part of the evaluation, Aurora reviewed the DEC's published ASS risk maps for coastal regions of WA (DEC, 2013). The online mapping for the Project area showed that the portion of the site associated with the Abba River channel had been mapped as *high to moderate risk of ASS occurring within 3 m of natural soil surface* (Landgate, 2014). This portion of the site is generally consistent with the area mapped by Belford (1987) as Unit M_{SC1} (clayey sandy silt alluvium deposits of Quaternary age).

The remaining majority of the site has been mapped by Belford (1987) to comprise Bassendean Sand, and the online mapping showed the ASS risk was *moderate to low risk of ASS occurring within 3 m of natural soil surface* (Landgate, 2014). The guideline for identification of ASS (DEC, 2012) states that Bassendean Sands may contain *single crystal and framboidal aggregates of sub-micron-sized pyrites*, which are likely to be highly reactive ASS when exposed to oxygen. Furthermore, the guideline notes that Bassendean Sands generally have less than one percent clay and therefore have extremely poor acid-buffering capacity. However, Project-specific testwork conducted on the Wonnerup North orebody by Cristal indicates that it comprises approximately 13.8% clay. As a result, the site soils are considered by Aurora to be likely to have significantly more inherent buffering capacity than typical Bassendean Sands.

In order to gather Project-specific data on ASS risk, Aurora undertook a two-phase targeted soil investigation in June and October 2013. Air core drilling was used to obtain 440 soil samples from 44 holes, which were collected and logged by Aurora at 0.5 m intervals. Soil bore locations were predominately located within the Project area, where the depth of drilling was targeted to be approximately 1 m deeper than the anticipated maximum depth of disturbance. Figure 3-6 shows the locations of the ASS sampling holes.

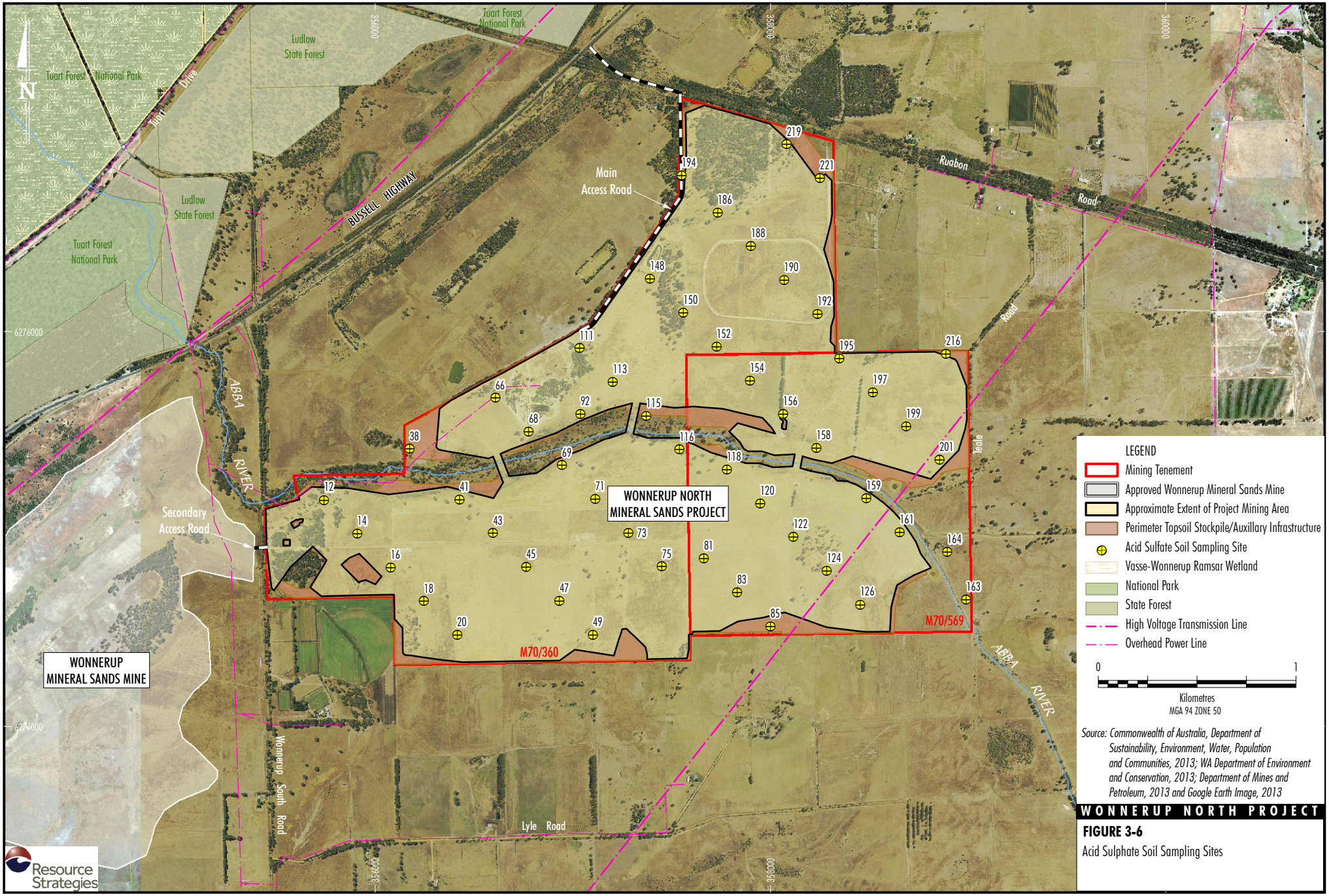
The soil samples were screened for the presence of ASS material in accordance with the DEC (2012) guidelines. The results showed:

- no sample from any borehole recorded a field pH (pH_F) < 4 (0%); and
- seven samples recorded a field peroxide pH (pH_{FOX}) < 3 (1.6%).

In order to consider whether significant risk of oxidation is present relative to mineral sands mining activities, DER uses the following assessment criteria (DEC, 2012):

- pH_F <4 in more than 10% of borehole locations; or
- pH_{FOX} <3 in more than 10% of the samples tested.

Comparison of the screening results to the DEC (2012) assessment criteria found no exceedance of the assessment criteria. Aurora's preliminary conclusion is that a significant risk of sulfide hazard does not exist at the site, and although some sulfide oxidation hazard has been identified (1.6%), there is a low risk that a significant issue would occur with potential to impact receptors.



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3.3.3 Potential Impacts

Potential Project-related impacts on the terrestrial environmental quality of the Project area and surrounds include the following:

- exposure of ASS material to oxidation processes, either through excavation or dewatering, resulting in the contamination of land and water resources; and
- changes to the topography of the Project area resulting in reduced agricultural capacity and/or significant impacts to environmental values (i.e. ecological and social).

3.3.4 Proposed Management of Potential Impacts

A summary of the above Project-related impacts and how they would be managed by Cristal is provided below.

Acid Sulphate Soils

As described in Section 2.10, Cristal has developed and implemented an Acid Sulphate Soil Management Plan (ASSMP) at its existing Wonnerup Mineral Sands Mine in accordance with the conditions of its EPBC Act Approval (EPBC 2010/5403). Notwithstanding the low risk findings of the Project ASS assessment, it is envisaged that a similar ASSMP would be prepared and implemented for the Project. Cristal would include in the ASSMP a description of the monitoring and contingency measures that would be implemented in accordance with the ASS guideline for mineral sands mining, *Investigation and Management of Acid Sulphate Soil Hazards Associated with Silica and Heavy Mineral Sand Mining Operations* (DEC, 2012).

The monitoring and contingency program would include, but would not necessarily be limited to, the following:

- regular monitoring of water that collects in the mine sumps and the Project process water dam;
- regular monitoring of the network of groundwater monitoring bores within and adjacent to the Project area;
- comparison of the monitoring results with background data and agreed trigger values for key parameters (e.g. pH, total acidity, total alkalinity); and
- implementation of appropriate management measures in the event that water quality does not meet the nominated criteria (e.g. addition of suitable alkaline material to water storages or sand residues, expediting the backfilling of the appropriate area of the pit and ceasing dewatering in a particular area of the pit).

Changes to Topography

As described in Section 2.7, sand residues generated at the wet processing plant would be placed behind the active mining area and would be progressively rehabilitated during the mine life. It is expected that the final rehabilitated land surface would be the same or very similar to the pre-mining topography (i.e. predominantly flat to gently sloping land). The Abba River would not be mined, and as a result, its ecological and hydrological function would not change during the mine life or following closure.

The final land use would be determined in consultation with the relevant Government agencies and landowners however, it is expected to be predominately agricultural, with some areas of native vegetation. Cristal has successfully rehabilitated numerous previous sand mining operations in the Swan Coastal Plain and has demonstrated that it can return disturbed areas to productive agricultural use and/or native vegetation.

A Mine Closure Plan for the Project would be prepared and implemented in accordance with the *Guideline for Preparing Mine Closure Plans* (DMP and EPA, 2011).

3.4 TERRESTRIAL FAUNA

3.4.1 EPA Objective for Terrestrial Fauna

The EPA's objective for terrestrial fauna is:

- *To maintain representation, diversity, viability and ecological function at the species, population and assemblage level.*

3.4.2 Existing Environment

Biologic Environmental Survey Pty Ltd (Biologic) has been commissioned by Cristal to survey and describe the existing terrestrial fauna and habitat values within the Project area and surrounds, and to conduct an assessment of the potential impacts on fauna.

A literature and desktop assessment has been completed by Biologic and included searches of the DPaW and DotE threatened fauna species databases. The database searches and literature reviews indicated 230 vertebrate fauna species have the potential to occur in the general locality. This list comprises 22 native mammal species, eight introduced mammal species, 147 bird species (excluding the strictly marine species), 42 reptile species and 11 amphibian species.

The database searches and previous survey records also indicates 35 of the 230 vertebrate species are of conservation significance (i.e. eight mammals, 25 birds and three reptiles). However, due to a lack of suitable habitat in the Project area, only 21 are considered to possibly occur in the Project area.

Biologic conducted a two-phase Level 2 fauna survey of the Project area, which targeted the conservation significant species identified during the literature and database review. The Phase 1 survey was conducted in May 2013 (autumn), and the Phase 2 survey was conducted in October 2013 (spring). The surveys were conducted in accordance with the EPA's *Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA, 2002) and the EPA's *Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA, 2004b) and the *Technical Guide - Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA and DEC, 2010).

The following six broad fauna habitats were identified by Biologic within the Project area:

- Marri – Jarrah – Banksia forest;
- Marri – Jarrah – Peppermint open forest;
- Flooded Gum – *Melaleuca* spp. – Marri open woodland;
- *Melaleuca* low open woodland;
- non-native planted vegetation; and
- cleared pasture.

Figure 3-7 shows the distribution of these habitat types across the Project area.

The woodland and forest habitats in the Project mining area were found by Biologic to have all been degraded to varying extents by clearing and agricultural practices (e.g. clearing and grazing). The woodland and forest habitats in the Project mining area are heavily fragmented and the patches are small. The most continuous habitat occurs along the Abba River, however, even the Abba River (and associated riparian habitat, i.e. Flooded Gum – *Melaleuca* spp. – Marri open woodland) in the Project area is severely degraded due to past clearance, livestock grazing and weed invasion. The reach of the Abba River downstream of the Project area (in Tuart Forest National Park) is in better condition.

Despite the degraded condition of the understory of the woodland and forest habitats in the Project mining area, there are habitat resources that are used by conservation significant fauna species (e.g. trees with hollows and food resources). The woodland remnants with Marri, Jarrah, Banksia spp. and Peppermint trees are of particular importance in this respect.

The woodland and forest habitats along Wonnerup South Road and Ruabon Road are reasonably continuous from the Tuart Forest National Park to the Whicher Scarp.

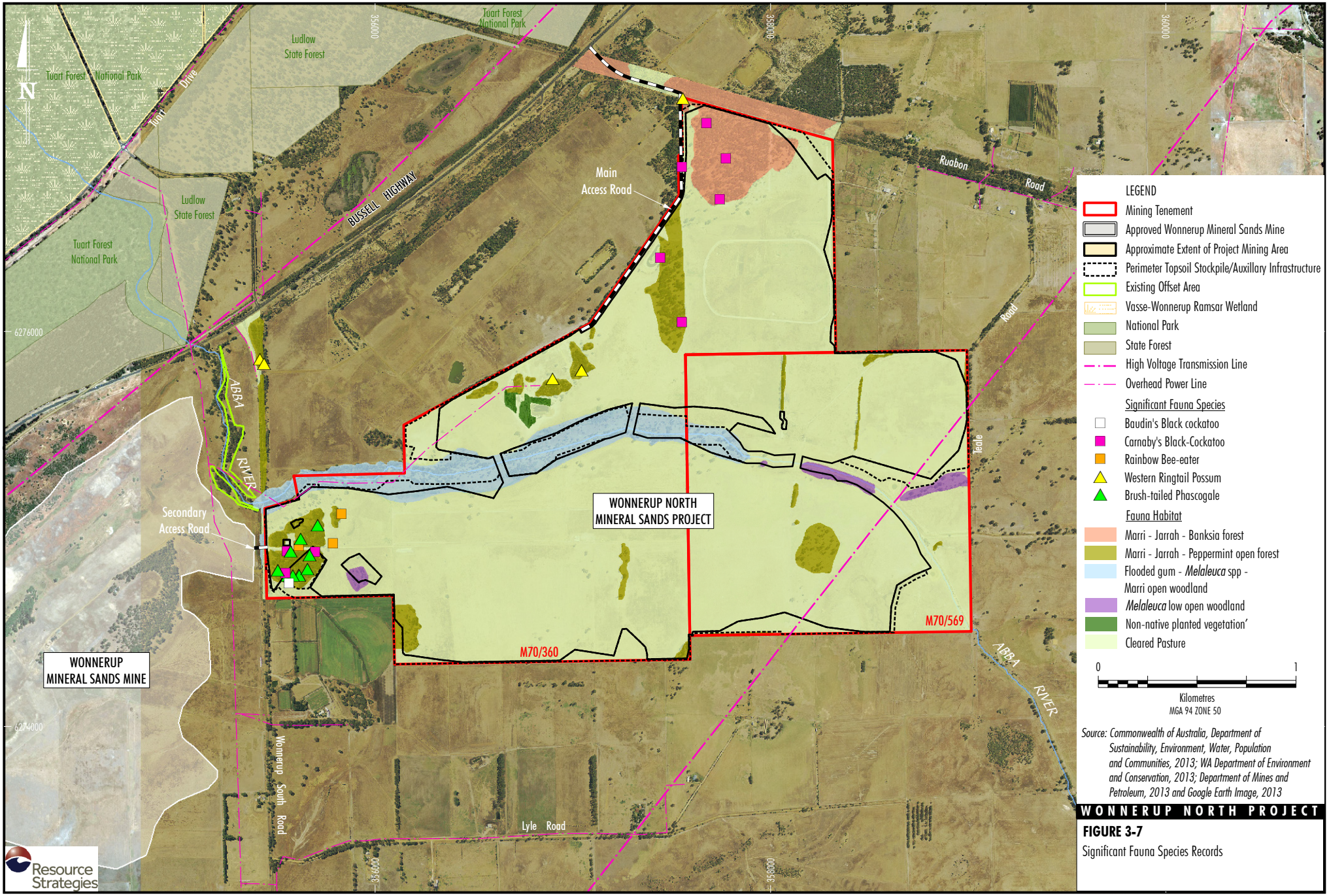
The field survey recorded a total of 85 vertebrate species within the Project area, comprising 11 native mammal species, eight introduced mammal species, 50 bird species, 10 reptile species and six amphibian species.

Conservation Significant Fauna

The following five conservation significant fauna species (i.e. two mammals and three birds) were recorded by Biologic:

- Southern Brush-tailed Phascogale (*Phascogale tapaotafa*): listed under Schedule 1 of the WC Act. Present in low numbers within Marri – Jarrah – Peppermint open forest in the Project area.
- Western Ringtail Possum (*Pseudocheirus occidentalis)*: listed under Schedule 1 of the WC Act and Endangered under the EPBC Act. Present in low numbers within Marri – Jarrah – Peppermint open forest in the Project area.
- Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*): listed under Schedule 1 of the WC Act and Endangered under the EPBC Act. Observed foraging on-site during the survey period.
- Baudin's Black Cockatoo (*Calyptorhynchus baudinii*): listed under Schedule 1 of the WC Act and Vulnerable under the EPBC Act. Observed foraging within the survey period.
- Rainbow Bee-eater (*Merops omatus*): listed under Schedule 3 of the WC Act and Migratory under the EPBC Act. Seasonal visitor, observed during the Spring 2013 survey, assumed to use woodland remnants for foraging and roosting.

Figure 3-7 shows the locations where the above conservation significant fauna species were recorded.



WONNERUP NORTH PROJECT

FIGURE 3-7

Significant Fauna Species Records

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Biologic assessed the potential value of the fauna habitats within the Project area for threatened fauna as follows:

- Cleared Pasture and paddock trees: Black Cockatoo species are likely to use paddock trees for feeding, although trees are scattered and limited in number. Little to no habitat value for other conservation significant species.
- Marri – Jarrah – Peppermint open forest: provides suitable habitat for the Western Ringtail Possum, Southern Brush-tailed Phascogale and Black Cockatoo species.
- Flooded Gum – *Melaleuca* spp. – Marri open woodland: contains only a small number of hollows in large trees, providing a suitable habitat for Black Cockatoo species.
- *Melaleuca* low open woodland: little or no habitat value for conservation significant fauna. Some potential foraging habitat for the Southern Brush-tailed Phascogale, though the species has not been recorded using this habitat type in the Project area.
- Marri – Jarrah – Banksia forest: contains a small number of tree hollows, providing a potential habitat for the Western Ringtail Possum, Southern Brush-tailed Phascogale and Black Cockatoo species. Of the species listed here, only the Black Cockatoos were recorded using this habitat type in the Project area.
- Planted (non-native) vegetation: present in the area around the former farm house and outbuildings in the northern portion of the Project area.

Black Cockatoo species are likely to use tree hollows for nesting. A survey of potential trees recorded 375 trees with a diameter of over 50 cm within the Project disturbance area. Based on size and orientation, Biologic determined that only 22 trees (6%) had hollows that appeared suitable for nesting of Black Cockatoo species. No Black Cockatoos have been observed nesting in the Project area.

3.4.3 Potential Impacts

The main potential adverse impacts on the fauna due to the Project include:

- loss of habitat through the clearing of remnant native vegetation within the Project area (and related impacts such as direct mortalities and/or fragmentation);
- clearing along a portion of Ruabon Road (for widening of the road) resulting in a reduction in the width of the vegetation corridor;
- lowering and raising the superficial watertable leading to adverse impacts on groundwater dependent vegetation;
- indirect impacts (associated with increased noise, light and dust); and
- introduction and/or spread of animal pest species.

3.4.4 Proposed Management of Potential Impacts

A description of the main potential adverse impacts on fauna and habitat and how they would be managed by Cristal is provided below.

Loss of Habitat

The Project would require the clearing of approximately 54 ha of native fauna habitat within the mining area, plus approximately 1 ha associated with the widening of the access road and an additional 8 ha associated with the perimeter topsoil stockpiles and auxiliary infrastructure (i.e. total of approximately 63.5 ha of native fauna habitat would be cleared for the Project [Table 3-2]). Table 3-2 presents the approximate amount and percentage of each fauna habitat types that would be cleared.

Table 3-2
Approximate Fauna Habitat Areas to be Cleared by the Project

Habitat	Approximate Area (ha)[1]	Percentage of Total Project Area
Marri – Jarrah – Peppermint open forest	30	5.9
Flooded Gum – *Melaleuca* spp. – Marri open woodland	12.5	2.4
Melaleuca low open woodland	2	0.3
Marri – Jarrah – Banksia forest	19	3.6
SUBTOTAL	**63.5**	**12.2**
Non-native planted vegetation	2	0.3
Cleared Pasture	445	87.5

[1] Based on mapping provided by Biologic.

Potential impacts on threatened fauna species located in the Project area are as follows:

- Southern Brush-tailed Phascogale: Individuals of this species are likely to be adversely impacted by removal of foraging and breeding habitat (particularly the patch of Marri - Jarrah - Peppermint open forest in the south-western corner of the Project area where the species was recorded on multiple occasions). The Southern Brush-tailed Phascogale has a wide distribution in south-western WA and adverse impacts from the Project are likely to be localised.
- Western Ringtail Possum: Individuals of this species are likely to be adversely impacted by removal of foraging and breeding habitat. Western Ringtail Possums occur in the Marri – Jarrah – Peppermint open forest and Marri – Jarrah – Banksia forest and may also occur in Flooded gum – *Melaleuca* spp – Marri open woodland. They may also utilise scattered trees within cleared pastures but these areas are not likely to be important relative to the remnant woodland patches. Important areas for the Western Ringtail Possum have been mapped as part of the *Significant Impact Guidelines for the Vulnerable Western Ringtail Possum in the Southern Swan Coastal Plain, Western Australia* (Department of the Environment, Water, Heritage and the Arts [DEWHA], 2009). The Project area is outside of core habitat, primary corridors and is on the edge of areas of supporting habitat (DEWHA, 2009). Core habitat occurs in Tuart Forest National Park (DEWHA, 2009).
- Carnaby's Black Cockatoo and Baudin's Black Cockatoo: These cockatoos have been recorded foraging in the Project area. The tree survey indicated that there are at least 375 large trees within the Project disturbance area suitable for foraging Black Cockatoos. No nests were found during the tree survey; however, 22 of these trees had hollows with characteristics that appeared suitable for cockatoo nesting, if the species nests in the Project area. However, Biologic describe that the preferred vegetation for these Black Cockatoos is widespread in the vicinity and the general area.

As described in Section 2.2, the Project has been designed to stand-off the Abba River. Management strategies that would be used by Cristal to reduce impacts from habitat loss would include, but would not necessarily be limited to, the following:

- Cristal would aim to limit vegetation clearing to the minimum amount necessary.
- Clearing boundaries would be clearly surveyed and demarcated prior to clearing activities.
- Habitat trees and possum dreys would be inspected prior to clearing. If possible, possum dreys would be removed from trees to be felled the day (or if occupied, during the night when unoccupied) prior to the clearing. This will reduce the chance of possums being present when clearing takes place.
- Use suitably qualified expert or wildlife carer to advise on methods of clearing to minimise impacts on fauna, and (if necessary) safely remove and relocate animals during the clearing processes.
- Employees and contractors would undergo a site specific induction, which would include information on the likely presence of threatened fauna species such as the Western Ringtail Possum and black cockatoos, as well as work requirements for vegetation clearing and access.

Cristal would salvage and reuse select trees (e.g. tree hollows) for use as fauna habitat in rehabilitation areas (e.g. habitat logs).

As described in Section 2.10, Cristal has developed and implemented a fauna management plan at its existing Wonnerup Mineral Sands Mine in accordance with the conditions of its EP Act Clearing Permit (3984/2) and EPBC Act Approval (EPBC 2010/5403). It is envisaged that a similar plan would be prepared and implemented for the Project.

Impacts Associated with Changes to Groundwater Levels

Refer to Section 3.2.3 for a description of the potential impacts on groundwater dependant vegetation. An impact on the groundwater dependant vegetation has the potential to adversely impact fauna species using the vegetation as habitat. Mitigation measures are described in Section 3.2.4.

Indirect Impacts

Indirect impacts may occur in surrounding fauna as a result of increased noise, light and dust. Mitigation measures would include reducing noise (Section 3.5.4), directing light to where it is needed and minimising dust (Section 2.7).

Animal Pest Species

As is the case at Cristal's existing Wonnerup Mineral Sands Mine, control of the European Red Fox and feral cat at the Project would occur on an annual basis and control of the European Rabbit would occur on an as needed basis.

3.5 AMENITY

3.5.1 EPA Objective for Amenity

The EPA's objective for amenity is:

- *To ensure that impacts to amenity are reduced as low as reasonably practical.*

3.5.2 Existing Environment

The Project is situated in a rural area approximately 10 km east of the city of Busselton. The Bussell Highway is located to the north-west of the Project area (Figure 1-2b), and would be used as the transport route for trucks carrying HMC to the Bunbury MSP (located approximately 44 km to the north – Figure 1-1).

Privately-owned residences in the vicinity of the Project are shown on Figure 1-4.

The Project area and surrounds are located on a relatively flat area of the Swan Coastal Plain. The existing landscape consists of mostly cleared agricultural land interspersed with isolated paddock trees and patches of remnant vegetation.

Background Noise

Background (i.e. non-mining) noise levels in the Project areahave not been specifically determined, as any noise monitoring conducted would be potentially influenced by the existing mining activities at the neighbouring Wonnerup Mineral Sands Mine (i.e. would not provide a representation of the non-mining noise environment). However, background noise monitoring was conducted prior to the commencement of the existing Wonnerup Mineral Sands Mine for a period of three months.

The measured background noise at the neighbouring Wonnerup mine site ranged from 29 to 36 dBA for the daytime period (7.00 am to 7.00 pm), from 25 to 33 dBA for the evening period (7.00 pm to 10.00 pm) and from 22 to 27 dBA for the night-time period (10.00 pm to 7.00 am). Traffic noise from Bussell Highway was the dominant noise source recorded during the background monitoring.

Given the similarities between the Wonnerup Mineral Sands Mine and Project (e.g. location, existing land use and the distance to the Bussell Highway), the background noise monitoring conducted for the Wonnerup Mineral Sands Mine provides a representative indication of the pre-mining noise environment of the Project area.

3.5.3 Potential Impacts

Potential Project-related impacts on amenity would include the following:

- noise impacts from machinery, equipment, vehicles and fixed infrastructure used during the construction and operation phases of the Project; and
- changes to the visual character of the locality due to excavation of the mining areas and placement of sand residues.

3.5.4 Proposed Management of Potential Impacts – Noise

Noise management in WA is implemented through the *Environmental Protection (Noise) Amendment Regulations 2013* (the Regulations).

SVT Engineering Consultants Pty Ltd (SVT) has been commissioned by Cristal to conduct a Noise Impact Assessment for the Project in consideration of the Regulations.

The objective of the Noise Impact Assessment is to demonstrate through predictive modelling that the Project can operate in compliance with the assigned noise levels specified in the Regulations at privately-owned receiver locations.

Methodology

SVT has conducted preliminary noise modelling for the Project using SoundPlan 7.1. The model inputs include noise source data (i.e. equipment sound power levels [SWLs]), topographical data, meteorological data and receiver locations.

Mining Scenarios

Five potential worst-case modelling scenarios have been developed to represent the construction phase (Scenario S1) and mining operations (Scenarios S2 to S5). The operational scenarios have been developed to model noise levels when mining is occurring in closest proximity to the surrounding receiver locations (as shown on Figure 1-4).

Equipment

Fixed and mobile Project equipment would be relocated from the existing Wonnerup Mineral Sands Mine following the completion of mining at the operation. As such, the existing performance of the equipment currently operating at the Wonnerup Mineral Sands Mine has been measured by SVT in June 2012, May 2013 and February 2013, and the results have been used to inform the SWLs of the equipment proposed for the Project.

Two categories of equipment (i.e. based on the required hours of operation) are required for the operational mining scenarios, as follows:

- Primary mining/processing equipment – required 24 hours per day (e.g. wet separation plant, trommel, front end loader (FEL) used to load the trammel and booster pumps).
- Secondary mining equipment – daytime only as required (e.g. scrapers, dozers and excavators).

Meteorology

For the Project noise modelling, SVT has used the potential worst-case meteorological conditions suggested by the EPA's Guidance Note No. 8 for assessing noise impacts from new developments. This includes:

- Daytime and evening – wind speeds of 4 metres per second (m/s) for each cardinal wind direction coinciding with Pasquill Stability Category E.
- Night-time – wind speeds of 3 m/s for each cardinal wind direction coinciding with Pasquill Stability Category F.

Tonality Adjustment

Based on preliminary modelling results, an assessment of tonality was conducted in accordance with the Regulations.

Assessment of tonality in received noise emissions depends on the existing level of ambient noise (i.e. whether tonality is likely to protrude above background noise) as well as the severity and duration of any tonality. Many of the items of Project mobile equipment would have some degree of tonality when measured at source. However, this tonality may not always be evident at the receiver for the reasons listed below:

- Tonality may not protrude above ambient noise.

- Tonality from particular items of equipment may be masked by noise received from other equipment.
- The level of noise emissions from items of mobile equipment will vary depending on their locations (which may be continuously changing).
- The severity and pitch of the tonality from mobile equipment will change depending on operating conditions.

The relevant tonality adjustment (i.e. 5 dBA penalty) was applied to the preliminary noise modelling results at receiver locations where:

- 5 dBA penalty may result in potential exceedance of the relevant assigned noise level; and
- a tonal noise source (e.g. scrapers) is likely to be distinguishable from other noise sources.

Potential Impacts

The preliminary noise modelling results indicate the Project would be able to comply with the assigned noise levels, subject to Cristal implementing appropriate noise management controls.

Operations – Night-time/Evening

For the operation of primary mining/processing equipment only, which is required 24 hours per day (e.g. wet separation plant, trommel, FEL and booster pumps), the initial modelling showed a predicted exceedance of the night-time assigned noise level at one sensitive receiver (R11) during the most adverse weather conditions without the implementation of noise management controls.

Based on assessment of meteorological conditions, this exceedance is expected to occur for approximately 35% of the night-time period during Scenario 5 only, which captures mining operations in closest proximity to receiver R11. These operations are expected to occur over a period of approximately 3 months.

However, subsequent modelling indicated that compliance with the night-time assigned noise level at R11 would be able to be achieved for the Project by moving the location of the trommel so that it would be further located away from R11 during adverse conditions or installing noise bunds. Cristal would use one or both of these mitigation measures to comply with the assigned noise levels.

Operations – Daytime

For the operation of both secondary mining equipment (e.g. scrapers, dozers, excavators) and primary equipment, which would occur during the daytime only, the initial modelling showed a predicted exceedance of daytime assigned noise levels during the most adverse weather conditions at sensitive receivers R2, R5 and R11.

Based on assessment of meteorological conditions, these exceedances are expected to occur for up to approximately 27% of the day-time period in certain operational years.

However, subsequent modelling indicated that compliance with assigned noise levels (inclusive of tonality adjustments) could be achieved by standing down and/or relocating scrapers (i.e. secondary equipment which would only operate during the daytime as required) away from receiver locations during adverse weather conditions. Cristal would use this mitigation measure to comply with the assigned noise levels.

Construction

Potential noise levels at privately-owned owned receivers have been predicted for the construction phase, which would involve the operation of mobile equipment (e.g. scrapers) during the daytime only.

According to the Regulations, no assigned noise levels apply for the construction period at privately-owned receivers, provided "*the construction work is carried out in accordance with control of environmental noise practices set out in section 6 of AS 2436-1981 Guide to Noise control on Construction, Maintenance and Demolition Sites"*.

3.5.5 Proposed Management of Potential Impacts – Visual Character

The proposed mining operations would involve excavation of the orebody, extraction of the heavy mineralisation and replacement of the sand residues in the mined-out open pit. As a result, much of the mining activity occurs below the ground surface and would not be visible from neighbouring vantage points.

Above surface Project activities that would be visible from nearby areas include the construction of bunds and sand residues that are above or near to the pre-mining topography. These impacts are expected to be relatively minor because of their relatively low height (i.e. typically less than 5 m above ground level), their temporary nature (i.e. usually less than 12-18 months before re-profiling and/or rehabilitation occurs), and the generally flat nature of the surrounding topography.

3.6 HERITAGE

3.6.1 EPA Objective for Amenity

The EPA's objective for heritage is:

- *To ensure that historical and cultural associations are not adversely affected.*

3.6.2 Existing Environment

Ethnosciences has been commissioned by Cristal to conduct an Aboriginal Heritage Assessment of the Project area. The assessment consisted of an ethnographic survey and consultation component, and an archaeological survey component.

The ethnographic survey and consultation component included:

- a desktop review;
- preliminary consultation with the DAA, the South West Aboriginal Land and Sea Council (SWALSC) and the local Aboriginal Community; and
- site inspections and interviews with nominated representatives of the South West Boojarah and the Harris Family Native Title Claim.

The archaeological survey component was undertaken by Snappy Gum Heritage Services. The survey was undertaken in June 2013 with Aboriginal stakeholders (i.e. representatives of the SWALSC and the South West Boojarah and the Harris Family Native Title Claim).

The desktop review of the Register of Aboriginal Sites using the DAA's online Aboriginal Heritage Inquiry System identified the following sites in the vicinity of the Project area:

- Abba River (DAA Site ID 17534);
- Abba River Mungar (fish-trap) (DAA Site ID 4399);
- Sabina River (DAA Site ID 17353);
- Woddidup Mission/Mulgarnup Mission (DAA Site ID 4401);
- Uligugillup Mission (DAA Site ID 17355); and
- Sabina River Camp Ground (DAA Site ID 17350).

Of these sites, only the Abba River (DAA Site ID 17534) occurs with the Project area (Figure 3-8).

No indigenous cultural material was recorded in the Project area during the archaeological survey.

Snappy Gum Heritage Services did note, however, that while the potential for the Project area to contain Aboriginal sites is low, there are some areas of remnant vegetation that may have subsurface undisturbed Aboriginal sites.

3.6.3 Potential Impacts

Potential Project-related impacts on heritage include the following:

- disturbance to a portion of the registered Abba River site (DAA Site ID 17534) where the proposed internal mine haul/access roads cross the Abba River (Figure 3-8);
- fencing and native vegetation enhancement works with the registered Abba River site (i.e. in the buffer corridor between the registered Abba River site and the proposed mining area); and
- potential disturbance to sub-surface aboriginal artefacts (currently unknown) that may be uncovered during mining operations.

3.6.4 Proposed Management of Potential Impacts

No objections to the Project were raised by the South West Boojarah or the Harris Family Native Title Claimants during the consultation undertaken by Ethnosciences for the ethnographic component of the Aboriginal Heritage Assessment.

Cristal would lodge an application under Section 18 of the WA *Aboriginal Heritage Act, 1972* (AH Act) for approval to undertake Project-related activities within the registered Abba River site (DAA Site ID 17534).

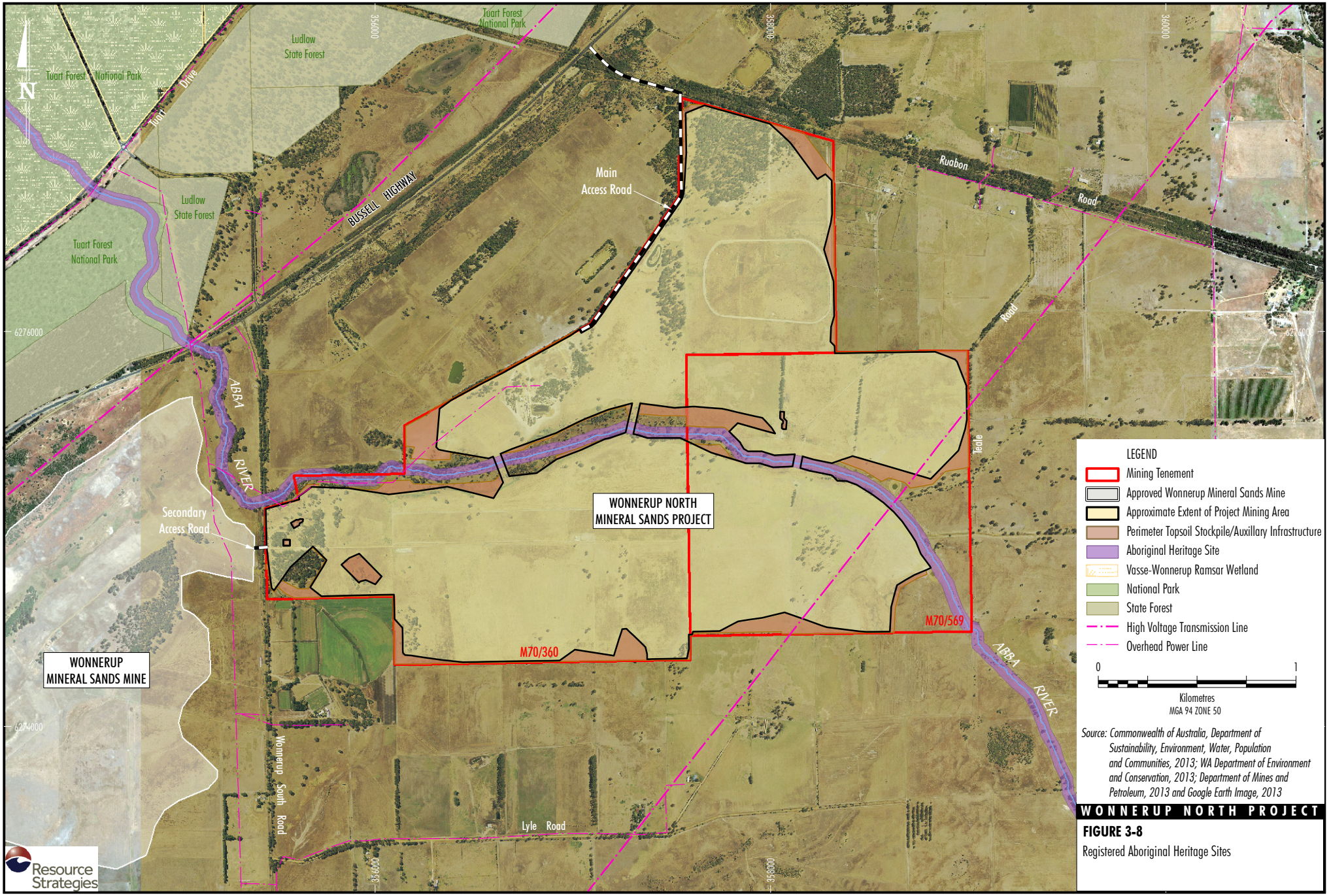

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FIGURE 3-8

Registered Aboriginal Heritage Sites

CMA-13-01_EPA Ref_210B

As indicated above, no indigenous cultural material was recorded in the Project area during the archaeological survey. Notwithstanding, Cristal would implement the following management measures during the mine life:

- land clearing within the areas of remnant vegetation would be monitored by trained members of the local Indigenous community;
- in the event that sub-surface aboriginal material is uncovered, work in the immediate area would cease and the DAA would be notified as required by Section 15 of the AH Act;
- in the event that any skeletal material is discovered, work in the immediate area would cease and the police and the DAA would be contacted as per Section 17 of the WA *Coroners Act, 1996*; and
- employees and contractors would undergo inductions regarding their responsibilities under the AH Act, EP Act and the Aboriginal heritage management measures for the Project.

3.7 REHABILITATION AND CLOSURE

As described in Section 2.7, sand residues generated at the wet processing plant would be placed behind the active mining area and would be progressively rehabilitated during the mine life. It is expected that the final rehabilitated land surface would be the same or very similar to the pre-mining topography. The final land use would be determined in consultation with the relevant Government agencies and landowners; however it is expected to be predominately agricultural, with some areas of native vegetation.

In June 2011 the EPA and DMP released the jointly prepared *Guideline for Preparing Mine Closure Plans* (DMP and EPA, 2011). The stated aim of the guideline is to ensure that a planning process is in place so that WA mines can be closed, decommissioned and rehabilitated in an ecologically sustainable manner, consistent with agreed post-mining outcomes and land uses, and without unacceptable liability to the State.

Cristal would develop a Mine Closure Plan which would provide details of how the closure planning and rehabilitation of the Project would be carried out in a co-ordinated, progressive manner. The Plan would be prepared in accordance with the G*uidelines for Preparing Mine Closure Plans* (DMP and EPA, 2011) and in consultation with the DMP, EPA and other relevant stakeholders.

Cristal anticipates that the Mine Closure Plan would include, but would not necessarily be limited to, the following:

- identification of closure objectives and commitments;
- identification and management of closure issues;
- development of completion criteria;
- financial provision for closure;
- details of the closure implementation strategy; and
- details of the closure monitoring and maintenance programs.

As is the case at the existing Wonnerup Mineral Sands Mine, local provenance seeds and propagating material would be used in areas rehabilitated to native vegetation communities.

4 CONCLUSION AND DISCUSSION OF THE EPA'S SIGNIFICANCE FRAMEWORK

The proposed Project would be very similar to the existing Wonnerup Mineral Sands Mine, which has been successfully operated by Cristal since late 2012. The type and scale of mining activities would be the same, and the on-site mineral separation would be conducted using the relocated Wonnerup Mineral Sands Mine plant. Road haulage of heavy mineral concentrate to Cristal's mineral separation plant in Bunbury would use the Bussell Highway, as per the current practice.

The proposed mining operations would be relatively shallow (i.e. generally within 3 m of the surface, and up to a maximum of 5 to 6 m). They would also be conducted relatively quickly (i.e. each section of the active mining pit would generally be mined, backfilled with sand residues, and re-profiled within 12 to 18 months).

The Project would provide direct employment for a construction workforce of approximately 50 employees and an operational workforce of 80 employees. It is expected that many of the existing employees would transfer across to the Project from the Wonnerup Mineral Sands Mine when it ceases operation in 2017/2018. Extraction of mineral sands from the mine would contribute to Western Australia's export income, royalties and State and Commonwealth tax revenue.

Over the eight year mine life, Cristal would progressively rehabilitate the mine landforms to a final land surface that would be the same or very similar to the pre-mining topography. The final land use would be determined in consultation with relevant Government agencies and landowners, however it is expected to be predominately agricultural, with some areas of native vegetation. Fencing and native vegetation regeneration works would also be conducted along the Abba River during the life of the Project. These works would protect and enhance the existing remnant vegetation along the River, which is registered as an Aboriginal site under the AH Act.

The existing Project area has been significantly altered from its pre-European condition through a long history of agricultural practices. Approximately 89% of the Project area has been completely cleared of the original native vegetation communities and now consists of cleared pasture with occasional paddock trees. The understorey of most of the remnant vegetation that occurs within the Project area was found to be in degraded or completely degraded condition. The exception is the remnant vegetation along the Ruabon Road reserve, parts of which are considered by Astron to be in good to excellent condition. However, disturbance to these areas through the widening of Ruabon Road would be reduced to the practicable minimum (i.e. less than 0.5 ha in total), and would be avoided altogether if possible during the detailed design phase.

The degraded condition of the native vegetation limits the habitat potential of the Project area for fauna. Notwithstanding, several conservation significant species have been recorded (e.g. the Southern Brush-tailed Phascogale, Western Ringtail Possum, Carnaby's Black Cockatoo, Baudin's Black Cockatoo, and the Rainbow Bee-eater). All of these species and their habitat occur more widely in the region. However, in order to minimise the potential impact of the Project on these species, Cristal would develop and implement appropriate fauna management measures during the life of the Project.

The Project is located in a rural area. As a result, the number of potentially sensitive residences in the vicinity is limited. Potential Project-related impacts on these landholders include drawdown of local groundwater levels affecting other users, noise from the operations affecting the amenity at nearby residences and alteration of the existing landforms causing visual impacts.

The groundwater modelling conducted to date indicates that the drawdown of the superficial aquifer caused by Project mining activities would be predominately limited to the immediate pit area, with very little effect beyond the mining tenement boundaries. Abstraction of groundwater from the underlying Yarragadee aquifer to meet the Project water demand would also result in a localised drawdown effect.

The preliminary results indicate that pumping at a rate of 1.6 GL/annum over the life of the Project would result in a maximum predicted drawdown of approximately 4.6 m at the nearest non-Cristal owned Yarragadee production bore.

Cristal has established a network of groundwater monitoring bores around the proposed mine site and would use these to measure the impact of the Project on the local aquifers. In the event that the monitoring indicates that water level changes are greater than predicted, or are likely to be if no action is taken, Cristal would implement appropriate mitigation strategies or contingency measures. These may include, but would not necessarily be limited to: reducing the volume of abstraction from the production bore to minimise drawdown effects; and enactment of appropriate compensatory measures for other users if required.

Cristal has conducted preliminary noise modelling of the Project. The results indicate that the Project would be able to comply with the prescribed noise criteria, subject to Cristal implementing appropriate noise management controls. As per the existing Wonnerup Mineral Sands Mine, Cristal would prepare and implement a noise management plan for the Project, which would provide details of the noise control measures and monitoring program.

Cristal would lodge an application under Section 18 of the AH Act for approval to undertake Project-related activities within the registered Abba River site (DAA Site ID 17534). No indigenous cultural material was recorded in the Project area during the archaeological survey. Notwithstanding, Cristal would implement management measures during the mine life to manage Aboriginal heritage aspects (i.e. monitoring of land clearing activities, protocols to be used in the event of sub-surface material being uncovered, inclusion of a heritage management component in the mine site induction program).

Cristal would develop a Mine Closure Plan which would provide details of how the closure planning and rehabilitation of the Project would be carried out in a co-ordinated, progressive manner. The Plan would be prepared in accordance with the G*uidelines for Preparing Mine Closure Plans* (DMP and EPA, 2011) and in consultation with the DMP, EPA and other relevant stakeholders.

Discussion of EPA's Significance Framework

Cristal has considered the EPA's Significance Framework for determining the likely significance of impacts in relation to a proposal (i.e. EAG#9). As discussed in Section 3, the environmental factors relevant to the Project are:

- hydrological processes;
- flora and vegetation;
- terrestrial environmental quality;
- terrestrial fauna;
- amenity;
- heritage; and
- rehabilitation and closure.

Each of the above environmental factors has been evaluated in terms of whether or not the Project is likely to meet the EPA's environmental objectives. Cristal believes that the Project can meet all of the EPA's objectives. Figure 4-1 illustrates Cristal's application of the EPA's significance framework to the Project.

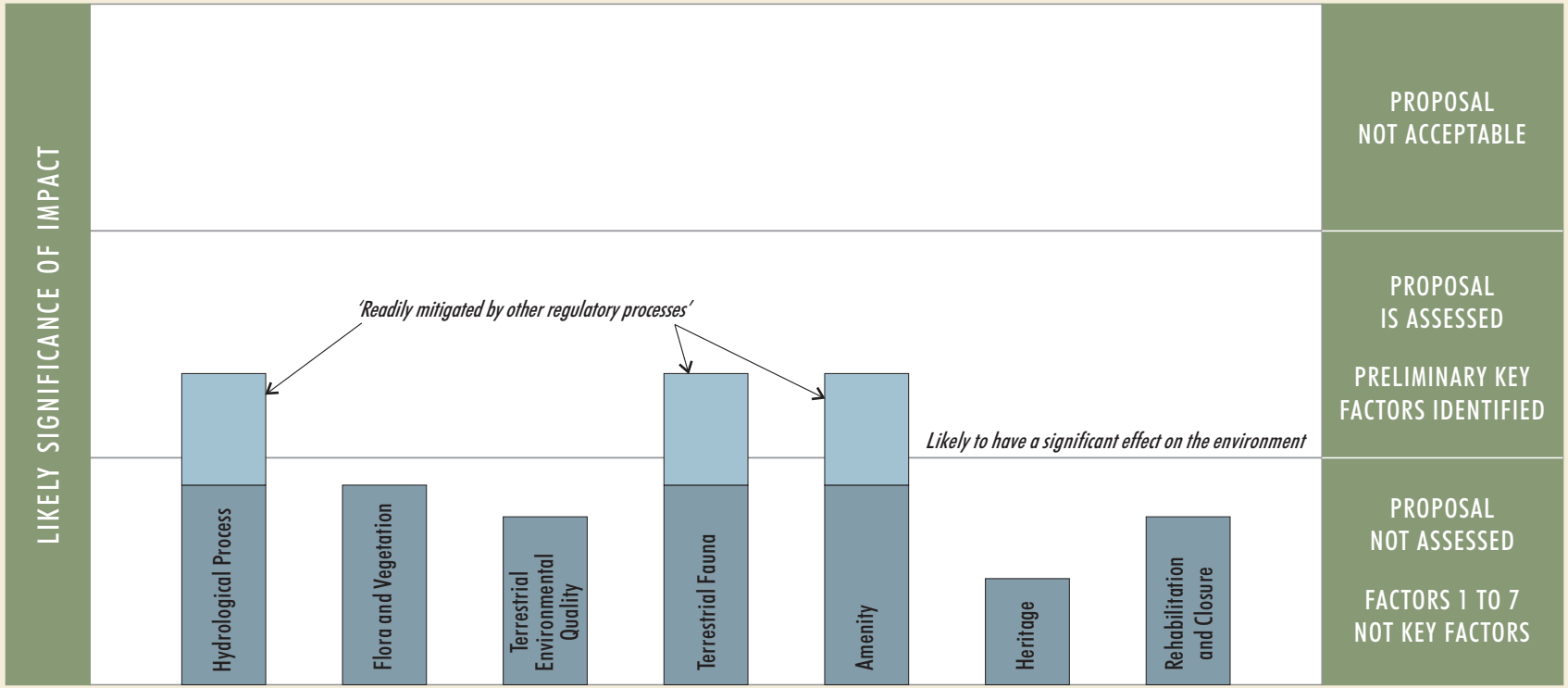

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FIGURE 4-1
Application of the EPA's Significance Framework to the Project

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